M - ELROB 2010

The European Robot Trial

INFANTRY SCHOOL

HAMMELBURG

GERMANY

17. – 20. May 2010

Bundeswehr

M-ELROB 2010

The European Robot Trial

Infantry School Hammelburg
Germany

17. – 20. May 2010

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2010

Welcome Notes

Dear Guests, dear Visitors!
Welcome to ELROB 2010

As a result of the ongoing fundamental global changes, the mission spectrum of our armies today is more comprehensive and complex than ever. The current operational environment includes a great variety of challenges for all actors in theatre.

Especially our military forces are exposed to a wide range of threats like improvised explosive devices (IED), suicide attacks, landmines, kidnapping, snipers and ambushes. Therefore, protection of our soldiers has top priority as urgent requirement for the accomplishment of military missions. Moreover, potential adversaries are constantly adapting and improving their tactics and techniques.

Five years ago we have initiated a future oriented and innovative process in order to cope with some of these challenges: In 2004 we have started to investigate fields of applications for robotics in the army in a joint and multinational effort in close cooperation between the German Armaments Directorate and the defence industry. The European Land Robot Trials (ELROB) were conducted for the first time in 2006 and provided an excellent overview of unmanned ground vehicles.
This success story continued with ELROB 2008. Ways and means to effectively support our soldiers on current operations and missions in the foreseeable future clearly became the main effort. Even more today, in the face of the ongoing operation in Afghanistan, the short-term realisation of creative solutions is important. Our soldiers are looking forward to benefit from the results of the fruitful cooperation of researchers, developers, industry and military. The expectations for ELROB 2010 are high once again!
The German Army and the Bundeswehr Armaments Directorate are hosting the European Land Robot Trial (ELROB) at the Infantry School in Hammelburg from 17th to 20th May 2010. ELROB is growing up and is certainly going to improve our knowledge with respect to key criteria like communication, autonomy, standoff capability and precision. For sure, the trials will be again extremely demanding for the teams. Yet, the race for the best and the most intelligent solution under challenging conditions drives our common effort and guarantees valuable results and insights. Several teams have already decided to accept the challenge and to participate in the 2010 competition.
Our soldiers are waiting for solutions that only become real through a constant dialogue between all relevant partners. To this end, ELROB 2010 will be a major communication forum for the continuously growing global community interested in the military use of robotics in support of land forces. The opportunity to discuss with subject matter experts from military, commercial and research organisations connects the elements of the robotics network.
This networking is the catalyst for the upgrading of key capabilities in order to enhance robustness, mobility, flexibility and situational awareness of the men and women who serve our countries abroad. This provides our soldiers with the necessary freedom of action and allows them to seize the initiative – wherever and whenever we deploy them.
I wish all visitors of ELROB 2010 a fascinating and rewarding week in Hammelburg.

Hans-Otto Budde
Generalleutnant

Word of Greetings from Ministerialdirektor Dirk Ellinger

FMoD Director General of Armaments

Germany is facing significant security challenges and must confront threats arising from international terrorism, the proliferation of weapons of mass destruction, regional conflicts and organised crime.

The Directorate General of Armaments of the Federal Ministry of Defence is conducting R&D activities to accelerate the development towards using unmanned vehicles on Bundeswehr operations. Unmanned systems relieve military personnel of the burden of routine tasks and improve flexibility during operations. They provide a significantly higher level of security by allowing our personnel to remain well outside the range of enemy weapons. We are therefore maintaining our focus in particular on unmanned ground vehicles.

During the past five years, the European Land Robot Trial (ELROB) has emerged as the leading outdoor robotics event in Europe. In 2008, more than 1,600 visitors from over 20 countries worldwide attended ELROB. ELROB 2010 will again focus specifically on military tasks in the field of land robotics. It is to point the way for feasible robotic systems for Bundeswehr missions and to contribute ideas for further studies and research.

In 2010, the European Land Robot Trial will again function as an effective instrument to intensify cooperation between industry, the R&D community and military users. Military and civilian decision-makers will use the event to learn about the current state of the art in the field of unmanned ground vehicles (UGVs).
As in the previous years, a high-calibre panel of independent judges will ensure that the evaluation of trials meets the highest scientific standards.

In 2010, an innovation prize will be awarded for the first time. It is to honour participants who have made outstanding contributions to research and development in the field of outdoor robotics. The panel of judges will decide to whom the prize goes.

I wish all participants in ELROB 2010 success and hope our visitors will enjoy an interesting and pleasant stay in Hammelburg.

Dirk Ellinger

Welcome Notes

Dear Guests,

„Modern by Tradition“, is the motto of the German Infantry, and thus, it has already become a tradition that the European Land Robotics Trials – ELROB 2010 – are held in Hammelburg for the third time now after the previous events in 2006 and 2008. The fact that the Infantry School has been chosen again to host this event impressively underscores the pace-making role of the Infantry in the fields of robotics and other future technologies.

Multinational operations worldwide on the one hand and continuous technological progress on the other largely determine the increasingly complex tasks for today‘s armed forces. These changes have also shaped the image of the Infantry School enormously. As a modern service provider, we feel committed to the aim of the transformation of the Bundeswehr in general and to the „enhancement of our operational capabilities“ in particular.

Infantry troops are required not only in certain situations within any given military operation, but they are vital in a broad spectrum of conflict. Hence, our overriding aim is to train well equipped, properly motivated ground troops with distinct Infantry capabilities for multinational operations.

The increasing need for robotic systems for all applications becomes apparent against the background of current operational experience combined with the Infantry‘s focus on the future and on the integration of state-of-the-art technologies. Robotics offers great potential for the future due to its high efficiency and untiring precision also over extended times, giving the protection of our soldiers‘ life and limb top priority.

Exposed to the effects of enemy weapons because of the nature of dismounted close combat operations, the Infantry have a great interest in the use of robotics that may reduce the risk to human lives and the numbers of personnel required. Thus, the reconnaissance and transport capabilities of modern, largely autonomous robotic systems generate special interest among Infantrymen. Such applications are reflected in the taskings for the various trials courses presented during this year‘s ELROB.

Let me welcome you very cordially to ELROB 2010 at the German Infantry School in Hammelburg under the motto of „The Infantry as the engine of future development and of the employment of robotic systems“.

I wish you an interesting and pleasant stay at our Infantry School and remain,
For the Director of Infantry and Commandant of the Infantry School

Sincerely,

Peer Luthmer
Colonel
Assistant School Commandant

Welcome to ELROB 2010. This is the third instantiation of the military version of ELROB. Already today more than 5000 robots are in daily use by soldiers around the world as part of their work. Robot use ranges from EOD to scouting and logistics tasks. All of these applications are important to military and security operations. Typical systems are still operated predominately by tele-operation with little or no autonomy. It is evident that use of systems primari,o users.

It is, however, characteristic that few of the systems available today have been extensively evaluated prior to deployment. An important role for ELROB is to provide a comparison and evaluation of ground robot systems across applications such as basic mobility, scouting, EOD, convoying, etc. Such tests are essential for many different reasons. Firstly, the trials provide important information to military authorities in terms of current maturity of technology. It is also important for vendors to provide baseline comparison of systems to understand current limitations and needs of end-users. Secondly, ELROB provides an important venue for academics to identify and understand current research challenges in terms of both technology transfer from research and basic problems that remain unsolved.

The umbrella organisation EuropeanRobotics organises European Land Robotics challenges for both military and civilian contexts, alternating between the two. The last CELROB (civilian) event took place in Oulu, Finland in June 2009. A total of ten, almost all university, teams engaged in competitive real-world trails within the four categories of autonomous driving, transport (robot mule), reconnaissance and premises security. In all cases, highest marks were awarded for maximum autonomy, i.e. achieving the goals of each scenario with the least manual intervention. These demanding trials provided teams of robotics students and their professors with an extraordinary insight into the gap between current robotics research and the unforgiving demands of real-world operation, and the needs of end-users.

The military ELROB addresses the fact that it is generally difficult for companies to get access to user feedback from systems used in theatre. ELROB offers a unique insight into possible use cases. ELROB is thus an important event for all participants including end-users, providers, institutes, and universities.

To foster new and future looking innovation up to four special Innovation Prizes will be awarded. The purpose of these prizes is to recognize new ways of solving the challenges - approaches that are judged to have very strong potential.

It is our hope that ELROB can provide important insight into state of the art for military use of ground robotics and be a valuable resource in further dissemination of UGV technology.

Contact information: *EuropeanRobotics*
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Technological trends in the field of land robotics

In the current Bundeswehr missions abroad, the soldiers are exposed to permanent dangers as a result of asymmetric threats. Thus, particular attention needs to be paid to an effective protection of the soldiers in the execution of their mission and also to the capabilities of intelligence collection and reconnaissance. Even today, unmanned systems are used in the forces and provide support in operations. The scope of operations of unmanned systems – either already in use or still under development – comprises land, air, and sea. Land robots are still a major challenge since mobile systems are operated in most diverse environmental conditions in which dynamic obstacles such as vehicles or persons need to be considered.

Since 2006, the ELROB event has been held alternately as military event in one year (M-ELROB) and civilian event the other year (C-ELROB), with both events showing the products and the potential of European industry and universities in the field of land robotics. Innovative concepts such as a water surface detection by means of a passive optical system will be presented alongside miniature systems that can be employed in buildings (ready to use, remote controlled or semi-autonomous).

In the Bundesamt für Wehrtechnik und Beschaffung (BWB – Federal Office for Military Technology and Procurement), Team U5.5 is responsible for the planning and coordination of military research and technology (R & T) activities in the field of land robotics. These activities include system demonstrators in various classes as well as research work in individual technologies. With respect to locomotion technology, for example, wheel and track drive systems have been researched regarding their suitability for use in military operations, and in sensor technology, up-to-date 3D laser scanners have been tested regarding the avoidance of obstacles and path planning. Long-standing R & T activities, tests on the system demonstrator and, once a year, the European Land Robot Trial (ELROB) currently merge into the first respective Bundeswehr procurement project: the MoSeS land robot.

Mobile Sensor System (MoSeS)

The MoSeS Mobile Sensor System with its modular structure will be used by reconnaissance forces as a mobile, unmanned and ground-based system where it will be an effective addition to the capabilities of reconnaissance in the armed forces thanks to optical and acoustic sensors. The system will identify local threats and as such indirectly contribute to the protection and security of own forces.
MoSeS features a weight of around 50 kg and an operating range of up to 1500 m and will provide situational information from largely unknown terrain. The system has been designed for operation in both vegetated areas and urban environments (i. e. on roads, under bridges, in underpasses and in buildings). For the purpose of safe operation in these difficult environments, MoSeS employs a large number of technologies. The most important technologies are described in the following sections.

Technological trends

Navigation

It is vital that miniature land robots of this weight class follow a defined route precisely since even slight deviations may lead to damage to the system. For this reason, the own position needs to be determined as exactly as possible, using GPS position data, odometry, and IMUs (inertial measurement units). In addition, failure or malfunction of the GPS signal can be compensated for by means of sensor data fusion. The challenge of the future will be the optimization of sensor data fusion as well as weight reduction and miniaturization of highly accurate inertial measurement systems.

Semi-autonomy

The control of land robots is aimed at relieving the user to the greatest possible extent. Assistance systems such as obstacle recognition and avoidance as well as autonomous crossing of terrain sections with difficult radio coverage support the soldier in accomplishing the mission. In addition, the robots should have the ability to autonomously follow a path of pre-defined points. During operation, autonomously created maps provide orientation and assistance in the further mission planning to both system and operator. In the future, the systems will create 3D maps of the environment and detect any objects in the area autonomously.

Sensor technology

The system provides high-quality reconnaissance sensorics that can be installed on the sensor carrier and remotely controlled by the user: high-resolution day and night vision cameras, precision laser range finders as well as sensitive microphones for the detection of sources of sound. For the purpose of navigation and environment recognition, further sensors are integrated which will be used for semi-autonomy. Today, active sensors such as laser scanners, ultrasonic sensors or radar yield the best results in this respect. For the future, a challenge will be the use of passive sensors for the purpose of three-dimensional environment recognition.

Communication

Today, the COFDM modulation scheme (coded orthogonal frequency division multiplex) via broadband is used in urban environments for a stable data transfer of reconnaissance sensor data of land robots. It offers high stability against multi-path reception as caused e. g. by reflections from walls and can thus also be used to good effect within buildings. In the future, the focus of research work will lie on technologies that function reliably in both urban as well as open and wooded areas.

Ergonomics

So far, there has only been little research on ergonomic aspects of the control of mobile systems. If mobile systems are remote-controlled, the operator is confronted with a high level of stress due to wiggly camera images and a restricted field of view. Although there are technologies available that produce judder free camera images, research has shown that this reduces the feeling for the mechanic load acting on the system which leads to operation of the system beyond its load limit. A future challenge will be the realization of a control that is simple and intuitive at the same time.

Integration
An additional challenge lies within finding an optimum compromise between the opposing qualities

- long mission time,
- low volume and weight,
- high-resolution sensors,
- high computing power, and
- powerful drive.

The optimum selection of components must be integrated into a common system and all elements must be connected with each other via flexible hardware and software architecture. This approach ensures that the system remains understandable and maintainable – also with a view to future development work.

ELROB 2010

As in previous years, the ELROB will also in 2010 demonstrate the technological state of the art and serve as a display area for innovative ideas for further development of the presented technologies. With respect to land robotics, a pronounced performance enhancement potential stands to be expected. The exploration of the possibilities offered by the use of autonomy and the employment of new types of sensors for environment recognition in particular, but also by the connection to the existing Bundeswehr infrastructure via NetOpFü has just begun.
The ELROB 2010 will certainly give an impetus towards the development of concrete measures so that in the future, further capability gaps with respect to semi-autonomous and unmanned systems can be closed – beyond MoSeS.

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M-ELROB 2010 – Real Military Tasks in a Real World Scenario

The third military serial of the European Land Robot Trials (M-ELROB) directly ties in with its preceding events, however, its focus will be on the future employment of autonomous, unmanned systems for the support of soldiers on operations. A joint project of the German Army and the Bundeswehr Armaments Organisation, M-ELROB aims at driving ahead the technical development of unmanned systems for employment by the military in Europe – in particular of Unmanned Ground Vehicles (UGV).

In the course of Bundeswehr operations abroad, soldiers are the targets of attacks almost every day. They have to face unknown threats to fulfil their missions. Ensuring the physical integrity of deployed service members is of high priority and an essential prerequisite for the performance of military tasks. It is therefore crucial to consider technological developments early enough to provide comprehensive protection for the soldiers. One option is the employment of unmanned systems to minimise exposure to threat situations.

The foundations have already been laid; unmanned systems can take over military tasks. As they are exposed to the threat instead of the soldier, they essentially contribute to his protection. This concept is not entirely new. The use of remote-controlled EOD systems and reconnaissance UAVs has become routine for Bundeswehr personnel. On operations, Unmanned Airborne Systems (UAS) such as the LUNA, ALADIN and MIKADO reconnaissance UAVs provide valuable intelligence without exposing operators to a direct threat. Unmanned Ground Systems (UGS) such as the tEODor manipulator vehicle are commonly used for EOD operations.

All these systems have one thing in common. They are remote controlled and do not have any autonomous functions. Without autonomous functions, though, the soldiers are not really relieved. A reconnaissance patrol becomes more effective if the soldiers no longer have to worry about how the unmanned system is going to reach its reconnaissance target. Systems that detect threats autonomously by scanning the environment are more effective than soldiers who might be distracted at the wrong moment. Autonomy is the challenge we need to master to achieve progress in technical developments and to turn remote controlled robots into autonomous unmanned systems.

While continuously relying on existing remote-controlled systems, the German Army as the mainstay of land operations must try and embark on the development of unmanned autonomous systems.
It must be ensured that systems are put into use as quickly as possible which relieve the soldier and enhance his protection.

The Challenge of Autonomy

What makes a robot an autonomous unmanned system? Apart from mobility, sensors and an actuator system, autonomy plays a decisive role. Strictly speaking, remote controlled systems or industrial robots are not autonomous systems, they are rather referred to as manipulators. To obtain the capability for autonomy, the challenge is to scan the environment

electronically so that intelligent algorithms can access a coherent, digitalised situation picture with a low latency and a high repetition rate. This sounds complicated, which indeed it is, because autonomy is the essential challenge. In the face of this challenge, many institutes, universities and companies are working on different solutions and approaches.
Autonomous land movements present considerably more complex challenges in terms of environment scanning than aerial movements do. The mere effort of combining data from several sensors to a common reproduction of the surroundings as part of what is referred to as sensor data fusion is a tall order. The fusion of data from several identical sensors (e.g. for covering the entire surrounding area) is a complex task, let alone the fusion of data from different types of sensors (e.g. video and laser scanners). At increased speeds, the situation picture must be available in near real time; moreover, the repetition rate must be high enough. If neither condition is met, the robot‘s movement cannot but be unstable. Even if data fusion is achieved, the task is not yet accomplished. The situation picture still has to be interpreted. Routes, obstacles, persons etc. must be identified. Complete autonomy depends on the learning ability of the system, i.e. artificial intelligence features need to be employed.

Unmanned, Autonomous Systems for Military Tasks

The technology domain of military robotics offers armies the opportunity to achieve a capability gain in almost all capability categories. As for the opportunities offered by such systems, the efforts of the Army are determined by two factors. The top priority is on minimising the risk to our deployed personnel and thus on improving force protection on operations. The focus is on unmanned systems enhancing the soldiers‘ protection. As a consequence, considerations regarding unmanned warehousing, for example, have been deferred.
The second factor is to extend the Army‘s capabilities and operational spectrum, for example by improving in-theatre reconnaissance or tactical mobility by means of unmanned systems. Unmanned systems are meant to complement and improve the capability profile of the Army and of the armed forces as a whole. In this context operational requirements are the benchmark.

In addition to existing unmanned systems, the German Army intends to identify armaments projects that can be realised in the near future to protect deployed soldiers even better from immediate threats. It will be necessary in this context to give up wishful thinking, e.g. full autonomy, and prioritise feasibility instead. The European Land Robot Trials are a generally accepted means to assess technological developments and to evaluate their feasibility.

Objectives

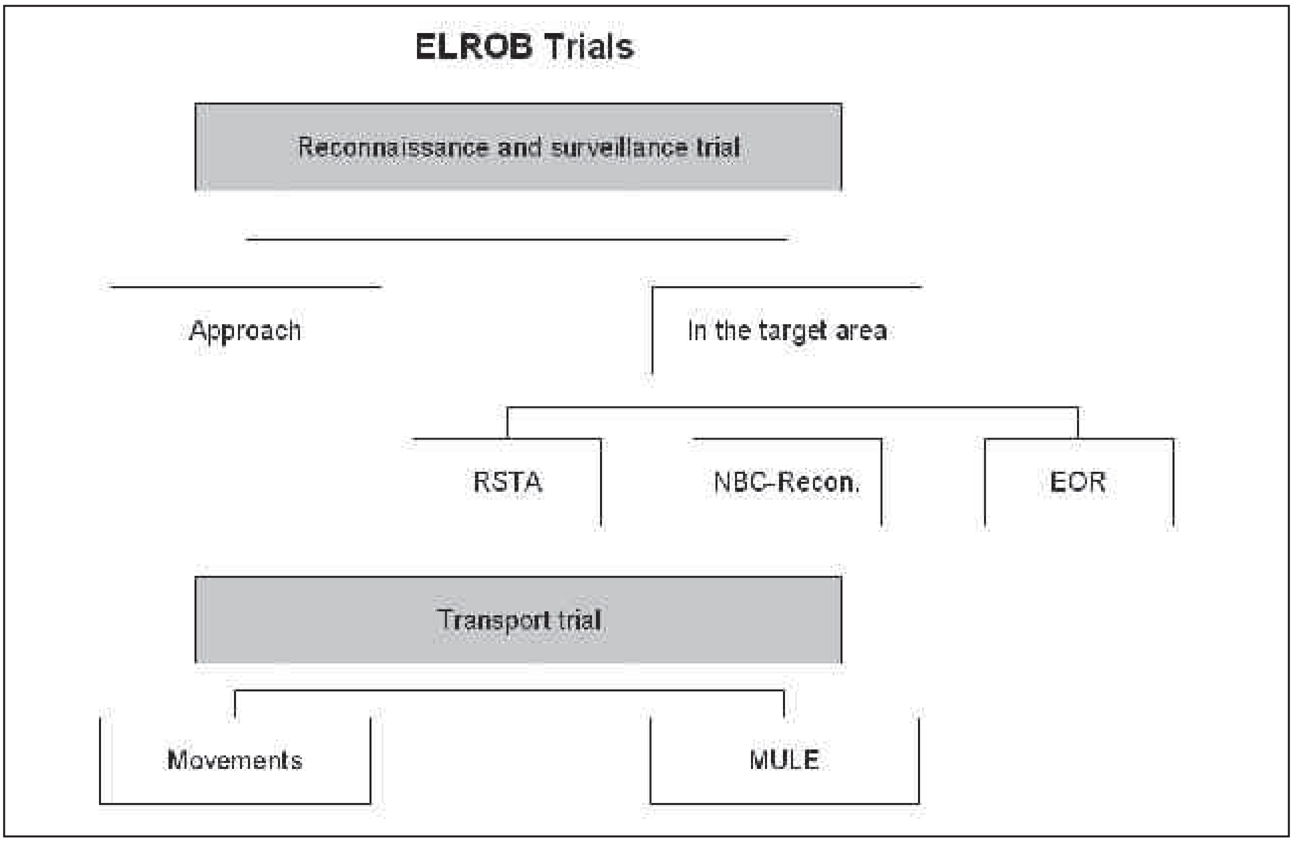
The objective of this year‘s trials is clearly focused on the military tasks to be supported by the employment of unmanned, autonomous systems in the future: Reconnaissance and Transport.

The centre question will be whether unmanned, autonomous systems can effectively support our soldiers on operations in the foreseeable future. The organisational features of ELROB 2010 provide a large number of interested parties an opportunity of taking part. Either complete and serviceable systems or modular solutions may be presented. ELROB

2010 tries to identify the systems and/or modular solutions that offer technical short- or medium-term approaches for the German Army's priority requirements.

For defining the trials, the requirements of the Army's arms and services regarding future applications for robotic systems were collected and evaluated first. This year's „Reconnaissance and Surveillance" and „Transport" trials reflect the areas of application.

Tasks



The Reconnaissance course is divided into two subject areas. The task for the participating systems in the "approach" trial is to cover a distance of 3,000m through wooded terrain as autonomously as possible. In the "target area" several military tasks are assigned. Participants can choose whether they want to solve general reconnaissance tasks (e.g. threat detection) or special tasks such as explosive ordnance reconnaissance (booby trap detection), or NBC reconnaissance.
Both parts of the reconnaissance trial have to be accomplished by day and night. In spite of the fact that, from a military standpoint, reconnaissance capability even or especially at night is a matter of course, ELROB is, for all the organisers know, the only event worldwide where a such a trial is conducted at night. Land robots as well as mini-drones have been entered for this trial.

The transport course is composed of two independent tasks: In the “movements” trial, participants are to follow a manned vehicle with an unmanned system over a longer distance at high speed and with maximum autonomy. In the “mule” trial, the participating systems are to transport loads in a shuttle service between two places as often and as autonomously as possible.

These tasks make high demands on the participants. This did not discourage 14 active participants and 45 exhibitors from 8 European nations from entering ELROB 2010 when this catalogue went to print.

The range of participating systems reaches from commercially available products to prototypes to genuine test rigs. The fact that several universities will be involved in the subject area of autonomy fuels hopes for valuable input.

Those facts prove again that ELROB is a highly successful and efficient tool to enhance the required synergetic effects of intensive co-operation between the robotics community and the users.
One of the key objectives of the event is to fill the gap between users, researchers and industry in the area of unmanned systems.
The Armaments Directorate supports this process through its consistent research and development strategy in this field.

This year’s event will again be a combination of field trials and a concurrent exhibition, offering an international audience of experts from the military, industry and research communities a forum for exchanging ideas. This year‘s European Land Robot Trials are designed to adhere to their tried and tested philosophy:

- ELROB is conducted to provide an overview of European state-of-the-art technology in the field of unmanned vehicles with focus on short-term realisable robot systems.
- ELROB is explicitly designed to assess current technology to solve real world problems at hand.
- ELROB also is an opportunity to bring together users, researchers and industry to form a community.

ELROB is not conceived as a „competition“ with high-tech visions but meant to demonstrate what is currently technically feasible in the field of robotics, to promote useful technological developments in Europe and to network innovative people in this field.

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Contributing Institutions

at

M-ELROB 2010

AIM Infrarot Module GmbH

Infrared Devices

See page 154

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- Static Display

AIM INFRAROT-MODULE GmbH, based in Heilbronn, Germany, belongs to a small elite of suppliers for premium infrared detectors and thermal sights as well as Stirling cooling engines required for the operation of detectors at cryogenic temperatures. The high-tech company combines all core competencies for development and production under one roof, from IC design, pcb development over semiconductor material technology including crystal growth to optics and precision engineering.

UAVs have become an inevitable recce tool for mission success and survivability. AIM detectors are the eyes of the KZO UAV. For the LUNA UAV AIM even moved one step higher on the integration level and fielded her first fully integrated FLIR. For the ALADIN UAV, weight limitation required the use of AIM‘s uncooled FLIR.

After the success of the LUNA FLIR, AIM developed in short time the thermal weapon Sight HuntIR, which was selected for the German soldier modernisation program "Infanterist der Zukunft" (IdZ) for surveillance and long range targeting. HuntIR was also selected as thermal sight for acoustic shot detection systems to pinpoint the shot-location and detect the shooter at night. For the enhanced system of the German SMP program IdZ-ES and to fill the capability gap of a day/night sight for the 40mm AGL, a new sight was developed under the brand name RangIR, an upgrade of HuntIR with eyesafe laser range finder, digital magnetic compass and ballistic computer for outstanding first round hit probability at long ranges. For IdZES, the so called WBZG is additionally equipped with a bidirectional data link.

Today's R&D activities are focused on improved resolution of FLIRs e.g. as upgrade for the LUNA UAV. Key component is a new generation of detectors with very small pixels which allow full TV resolution in the same form factor as the so far used ½ TV detectors. New application categories are emerging due to detectors measuring the time of flight of an invisible eyesafe IR-laserpuls and thus generate a highly resolved 3D „LIDAR“ image or due to highly resolved „hyperspectral“ technology for improved change detection with the goal to improve C-IED techniques.

AirRobot GmbH & Co. KG

Air Robots

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- Static Display
- Open Display

- Reconnaissance and surveillance - Approach
- Reconnaissance and surveillance - RSTA
- Reconnaissance and surveillance - EOR / CRNE

Airrobot is a German manufacturer for unmanned aerial systems with unique technology. The current system, the AirRobot AR100-B is a micro unmanned aerial vehicle with vertical take off and landing. Due to its advanced technology with extensive autonomous flight management and stabilization, operation is easy to learn and does not require prior flight experience. When the aircraft does not receive a command, it immediately initiates auto positioning, autonomously maintaining altitude, absolute position and heading. The operator can fully focus on his or her mission.

The modular payload concept enables the user of the AirRobot to swap the available cameras and sensors within seconds in order to respond quickly and effectively to changes in mission requirements like a change from day to night operations. Video and data are displayed and saved in real time on the ground control station. Currently available payloads include daylight color -, b/w low light imager -, IR thermal image - as well as high resolution still cameras. Sensors for gas detection can be integrated into the payload as well.

The AirRobot provides a valuable asset for applications in Law Enforcement, Armed Forces and Defense, Border Security, Fire Brigades / Disaster Relief, Search and Rescue, Special Operations and Intelligence. It substantially enhances situational awareness by providing crucial real time information during operations, resulting in improved public safety and the protection of those, working for it.

Especially in Defense and Counter Terrorism, Micro UAS Systems (MAS) like the AirRobot will be essential instruments for unmanned ISR (Intelligence, Reconnaissance, Surveillance) operations in the near future. As partner of the German Armed Forces under the program name MIKADO, Airrobot will take a key role in formulating the future of Micro UAS within the future force structure.

The development of multiple new technologies, both to enhance safety and reliability, as well as to extend operational capabilities is constantly pursuit. Two milestones will be the completion of auto collision avoidance, and the introduction of a larger system, AR150 with a new propulsion system increasing efficiency in early 2010.

In addition AirRobot GmbH & Co. KG is a partner in several active EU projects. The AirRobot flight platform is an integral part of developments focusing on relevant security applications, specifically mine detection, early fire detection and perimeter security.

Allen Vanguard Ltd

Ground Robots

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- Static Display

- Reconnaissance and surveillance - RSTA
- Reconnaissance and surveillance - EOR / CRNE

Allen Vanguard™ is a global leader in developing and providing equipment, services and training to protect against hazardous threats, including Improvised Explosive Devices (IEDs), Radio Controlled IEDs (RCIEDs), Chemical, Biological, Radiological, Nuclear threats, and the effects of heat on military personnel and combat vehicle electronics. Its products and services are trusted by elite military and police forces in over 120 countries worldwide.

The company operates in close collaboration with end users and program managers to develop and field solutions for sustainable capability against these evolving threats. Its product development efforts are founded on aggressive research engineering programs, and the deep front line experience of its industry-specific experts. This team includes world-leading subject matter experts, trainers and decorated practitioners in Counter-IED and many related fields. Their experience has been earned from many years of front line operations in combat theaters involving thousands of hazardous devices and a deep understanding of threats and tactics.

The company's research and analysis, engineering and technical staff include experts in blast mitigation, Radio Frequency exploitation, robotics, chemical-biological agents and decontaminants, and thermal management as well as other disciplines such as materials and human physiology. These are further supported by the company's rapid prototyping capabilities in support of continuous product development programs.

Allen Vanguard™ provides its customers with industry leading equipment such as its Electronic Countermeasures (ECM) platforms to prevent the detonation of RCIEDs, the Med-Eng bomb suit, the Defender and Vanguard® bomb disposal robot systems, CASCAD™ blast suppression and decontamination foam, and vehicle survivability systems comprising customized cooling systems and blast protection seats.

The company has Sales and Manufacturing facilities in the United States, Canada and the United Kingdom, with staff and facilities cleared for classified programs.

Contributing Institutions

BASE TEN SYSTEMS Electronics GmbH

Ground Robots, Alternative Communication Systems

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- Static Display
- Open Display
- Transport-Movements
- Transport-Mule
- Reconnaissance and surveillance - Approach
- Reconnaissance and surveillance - RSTA

About BASE10

Thirty years ago BASE10 pioneered the implementation of civil market microprocessor technology into military equipment. Today, BASE10 as a system house and main contractor to the German MOD creates RoboScout, an Unmanned Ground Vehicle helping our soldiers to protect us.
BASE10 - a small company pioneering great ideas.

Company Focus

BASE10 is a project focused company. Our home is the defence market within NATO. Since our formation we have undertaken over 100 military projects. Typically, these projects incorporate systems engineering, multi-disciplined teams, system integration, system qualification, manufacturing and long term support.

Core Skills

System Design

BASE10 system designers are experts in selecting appropriate trade offs between COTS and bespoke Hardware, Software and physical design to meet demanding total system requirements.

Hardware Design

BASE10 hardware designers make use of the latest computer aided tools to produce high performance and high availability hardware that will operate in the harshest, often safety critical environments.

Software Design

BASE10 software engineers work closely within integrated teams to produce both embedded and standalone software applications.

Mechanical Design

In order to meet demanding environmental, thermal, shock, vibration and EMC performance requirements BASE10, as part of a multi disciplinary approach, often employs in house specialist mechanical design skills

Qualification

BASE10 qualifies its products, where requested, to the required military and customer standards. The generation of qualification records and test results, often in form of a Declaration of Design and Performance, enable the customer to apply for flight clearance

Manufacturing

To provide a complete end to end capability BASE10 also offers small to medium scale manufacturing capability. Typical production runs range from 1 off to several hundred units.

Service

BASE10 maintains its whole product range at the customer‘s site or in his own product support department for all levels of Logistic Support.

BFFT GmbH

Video, Audio and Telemetry Surveillance Systems

See page 170

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- Static Display

Complete construction of vehicle systems is complex and calls for ample vertical integration. We have grown with the demands of the automobile industry and today have a wide range of expert knowledge in essential areas of vehicle construction and vehicle technology at our disposal:

- Rapid prototyping
- Cases and mechanical components
- Infotainment
- Operator interface and operator assistance systems.

Our wide range of experience from the automotive can be your advantage. Would you like to lower your development cost significantly? We can draw a wide choice of high volume products from automobile market for your design.

Do you need support for one or more following topics?

- Software design
- Electronic design
- Bus systems (CAN, LIN, Flexray, MOST, Ethernet, USB)
- Display Units with DVI and LVDS control
- Alternative propulsion systems
- CAD (Catia V4 / V5, Cadds 5, ProE)

Do you require prototype vehicles for your customer base or visually appealing presentations of vehicle systems at trade fairs and customer presentations? Just talk to us.

Broadcast Microwave Services Europe GmbH

Video Transmission Systems

See page 169

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- Static Display

BMS Europe GmbH (Germany) - BMS Inc. (California, USA)

The Downlink Experts

Planning, manufacturing and service support for advanced wireless video (SD / HD) links and remote control systems.

Products include transmitter, receiver and antennas. BMS offers full system integration, frequency management as part of the OEM service. BMS products can be found on different UAV's since more than 25 Years around the world. Broadcast Microwave Services' (BMS) digital microwave systems are standards-based designs, ensuring interoperability and integration with security and defense systems.

Our systems are for use on aircraft, maritime and ground vehicles to collect critical information from safe distances. Video cameras mounted on unmanned aerial vehicles record information behind enemy lines and transmit the video and location coordinates back to command centers and tactical ground troops. Ground personnel can quickly analyze and respond to suspicious, volatile, or perilous situations. Access to this critical information fosters well-informed decisions, providing a major tactical advantage to ground troops while minimizing casualties.

The applications range from electrical-powered, ultra light short-range UAV-systems to long ranges of up to 100km including tracking (GPS-independent). OEM-solutions from low power to high power, frequency ranges from 100MHz to 7GHz give full flexibility to meet your needs.

Areas of interest:
Telemetry Systems (GPS; Control Data;...)
Wireless Video transmissions (SD / HD; Video over IP)
Unmanned airborne applications
Unmanned ground applications

BORMATEC unmanned vehicles

Ground Robots

See page 98, 128

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- Static Display
- Open Display

BORMATEC specializes in the development and manufacture of unmanned aircraft and vehicles. It concentrates on the platform. The vehicles are versatile and offer plenty of space for various applications. BORMATEC is a small company in southern Germany, which in addition to the development of vehicles including developed and manufactured remote-controlled of aeroplanes.

CT-Video GmbH

COFDM Audio-, Video- and Datatransmission

See page 147

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Website: www.ct-video.de

CT-Video GmbH was founded 1999 in Lutherstadt Eisleben, Germany and develops, produces and distributes analog and digital special solutions for wireless video audio and data communication.

The main field of activity are mobile, digital COFDM solutions, which are adapted to the special customer requirements; but also standard solutions are part of the diversified CT-Video product range. The systems are developed in-house and in close cooperation with the user.

CT-Video has not only a wide experience of engineering, but also a broad know how of the differing areas of application in the sectors authorities, automotive industry, fire departments, nuclear technology, etc. This guarantees the development of perfect functioning systems – also in very sensitive and security-relevant areas and difficult usage conditions.

Areas of Interest:

- Mobile radio solutions for the analog and digital transmission of video and audio data (including COFDM modulation)
- Camera technology including wireless and wired control
- Recording technology for video, audio and data signals
- Electric power supply components for a mobile use

Distance University of Hagen

Air Robots

See page 134

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- Static Display

The FernUniversität in Hagen is a university of the state of North Rhine-Westphalia. As the only distance-teaching university in Germany, it offers undergraduate and graduate degree programmes for professionals.

Their research groups in "Control Systems Engineering" (Prof. Dr.-Ing. Helmut Hoyer) and in "Mechatronics Systems" (Prof. Dr.-Ing. Michael Gerke) work closely together within systems engineering. Joint research in mechatronics and robotics is being conducted here.

Their research focus is in the area of stationary and mobile robot systems. Omnidirectional robot vehicles for heavy-duty transport and for assistive technology applications have been successfully developed in numerous projects. Not only innovations in vehicle technology, but also the principle of multi-sensor integration and increasing system autonomy are at the fore of the research work here.

The range of applications of distributed and heterogeneous robots has been extended recently, through mobile flight systems, to safety regulation requirements and catastrophe scenarios. A co-operation between terrestrial and airborne robots is intended to automate challenging operations (security and rescue). For example, teleoperated or partly autonomous mobile robot systems allow targeted and continuous 'monitoring' (observation and measurement) in critical areas of application.

A minuscule airship is currently being developed into a semi-autonomous sensor platform, which is distinguished by an extremely high dwell time and a stationary operation close to the ground. This flight system can be used for the early identification of hazardous situations, for reconnaissance and data acquisition ("view from above") and as a communication relay.

Co-operation with terrestrial mini-robots or sensor technology dispersed over the ground enables a powerful communication network to be created with the flight system.

To implement the described innovative robotic applications, the two research groups are contributing to national and international research projects.

EMT Ingenieurgesellschaft

Air Robots

See page 125

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- Static Display
- Open Display

Unmanned Airborne Reconnaissance Systems by EMT
The solution for all-weather day and night reconnaissance and surveillance

EMT, a medium-sized enterprise has been established in 1978 by Dipl.-Ing. Hartmut Euer. For more than thirty years innovative systems for Armed Forces are designed, manufactured and supported.
From the beginning, our ambitious goal has been and will always be the development of new products that are especially sophisticated technically and scientifically. Numerous patents have been applied for and granted up to the present day.
Quite a few of our attempts led to economically sustainable results and made our business a leading-edge manufacturer in special fields such as unmanned airborne reconnaissance. Our portfolio encompasses a growing family of UAV systems ranging from micro- and mini-drones to larger tactical systems. Several NATO countries and other nations employ our UAV systems on a worldwide scale.
Moreover, the military utilization represents only a comparatively small portion of possible applications. In the near future, when German and International Air Traffic Laws will have approved UAV to participate in general air traffic, the number of civil aviation applications will be many times greater than military ones.
EMT's guiding theme is the uncompromising technical product reliability. This is ensured on the one hand by high-quality components and manufacturing processes, on the other hand by consistent simplicity and design transparency of the basic technical conception. The modular design of our systems allows not only the easy exchange of different payloads, such as optical sensors for day and night reconnaissance, radar sensors (SAR) or data link relay systems, just to name just a few, but also the integration of the ground station in hardened vehicles and cabins of different sizes supporting the drone systems' quick reaction deployment using helicopters.
For more than eight years the German Armed Forces (Bundeswehr) have exclusively and continuously been employing our UAV systems during their missions abroad – totalling more than 1000 missions a year.
The Bundeswehr refers to our LUNA drone system as a success story and states: „This medium-sized business with 150 employees is an extremely cost-effective and reliable partner of the Bundeswehr and is quickly adjusting to our requirements. The new tasks of the Bundeswehr, such as the participation in worldwide peace-keeping UN-missions, are being optimally supported by products of this firm. These multi-purpose reconnaissance drone systems enable the Bundeswehr to conduct their reconnaissance tasks for instance in Afghanistan or Kosovo from the air without endangering the lives of their troops."
EMT is a certified aviation company and supplier of military air vehicles.

Fraunhofer Institute (FKIE)

Ground Robots

See page 68, 88

Organization:	Fraunhofer Institute for Communication, Information Processing and Ergonomics (FKIE) – Research Group Unmanned Systems (US)
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- Static Display
- Open Display

The Fraunhofer Institute for Communication, Information Processing and Ergonomics (FKIE) employs currently 190 staff members, who perform studies in computer science and ergonomics with application to the defence research area of command & control, communications, intelligence, surveillance, and reconnaissance (C3ISR). There is a broad spectrum of single research topics. We deal among others with the development of modern target tracking procedures in a network of different sensors, with the selection and design of communication systems, with problems of information dissemination in radio networks – also over long distances - with the reconnaissance of location and property of transmission devices, with the condensed processing (fusion) and consistent distribution of data in complex Communication and Information Systems (CIS) up to the design and implementation of intelligent user interfaces.

The research group Unmanned Systems of the Fraunhofer Institute for Communication, Information Processing and Ergonomics (FKIE) is actively researching in the area of unmanned systems for more than 20 years. Our main expertise is the development and evaluation of complex human-robot systems. The main focus is on the RSTA and CBRNE-reconnaissance missions using heterogeneous multi-robot systems. Working with such multi-robot systems is a competitive task for the operator. Even a single robot utilizes several different sensors and provides a high degree of mobility, which all need to be controlled by the operator.

The research group Unmanned Systems approaches this challenge through intelligent assistance functions. The operator is supported by these assistance functionalities on all levels, ranging from navigating a single robot to complex planning problems of multi-robot systems. Assisting the operator is achieved by two key components. First, we enhance the autonomous capabilities of each single robot, and second, we reduce the burden on the operator through the assistance functions. Navigation algorithms like obstacle avoidance in dynamic environments as well as methods to improve the presentation of available information are both examples of such functions.

Fraunhofer Heinrich-Hertz-Institut

Sensors

See page 161

Organization:	Fraunhofer Heinrich-Hertz-Institut Department: Fiber Optical Sensor Systems
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Contributing Institutions

- Static Display
- Open Display

The department "Fiber Optical Sensor Systems" is one of six departments located at the Fraunhofer Heinrich Hertz Institute. The core skills lie in the development and production of innovative, miniaturized and fiber optic sensors and sensor networks, nanophotonic solution strategies for industrial applications in process control, process optimization for use in safety engineering, and intelligent sensorics in offshore wind energy plants and power cables. Intelligent cables through fiber-optic sensor systems for controlling load on wind energy plants and power cables, in order to forecast any possible outages at an early stage. For example, By means of optical processes, variables in cables such as spatially resolved temperate profiles, mechanical load and ozone concentrations are measured continuously as dimensions for corona discharge and then evaluated via the sensor network. The current topics of our R&D activities are:

Miniaturized fiber optic photoacoustic sensors for highly sensitive gas diagnostics and gas analytics in:

- the controlling of industrial processes (for example, for the early identification of fires, methane detection in mines)

- safety engineering (e.g. highly sensitive and selective detection of volatile explosive substances and acetylene detection in high-performance transformers)

- bio-med analyses (e.g. analysis of respiratory gas, measuring of oxygen or acetone) using photoacoustic spectroscopy (PAS), cavity ring-down spectroscopy (CRDS) and multi-pass absorption spectroscopy (MAS).

GeoTec

Fluorescence Scanner and Biosensors

See page 158

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- Static Display
- Open Display
- Reconnaissance and surveillance - EOR / CRNE

GeoTec is a small enterprise engaged in the development of a new airborne remote sensing technology. The technology combines genetically engineered whole-cell biosensors (soil bacteria) and scanning airborne laser technology to detect trace substances on the ground.

Biosensors are spread over an area of interest using crop duster planes. Once settled on the ground, the biosensors will start to interact with trace substances they were designed to detect.

Upon detection of a specific trace substance the biosensors start the massive production of fluorescent proteins in their cell envelopes. This works as a very powerful biological amplification of an otherwise very weak signal emitted from a trace substance.

In a following step the fluorescent proteins in biosensors are excited to emit fluorescent light. This is done using an airborne scanning laser system with a wavelength matching the biosensors. The laser system is capable to detect and geo-reference instantaneously the fluorescent light from biosensors on the ground.

This remote sensing technology is currently being developed in cooperation with the Fraunhofer Institutes for Laser Technology (ILT) and Molecular Biology (IME) with the main intention to field it in Humanitarian Demining operations (detection of single mines and minefields from the air, suspected mined area reduction).

The technology is equally suitable for the airborne detection of trace explosives originating from IEDs.

With different biosensors it shall be used for the airborne wide area detection and localisation of sources of ionising radiation (radiological bomb, fall out from such a bomb) and biological and chemical warfare agents.

Of course – spreading of biosensors and their detection with scanning laser equipment could also be ground based using manned or unmanned vehicles.

Glückauf Logistik GmbH & Co. KG

Ground Robots

See page 80

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- Static Display
- Open Display

Glueckauf Logistik is an engineering company that offers spares; components and different systems to several NATO armies and defence companies. Glueckauf is the service and sales partner of ODF in Germany.

ODF Optronics Ltd, part of the Wave Group Ltd. provides innovative vision-based systems for the Defense and Homeland Security and Consumer Electronics markets. ODF's unique products are based on its proprietary achievements in the fields of Omni-Directional Imaging, Advanced Electro-Optic Sensors, Remote Observation Systems, Image Processing and Image Understanding Software. The company's product lines include a wide variety of innovative products for Counter Terrorism, Military Reconnaissance, Low Intensity Conflicts (LIC), Homeland Security, Search & Rescue and Surveillance. German Sales & Service Partner is Mr. Harald Schubert +49(0)561 93579-16 in Kassel, Germany.

Hörmann IMG GmbH

Air Robots

See page 151

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- Static Display

The company IMG (Institut für Maschinen, Antriebe und elektronische Gerätetechnik - institute for machines, drives and electronic device technology) was founded in 1995 as a non-profit research institution with its registered office in Nordhausen, called IMG gGmbH. Since 1 January 2009, IMG has been part of the Hörmann Group and since this date it has been working under the name of Hörmann IMG GmbH.

The range of activities from Hörmann IMG GmbH reaches from electronic components, devices and systems via components and systems of electrical and hybrid drive engineering, innovative power engineering in the field of regenerative energies up to test services, tests and standard measurements in different fields of application (e.g. drive technology, climatic tests, EMC, motor vehicle EMC, materials engineering).

Innovative and advanced developments are the results of our long-term persistent work. Hörmann IMG can reveal modern hybrid diesel/ electric vehicle power train with references to different market segments. Examples of projects for applications of our hybrid systems are hybrid drives for a well-known German car manufacturer, hybrid drives and energy systems for military vehicles, hybrid drives for boats and hybrid drives for tram vehicles.

Because of object-oriented connection between special expert competency, particular know-how and our team‘s high motivation we are able to solve your demanding tasks or to support you with solutions.

Jacobs University of Bremen

Ground Robots, Air Robots

See page 62, 130

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- Static Display
- Open Display

- Reconnaissance and surveillance - Approach
- Reconnaissance and surveillance - RSTA
- Reconnaissance and surveillance - EOR / CRNE

Robotics Research at Jacobs University Bremen focuses on Autonomous Systems. The expertise of the group ranges from the development of embedded hardware over mechatronics to high-level software. On the basic research side of autonomous systems, machine learning, cooperation, and mapping are core themes of robotics research at Jacobs University. The main application domain is Safety, Security and Rescue Robotics (SSRR) where the group engages in since 2001. The Jacobs robotics group has a special evaluation environment for SSRR in form of one of worldwide six test arenas, which is set up and operated in cooperation with the US National Institute of Standards and Technology (NIST).

Jacobs University – formerly International University Bremen (IUB) - is a private, independent research university founded in 1999. It is a highly selective institution for the advancement of education and research. Multinational students, faculty and researchers of distinction, with educational partners around the world, collaborate in learning, creating and disseminating information and new knowledge. Robotics research started at Jacobs University with the very beginning of research and teaching activities in September 2001 under the direction of Prof. Dr. Andreas Birk. Since fall 2003, the computer science program “Smart Systems” offers both a master and a PhD track for graduate students interested in robotics.

LFK Lenkflugkörpersysteme GmbH

Air Robots

See page 129

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- Static Display
- Open Display

LFK GmbH - Germany's Core competence for Guided Missile Systems

LFK GmbH and its associated subsidiaries are part of the European MBDA Group. With an annual turnover of € 3 billion, a forward order book of over €13 billion and over 70 customers worldwide, MBDA is a world leading, global missile systems company. MBDA currently has 45 missile system and countermeasure programmes in operational service and has proven its ability as prime contractor to head major multi-national projects.

Of MBDA's 10.000 employees, 1.250 are working for LFK GmbH. As the market leader in Germany, LFK GmbH together with joint-venture companies and subcontractors design, develop and manufacture guided missile systems for aircraft armament (TAURUS KEPD 350), air defence (MEADS, Patriot, Stinger, SysFla/ LFK NG), helicopter armament (PARS 3 LR), ships (RAM, ESSM) as well as for „Battlefield Engagement" (MILAN ADT-ER).

In addition, LFK GmbH and its subsidiaries design, develop and manufacture subsystems and key components for guided missile systems (e.g. warheads, propulsion systems, guidance control and navigation systems). They also provide complete logistic support for the systems.

Subsidiaries and Joint Ventures of LFK GmbH are: TDW, BAYERN-CHEMIE, TAURUS Systems, euroMEADS, GLVS, Comlog, RAMSYS, Euromissile, EMDG G.I.E, SysFla GmbH and PARSYS. LFK GmbH as well as its subsidiaries develop their technological competence further, e.g. in the domain of air defence, to make sure they can offer their customers the guided missile systems required to fulfil the challenging tasks of the future.

MIRA Ltd

Ground Robots

See page 84, 86

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- Static Display

MIRA Ltd is a world-class, independent engineering consultancy to the global automotive industries. We have a diverse, global customer base within the civilian and defence sectors.

With over 300 vehicle engineers and technicians and 30 major test facilities on 1 site, we have access to the most advanced tools required for vehicle and systems development.

MIRA is also a provider of advanced R&D, providing cutting edge technology to leaders in industry. MIRA's R&D portfolio includes a significant programme of Unmanned Ground Systems development as well as hybrid vehicle engineering.

MIRA's relevant world-leading technology includes:

- High mobility, light weight UGV – MACE 2. An extremely capable platform with a high payload capacity. MACE 2 is a Universal Carrier and has several low speed and high speed applications.
- Advanced Hybrid UGV – MACE 1. MACE 1 has a silent running capability, and fully-autonomous operation mode. MACE 1 won the UK MOD Grand Challenge 'Best Use of Autonomy' award in 2008.
- Augmented tele-operation systems. Systems have been and continue to be developed at MIRA in order to reduce the UGV Operator workload. The intelligent systems fitted to our UGVs will determine the response of the vehicle in relation to Operator demand. Systems include vehicle limit handling, intelligent cruise control, haptic feedback, predictive path etc.
- UGV conversion kits for legacy vehicles. The autonomous / augmented tele-op systems fitted to our UGVs can be installed in to existing vehicles.
- Payload systems integration. MIRA has expertise in the integration of other payload systems such as ECM, IED-D, and fire suppression.
- Ruggedisation – MIRA has the relevant experience in converting civilian vehicles for military applications. Our design, environmental and EMC engineers daily develop vehicles to meet the stringent Defence standards required of all military equipment.

MIRA, in summary, is a provider of total UGV platform solutions.

M-Swiss Consulting S.A.

Ground Robots

See page 66, 110, 116

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- Static Display
- Open Display
- Reconnaissance and surveillance - RSTA
- Reconnaissance and surveillance - EOR / CRNE

MacroUSA CORP.
Macro USA is a Non Traditional, Small Disadvantaged, Minority and Veteran Owned Business based in McClellan Air Force Base in the USA. MacroUSA was incorporated in 2008 by a team of professionals with over 10 years of experience in the UGV market (the technical team came from MacroSwiss S.A. and has been developing military UGVs since 1999).

During 2009 MacroUSA signed a multimillion dollar contract with Singapore Technologies for the delivery of approximately 5000 Armadillo/ Throwcamera integrated systems to the Singapore Army. MacroUSA successfully met Preliminary Design Review milestones, Critical Design Review Milestones and is on schedule for delivery.

MacroUSA was also selected for the AEWE Army Expeditionary Warrior Experiment managed by the Maneuver Battle Lab (MBL) at Fort Benning, Ga., in coordination with TRADOC Army Capabilities Integration Center (ARCIC), conducts experiments through live force-on-force and constructive, virtual-land simulations. AEWE provides a repeatable, credible, validated venue for network-enabled small unit experimentation focused on emerging technologies and concepts in a live field environment providing operational insights across the DOD supporting AEWE Campaign Objectives and Tactics, Techniques and Procedures (TTP) for the current and future force. Our technology has been selected for integration and will run the experiment in January and February 2010.
Besides SUGVs, Macro USA also offers short range throw cameras, gun cameras, portable surveillance cameras, and pole cameras.

M-Swiss Consulting S.A.
M-Swiss Consulting S.A. is a Swiss defence company specializing in Unmanned Ground Vehicles and is headed by Cino Robin Castelli, formerly founder and CEO of Macroswiss S.A. between 1999 and early 2008. The company holds an extensive trade and brokerage permit in Defence materiel as well as a NATO CAGE registration. Robin is the team leader for Team MacroUSA and is responsible for the European market and initiatives.

ND SatCom GmbH

Equipment for Satellite Communication

See page 160

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Contributing Institutions

- Static Display

ND SatCom GmbH plays a leading role in the European military satellite communications industry. It offers all core competencies and qualifications required for the turnkey delivery and logistic support of military SatCom systems. ND SatCom builds on more than 25 years of experience in the design, development and implementation of SatCom systems. The company provides comprehensive, tailor-made communication network ground segment solutions to military, governmental and peace-keeping organizations worldwide. It has a long-standing experience in implementing satellite ground segments and military network management systems and has already proven to be a competent and reliable partner to its customers.

ND SatCom is a wholly owned subsidiary of SES ASTRA in Luxembourg.

Areas of interest:

The ND SatCom solutions portfolio includes:

- System Solutions
- Fixed Ground Terminals
- Mobile & Transportable Terminals
- Network Management Systems
- Components

OHB-System AG

Reconnaissance Satellites

See page 146

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- Static Display

OHB-System AG, Bremen, Germany

From its early beginning OHB-System AG has built up an extensive knowledge and competence in systems engineering and project management, which is reflected by the variety of projects successfully performed during the past 28 years.

OHB-System AG is a medium-sized system provider specialised in space technology and security applications. OHB-System's headquarters at the Bremen Technology Park is home to almost 300 highly qualified scientists and engineers working on numerous prestigious national and international projects related to small satellites, manned space flight, orbital- and transport systems as well as security and reconnaissance technologies. The experience and knowledge gained from numerous projects as well as the fruitful collaboration with other companies permits OHB-System personnel to assume system responsibility for complex projects.

OHB-System can look back on nearly three decades of high-tech development. It is already putting this experience into practice for example in the security and reconnaissance segment with great success.

Two examples of reconnaissance projects are:

ARDS

The Aerial Reconnaissance Data System (ARDS) is a modular solution for the secure real-time transmission of images, video and sensor data in aerial reconnaissance missions. ARDS consists of four main modules: a wavelet-based image compression, a high rate data link with an optional encryption module and a secure command link.

This solution provides a raw data rate of 274 Mbit/s and has been flight proven at ranges exceeding 200 km and can achieve more than 300 km in relay mode.

SAR-Lupe

The first satellite-based radar reconnaissance system in Germany, SAR-Lupe, had been developed with OHB-System as the main contractor. Five identical small satellites are used by the German Armed Forces to monitor the entire earth independent of weather and time of day. All satellites in the SAR-Lupe system have been orbiting the earth since July 2008 and deliver superb images.

OmniSTAR B.V.

DGNSS Services

See page 150

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- Static Display

OmniSTAR is world leader in providing high accuracy DGNSS correction data via satellite channels and internet for land, airborne applications and has offices in the Netherlands, India, Dubai, the USA, Australia, Singapore and South Africa. OmniSTAR is a member of the Fugro Group, a worldwide services and consultancy company with more than 275 offices in over 50 countries. Fugro provides surveying, positioning and geotechnical solutions for on- and offshore applications.

OmniSTAR delivers commercial DGNSS services worldwide by satellite and via internet and is leading in the design and development of Differential GNSS positioning technology. With approximately 100 reference stations, 6 high power satellites and 2 global Network Control Centres, OmniSTAR delivers consistent and highly reliable positioning services worldwide, 24 hours a day, 365 days a year. OmniSTAR's other advantages include worldwide coverage, consistent high accuracy, high reliability and robustness.

Parosha Innovators b.v.

Ground Robots

See page 70, 72, 74

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Web: www.cheatah-tugv.com

- Static Display

Parosha Innovators b.v. is founded in 1998 and is a subsidiary of The Parosha Group b.v. Parosha Innovators' core activities are Engineering, Designing, Researching, Developing, and Manufacturing Small Unmanned Ground Vehicles (SUGV's) (Cheatah VTE-2500 and Cheatah VTE-3600) and large UGV's (Cheatah VTE-3900) and hydraulic powered manipulator-arm and robotic-arm systems and grippers and special tools for UGV's purposes. Parosha Innovators b.v. is also developing long-range battery-driven-systems, separate track systems for SUGV's and electrical- mechanical- and hydraulic drive systems, wheel-suspension systems and remote control systems for third-parties. Parosha Innovators b.v. is using the latest 3D-CAD and Stress-Analyses software for all designs and exist of the following departments : Engineering, Research & Developement, Machining, Manufacturing, Welding and Construction, Assembly, Test & Evaluation , Field service and Support and has 84 full-time employees and has two production facilities.

Roboterwerk GmbH

Ground Robots

See page 82

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- Static Display

Contributing Institutions

Roboterwerk GmbH which was founded in 2000 is divided among three locations. Business management and administration are in Ruhpolding, Upper Bavaria. Development is carried out in Chieming near the Chiemsee and in Oberhaching near Munich, where the workshops are also located. Roboterwerk cooperates with Schlagheck Design GmbH, Wimmer Carbontechnik GmbH, LTT Lasertechnik and other regional partners in development, design and production.
Our main interest is the development, design and production of small scale (< 80 kg) robots for military, security and rescue areas, as well as for research and science.
Roboterwerk develops and furnishes standard as well as custom designed robots
The idea of a computer-guided, mobile robot was developed by Mathias Hubrich back in 1995. The first attempts in the years leading up to 2000 were concentrated on the development of suitable base vehicles and the general capabilities of remote control.

History:

Foxbot 1.0 (2004)
The major advantages a wheeled vehicle has over a tracked one represented the impetus for Roboterwerk's development of a six-wheeled robot with all-wheel drive weighing around 30 kg.

Foxbot 2.0 (MobRob B)
For the supplementary support of photographic and acoustic reconnaissance and monitoring, the Bundeswehr (German Army) ordered a small, unmanned ground vehicle (UGV) as part of an R&D contract with Rheinmetall Defence Electronics.

FORBOT (2008)
Project FORBOT came to fruition after many years of development specifically for use in R&D and the broad scope associated with it. „FORBOT was first used in a military development project called "Moss UGV", executed by Rheinmetall Defence Electronics. The first use in the academic and research area was by Prof. Dr. Michael Hofbauer of the Institut für Automatisierungs- und Regelungstechnik on the Private University UMIT in Austria.

FORBOT Edu (2010)
Our most sophisticated FORBOT was developed for use by educators and students in the academic area. This robot is "ready to use" and equipped with a CompactRio PAC (programmable automation controller) from National Instruments, as well as with accu, motors, gearboxes, elmo motion controller, Wi-Fi-router and a LabView graphical programming environment. FORBOT Edu is only available for educational use and has a special reduced price of € 9.800.

RoboticInventions

Ground Robots

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Website: www.roboticsinventions.com

- Static Display
- Open Display
- Transport-Movements
- Transport-Mule
- Reconnaissance and surveillance - Approach
- Reconnaissance and surveillance - RSTA
- Reconnaissance and surveillance - EOR / CRNE

Robotics Inventions is a Research & Development company specializing in autonomous robotics, vision systems, autonomy components, and robotics professional services.

Our Mission

Our mission is to design and manufacture semi- and fully-autonomous robots and its parts to allow human tele-presence in harsh and extra-terrestrial environments as well as to undertake dangerous repetitive tasks on human behalf.
Moreover we offer RI Professional Services to companies and organizations seeking support in designing and implementing solutions that require dedicated electronics, mechanical constructions, automatics, robotics, autonomous software and artificial intelligence.
In addition Robotics Inventions aspire to deliver a flexible autonomous component to animate any hardware.

Values

Robotics Inventions strategy is in peaceful applications of the robotics for the better present and future of all human kind.

History

Founded in 2004 the company is based in the Polish Space Exploration Center in Warsaw, Poland.

Marek Sadowski has been in charge of Research & Development since the beginning of the company. Mr Sadowski is an International Space University alumnus, a former vice president of Polish Astronautics Society, and a former researcher at NASA Ames Research Center on robotics 3D control systems and a Java researcher at Nippon Telegraph and Telephone Software Laboratories in Tokyo.

Marketing and strategy is led by Robert Sas, a former British American Tobacco marketing manager for European market and a chocolate marketing director in Kraft Foods Poland.

The Sales is led by Robert Szwed, a former Philips sales manager responsible for business development of distribution channels and currently holding a country manager position for an automotive oriented company.

The Production is led by Grzegorz Landsman, a former Accenture business consultant and a Flextronics internal international financial auditor.

The RI and European Space Agency liaison is Michal Misiaszek, an International Space University alumnus, the Computaris Chief Executive Officer.

Till 2009 the company has gathered 25 investors.

roda computer GmbH

Notebooks, Tablet PC, UMPC, PDA

See page 156

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Website: www.roda-computer.com

roda computer is specialized in developing, assembling and the distribution of rugged mobile computers.

roda products are placed in different European defence projects. roda computer is the frame contractor to the German armed forces for ruggedized notebooks. The German armed forces are currently using more than 5000 rugged roda products (notebooks, tablet PC, PDA). There are further thousands of ruggedized mobile computers in use at other European armed forces. The ruggedized mobile computers are also used in security projects.

roda's portfolio includes rugged notebooks, tablet PC, UMPC, PDA and displays.

Features are:

- Extremely ruggedized
- Different interfaces
- Daylight readable displays
- Integrable in mobile systems
- Large scale of accessories
- Modular assembling
- Integrated chip card reader
- Integrated finger scanning system
- Integrated DC/DC converter
- Attachment for vehicles
- Interfaces for radio connection
- Tempest (AMSG 788 720 B)

Rohde & Schwarz Vertriebs GmbH

Radio Equipment

See page 153

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- Static Display

Rohde & Schwarz has stood for quality and innovation in test and measurement, broadcasting, secure communications as well as radiomonitoring and radiolocation for more than 75 years. By pursuing this four-pillar strategy, the company addresses customers from various market segments: wireless communications, broadcasting, electronics – as well as government authorities and organizations with security missions. The electronics group, with its headquarters in Munich, Germany, counts among the leading suppliers worldwide in all of its business fields. As a manufacturer of EMC test and measurement equipment as well as terrestrial TV transmitters, Rohde & Schwarz is the world market leader.

Our business fields

Test and measurement

Rohde & Schwarz is one of the world's largest manufacturers of electronic T&M equipment for wireless communications, electronics, and microwave applications.

Secure communications

Radiocommunications systems

Rohde & Schwarz supplies interoperable and powerful communications systems to ensure prompt coordination of civil, government and military forces during missions or in crises.

Professional mobile radio

TETRA radio networks have already been put into operation in more than 30 countries by the Rohde & Schwarz Professional Mobile Radio GmbH subsidiary.

Communications security

Rohde & Schwarz SIT GmbH develops and produces crypto products for industry, government offices, the German Armed Forces and NATO. The new TopSec Mobile e.g. allows secured communications via mobile phones with Bluetooth® capability.

Radiomonitoring and radiolocation

The need for mobile, wireless exchange of information is increasing drastically, but the usable frequency spectrum for radiocommunications is limited. Therefore, Rohde & Schwarz develops and produces stationary and mobile systems for detecting, locating, and analyzing radiocommunications signals.

Broadcasting

TV viewers and radio listeners in more than 80 countries receive their programs via transmitters from Rohde & Schwarz.

SIM Security & Electronic System GmbH

Ground Robots

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www.sim-electronic.com
e-mail: j.gregor@sim-electronic.com

- Static Display
- Open Display

SIM Security and Electronic System GmbH is a major manufacturer and provider of professional video-, communication- and monitoring-technology.

We support national and international government agencies for more than 20 years. We develop and manufacture optoelectronic products and customized integrated systems.

Concept and design is based on customer's requirements. Our services include professional technical advice and support, training and maintenance.

Our product range includes

Mobile observation platforms and special vehicles
Unmanned air vehicles and robotics

Intensified and thermal imaging systems
Multi-sensor systems with IR-zoom-laser
Digital, miniature COFDM video transmission with integrated telemetry
Digital COFDM TCP-IP Transmission System
Digital audio and high-speed data transmission
Digital recording with high-speed download
Navigation and tracking systems

Radio monitoring and interception systems
Lawful Interception, tactical and strategic
Broad band and intelligent Jammer

szenaris GmbH

Simulation

See page 164

Company:	szenaris GmbH
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- Static Display

We create digital worlds

Individual learning software and simulation systems szenaris GmbH is your partner in conceptualizing, implementing and supporting individual, innovative internet based learning media in the arena of computer based training (CBT), web based training (WBT) including simulation and virtual worlds (VR). We offer e-learning programs and team-training systems.
This form of learning provides location independent and time independent study of pre-defined client tasks. It allows individuals or team members to learn independently and at their own pace. These cost-efficient solutions will, in many cases, replace original systems.

As a well-established team, we bring together extensive competence to the implementation of instruction, training and simulation. New techniques are innovatively integrated into learning solutions for our customers. Collaboration with research associations provides us, and therefore you, with an incisive advantage. We will advise you on your project from start to finish and beyond. We'll always be available.

High security standards are, for us, an important instrument in the avoidance of IT-security problems. Our customers use a variety of techniques to avoid potential gaps in security and we fulfill these standards regardless of which technique you use.

Advantages for our customers:

- Schooling and ongoing development of employees
- High quality personnel training
- Shorter practical training
- Saving in cost and time

Telefunken Radio Communication Systems

Ground Robots, Air Robots, Aerostat

See page 120, 126, 162

Company:	TELEFUNKEN Radio Communication Systems GmbH & CO. KG (TELEFUNKEN RACOMS)
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- Static Display
- Open Display

The global German brand TELEFUNKEN has been well-known for more than 100 years and is associated with innovation, technology and quality. Today, we continue the tradition by providing system solutions and products of highest benefit and quality for its customers. We are focussing on advanced radio communication products, systems and applications in the field of Defense, Homeland Security, Railways.

TELEFUNKEN RACOMS is a subsidiary of Elbit Systems Ltd which is a leading company in the field of defense systems for Air, Sea and Land platforms. The Elbit Systems group together with it´s world wide subsidiaries has developed and introduced a variety of robotic and unmanned vehicles. At ELROB 2010 Telefunken Racoms will present 3 unmanned systems: VIPeR®, SKYLARK® and Telestat.

The VIPeR® is a dismounted soldier device extending the field of view or performing other tasks that are too dangerous to be done by soldiers. The SKYLARK is a well suited UAV for all close range, over-the-hill missions tailored to the respective situation. The Telestat enables a powerful easy to use and silent surveillance from the air for hours.

telerob Gesellschaft für Fernhantierung mbH

Ground Robots

See page 114

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- Static Display
- Open Display

- Reconnaissance and surveillance - Approach
- Reconnaissance and surveillance - RSTA
- Reconnaissance and surveillance - EOR / CRNE

To develop machines, equipment and systems that protect or replace human beings in situations where their presence would be either impossible or place them at great risk.

This is the motto, motivation and mission of telerob Gesellschaft für Fernhantierungstechnik mbH. Whether it’s one of our Master- Slave Manipulators being used to dismantle a nuclear facility or an EOD robot being used to disarm a dangerous explosive device, protecting people and their surroundings is always our paramount concern anytime one of our products is deployed.

Our engineers and specialists in the fields of electrical engineering, electronics and precision mechanical engineering combine creativity and competence in the quest for advanced solutions in the worlds of bomb disposal and remote handling technology.

The telerob range of products encompasses EOD robots (tEODor and teleMAX), completely equipped bomb disposal vehicles (TEL600), bomb disposal equipment, non-magnetic special tools (NOMATOOLS), as well as manipulators for servicing, maintaining and dismantling nuclear facilities (EMSM).
telerob is an official NATO supplier and development partner (NATO supplier code: C 5152).

The QS service of the German Armed Forces has certified our adherence to the requirements of AQAP 2130.

Thales Deutschland Defence Solutions & Services

UGV Link, Radio Propagation and Mission Planning Tools

See page 165

Company:	Thales Deutschland Defence Solutions & Services
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- Static Display

With operations in 50 countries and 68,000 employees, Thales is a global technology leader in Mission-critical information systems for the Aerospace, Defence, Security and Transportation markets.

Building on proven capabilities in large and complex systems, Thales steps up to the security challenges of its customers in an increasingly interconnected, technology-driven world.

Civil and military systems benefit from many of the same technologies and innovations. Developing these dual technologies has been a long tradition for Thales, with its global network of 25,000 high-level researchers.

Leveraging a global presence and spanning the entire value chain, from prime contracting to equipment, Thales plays a pivotal role in making the world a safer place.

University of Catania

Ground Robots, Wall Climbers

See page 106, 118, 138

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- Static Display
- Open Display
- Transport-Mule
- Reconnaissance and surveillance - Approach

The University of Catania was founded in 1434 and is one of the oldest University in Italy. The Dipartimento di Ingegneria Elettrica Elettronica e dei Sistemi (DIEES) was established in 1971. In the laboratory of DIEES several prototype of service and mobile robots have been designed and built. The Service robotic group has carried out research activity in the mobile and industrial robotic sectors within several national and international projects, in cooperation with private and public research centres. The group is expert in the design, realisation and testing of mobile robot prototypes, indoor and outdoor, climbing robots with particular reference to the development of embedded control systems.

Service robotic group has been involved in many research activities concerning the development of mobile robots for outdoor applications. Main field of activities have been volcanic exploration with the development of the ROBOVOLC robot a six wheeled robot with a manipulator arm and many different cameras and sensors, the WHEELEG hybrid robot with two front legs and two rear wheels acting together and the M6 articulated robot. The group has coordinated the European project ROBOVOLC (www.robovolc.dees.unict.it). Recently research activities have been performed, also in cooperation with the INGV (Volcanology institute of Italy), for the adoption of UAV for gas collection and visual inspections and an autopilot and several UAVs have been developed and tested. Other activities involve agricultural applications with the development of a robotic system for orange picking, a design of a robot for artichoke picking and the development of a robotic system for autonomous spraying in greenhouses. The group is partner of the European project MOW-BY-SAT (www.mow-by-sat.eu) for the development of an autonomous lawn mower robot by using cheap GPS systems.

In cooperation with the University of Hertfordshire the group has started in the last years strong research activities on the telecontrol of remote robots by using stereovision and augmented reality interfaces.

Home page:
http://www.diees.unict.it/users/gmuscato

Robotic page:
http://www.robotic.diees.unict.it

University of Hannover

Ground Robots

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Organization: RTS – Leibniz Universität Hannover

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- Static Display
- Open Display
- Transport-Movements
- Transport-Mule
- Reconnaissance and surveillance - Approach

The Institute for Systems Engineering (ISE) at the Leibniz Universität Hannover deals with the modeling, simulation, analysis and realization of hardware and software architectures of complex and technical systems.

The Real Time Systems Group (RTS) is part of the Institute for Systems Engineering. Head of the RTS is Prof. Dr.-Ing. Bernardo Wagner. The RTS focuses its work on the fields of distributed automation systems and mobile service robots. Such systems have to interact with their real surroundings in a correct, reliable and secure way and furthermore with deterministic time response, that is in real time.

Our main research areas are autonomous navigation in indoor and outdoor environments, multi robot interaction and sensor fusion. In cooperation with industrial partners, substantial research results have been transferred to prototype robotic applications. One example is the „FM-X Autonom“, an autonomous fork lift truck which we developed together with the Still GmbH. Since 2006 the RTS is demonstrating its latest research results annually at the ELROB trials.

At the M-ELROB 2010 the RTS is presenting results of ongoing research projects. This includes the sensor data fusion between multiple robots in real time as well as autonomous convoy operation of multiple vehicles with a single operator. In addition, the M-ELROB is utilized to present a novel mule function and fully autonomous vehicle control. In this context our robot RTS-HANNA is utilized as a demonstrator for robotic technology that can be adapted to any steer-by-wire platform.

University of Kaiserslautern

Ground Robots

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Organization:	Robotics Research Lab Department of Computer Sciences University of Kaiserslautern
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- Static Display
- Open Display
- Transport-Movements
- Transport-Mule
- Reconnaissance and surveillance - Approach
- Reconnaissance and surveillance - RSTA

Team RAVON is part of the Robotics Research Lab at the University of Kaiserslautern (http://rrlab.cs.uni-kl.de/). The work group was founded in April 2003. Today, 18 research assistants, most of them computer scientists, work under the leadership of Prof. Dr. Karsten Berns.

Since its foundation, the Robotics Research Lab develops complex biologically motivated robotic systems. The methodological research is carried out regarding algorithmic approaches as well as mobile robot control architectures. Off-road robotics and humanoid robotics are the group's research focuses. But there are also two indoor vehicles and a climbing robot.

For the development of elaborate machines innovative computer architectures and electronic concepts are studied. Furthermore, tools for adequate support of the development process over the full life cycle of robotic systems are implemented. These are published on the RRLib webpage (http://rrlib.cs.uni-kl.de/), which is meant to be a compendium of best practices and tools for the robotics community.

University of Oulu, Robotics Group

Ground Robots, Software architecture for robotics

See page 90, 157

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- Static Display
- Open Display
- Transport-Movements
- Transport-Mule
- Reconnaissance and surveillance - RSTA
- Reconnaissance and surveillance - EOR

Robotics Group is a part of Intelligent Systems Group in University of Oulu, dealing with research on embedded systems and robotic systems. The research includes mechanic, electronic and software architectures as well as sensor fusion, machine vision and intelligent control. The group concentrates on applying research world results on real world challenge. Several outdoor and indoor robots have been developed by the group. Applications for outdoor robots are Search and Rescue, Mapping, Equipment transportation, area monitoring and measuring.

The group consists of 5 research workers. The principal investigator of the group is Prof. J. Röning and project manager is Antti Tikanmäki

University of Siegen

Ground Robots, Air Robots, Amphibic Robots

See page 64, 132, 142

Organization: University of Siegen

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- Static Display
- Open Display
- Transport-Movements
- Transport-Mule
- Reconnaissance and surveillance - Approach
- Reconnaissance and surveillance - RSTA

At the Institute of Real-Time Learning Systems the research focuses on 3D computer vision and real-time learning. These basic technologies are applied to outdoor robotic scenarios which provide the ultimate litmus test for robustness and usability. Different vehicles (AMOR, PSYCHE, DORIS) are now operated to cover flexibly a very wide range of possible applications. By a 3D environment model several types of objects like roads, obstacles or persons are recognised. Fully featured local and global maps allow navigating autonomously in complex terrain while handling the present objects appropriately.

University of the Bundeswehr Munich

Ground Robots

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- Static Display
- Open Display
- Transport-Movements
- Transport-Mule

Our research group is headed by Prof. Dr.-Ing. H.-J. Wuensche, professor for “Autonomous Systems Technology” and successor of Prof. Dr.-Ing. Ernst D. Dickmanns at the University of the Bundeswehr Munich.

Main focus of research is the development of autonomous mobile robot platforms. For example, such systems are to be enabled to explore and navigate in unknown unstructured environments on their own.

As a demonstration platform, MuCAR-3, a modified VW Touareg, is available. “MuCAR-3” is the third generation of our Munich Cognitive, Autonomous Robot Cars, hence its name. The first generation vehicle was “VaMoRs”, which demonstrated fully autonomous driving at its maximum speed of 96 km/h 23 years ago, covering a distance of 20 km. The second generation vehicle “VaMP” established further records in 1995, when it drove from Munich to Denmark and back for a distance of almost 1800 km, of which about 1660 km were driven fully autonomous at speeds up 180 km/h. The new vehicle was chosen to be a good vehicle both for participating in traffic on public roads as well as for off-road driving.

Apart from inertial sensors we continue to focus on vision as a main sensor for perception, as this sensor provides most of the information humans need for driving. In addition we use a high definition 360 deg. Velodyne laser scanner mounted on the roof of the vehicle. The main vision sensors are 3 forward looking cameras placed on a two-axis platform inside the vehicle. The arrangement resembles the human eye, with an inertially stabilzed tele-camera as “fovea” and 2 wide angle cameras for peripheral vision. All cameras are mounted on a yaw axis platform to allow for active control of the horizontal viewing direction.

Our research group participated at the ELROB 2007, ELROB 2008 and the ELROB 2009 and – together with TU Karlsruhe and TU Munich through Team AnnieWAY – at the DARPA Urban Challenge 2007, where this team was one of only 11 teams which made it into the finals on 3 Nov. 2007.

University of Versailles

Ground Robots

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- Static Display
- Open Display
- Transport-Movements
- Transport-Mule
- Reconnaissance and surveillance - Approach
- Reconnaissance and surveillance - RSTA
- Reconnaissance and surveillance - EOR / CRNE

The University of Versailles team is composed of nine students preparing a degree of mechatronic engineering at the Yvelines Science and Technology Institute (ISTY).

The ISTY depends on the University of Versailles, located near Paris. We are under the leadership of Pierre BLAZEVIC, who is the director as well as a teacher of the ISTY. In this school, students and professors work together on different projects which include electronic, mechanic and computing sciences. We haven't had any sponsors up to now. The school provides us with material and components, and sometimes different companies provide us material for free.

We will participate to the trial with our two vehicles, called MX3 (Mantes eXplorer 3) and MX4.

MX3 is a mini-UGV with which we participated to C-Elrob 2009 and MX4 is a UGV, predicated on an electro quad. Our robots are entirely developed by students at school. The goal of our robots is to help humans to do some tasks, like searching and rescuing people after natural disasters such as earthquakes. That is why we also participate to the worldwide Robocup Rescue. Our robots are powered by batteries packs and are remotely controlled by WIFI, in a maximum range of 500 meters. Vehicles incorporate measurements from accelerometers, gyros and wheels speeds for pose estimation.

While moving, the environment is perceived through a laser range finder, sonars, infrared thermal sensors and webcams.

The control station is a laptop and all data are retrieved from the robots in real time.

MX3 and MX4 can be controlled together at a same time are separately thanks to a joystick, or can be autonomous, where appropriate.

MX3 is in development since September 2007 and MX4 since September 2009.

Today, vehicles are always prototypes which are constantly evolving.

University of Würzburg

Ground Robots

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Organization: Universität Würzburg & Zentrum für Telematik (ZfT) & Steinbeis Transferzentrum ARS

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- Static Display
- Transport-Movements
- Reconnaissance and surveillance - Approach
- Reconnaissance and surveillance - RSTA

The combination of advanced information processing methods with control engineering offers interesting research and application perspectives in robotics and telematics. Therefore the institute “Computer Science VII” has research emphasis in the framework of computer science and the following interdisciplinary topics:

- Robotics and mechatronics: combination of computer engineering, electronic engineering, mechanical engineering and control engineering to design robots that are adaptable to changing work environments
- Telematics: integration of telecommunication, information technology and control engineering for remote services

With respect to applications, emphasis is placed on

- Mobile Robots: industrial transport robots, cooperating robots, sensor data processing
- Tele-robotics: tele-maintenance, laboratory experiments with hardware in tele-education, remote operation concepts, augmented reality user interfaces
- Spacecraft systems: pico-satellites, Mars rovers, tele-operation of satellite formations, networks of ground control stations
- Robots in medicine: robots for radiation therapy and assistance, haptic user interfaces, tele-medicine

voice INTER connect GmbH

Speech Control, HDR-Camera

See page 166, 167, 168

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E-mail: info@voiceinterconnect.de
Website: www.voiceinterconnect.de

- Static Display

voice INTER connect GmbH is your partner for signal processing in electronic devices. We offer high-tech products, development and integration services in with a strong customer orientation. Our business units are:

- business unit Speech and Signal Processing
- business unit Sensors and Embedded Solutions

Speech and Signal processing offers patented algorithms for

- robust signal detection, acquisition and preprocessing (noise reduction and echo cancellation),
- signal encoding and transmission (analogue and IP-based transmission modes) and
- speech and object recognition for the control of technical devices and machines

The business unit Sensors and Embedded Solutions delivers

- combined hardware and software solutions for acoustical and optical sensor applications,
- miniaturized DSP- and microprocessor-based hardware-plattforms for intelligent audio- and signal processing and -transmission,
- smart cameras,
- signal recorders,
- access control solutions.

Voice INTER connect offers the following products for the markets Industrial process control, Automotive and Mobile Communication and Consumer:

- vicCONTROL speech control platform
- vicCOM – single chip full duplex communication solution
- vicCAM – intelligent HDR smart camera
- AzAR - Computer assisted training tool for foreign language acquisition

Speech recognizer and speech processing algorithms of the company are essential tools for comfortable man-machine-interaction and are used in numerous different communication, control and supervisory tasks in common and military applications.

VTQ Videotronik GmbH

Digital Videolink

See page 108

Company:	VTQ Videotronik GmbH
Contact information:	Gruene Str. 2 06268 Querfurt Germany Tel.: +49-34771 510 Fax.: +49-34771 22044 E-mail: main@vtq.de Website: www.vtq.de

- Static Display

Since its establishment over 40 years ago, VTQ Videotronik GmbH has acquired many years' experience in the field of wireless technology.

We manufacture electronic modules and equipment on customer order, and are developers and manufacturers of video, audio and wireless data transmission systems. Our brand products are known throughout the world. State-of-the-art production halls offer the means to meet today's technical and qualitative requirements. We take care of your order with flexibility and speed, and to the highest standards!

Thanks to our high degree of flexibility and wide product range, we've been able to assert ourselves on the global market as successful developers and manufacturers of finished goods for the video, audio and wireless data transmission industries. We work with authorities, military and well-known companies throughout the world. That way, we ensure quality-conscious products and positive realisation of your projects.VTQ draws on decades worth of experience in developing, manufacturing and marketing top-quality, professional video, audio and wireless data transmission systems. Our expertise, reliable sense of quality and unbridled spirit of innovation have attracted customers from all over the world. Our manufactured systems can be found in the safety technology industry, but are also increasingly used in the industrial and private spheres. In order to meet the varied requirements of our customers, we concentrate on developing versatile systems. We make important discoveries through consistent market analysis, which enables us to react appropriately to the continually growing demands of our customers. This steadfast dedication guarantees further innovative developments in the future.

Customised solutions

Our customers come from the most varied of industries, authorities and military. However, there's one thing that connects them - if it's tailor-made solutions they're looking for, then we're their first choice! We develop innovative wireless systems and installations, both for and in co-operation with our customers. State-of-the-art development and manufacturing conditions enable us to meet customer demands. So apart from our standard products, we also offer customer-specific solutions that have been specially tailored to meet your needs.

Ground Robots

at

M-ELROB 2010

3D Mapping Response Robot (UGV)

Jacobs University of Bremen

Team name:	Jacobs Robotics Team
Team leader:	Andreas Birk
Team leader's email:	a.birk@jacobs-university.de
Nationality:	German

Use at ELROB 2010: • **Static display** • **Scenario**

Basic data

Height (max):	50 cm (including elevated arms and antennas)
Height (min):	60 cm (without arms and antennas)
Width:	50 cm
Length:	60-90 cm
Weight:	20 kg (including all accessories)
Turning diameter:	0 cm (turns on centre off robot)
Ground clearance:	15 cm
Average noise level:	2 dB(A)
Others:	metallic coating

Mobility

Climbing performance:	30 deg
Wheel or track driven:	track
Propulsion:	battery
Endurance:	2.5 hrs
Max. speed:	1.5 m/sec
Payload:	15 kg
Locomotion:	2 tracks, 1 flipper
Steering:	differential
Tether:	optional
Control:	remote teleportation / full autonomy
Manipulator:	None
Stairs:	Yes, 30 deg
Incline:	30 deg

Communication equipment

Type:	WLAN
Frequency:	2400 MHz
Power:	100 mW to 99W

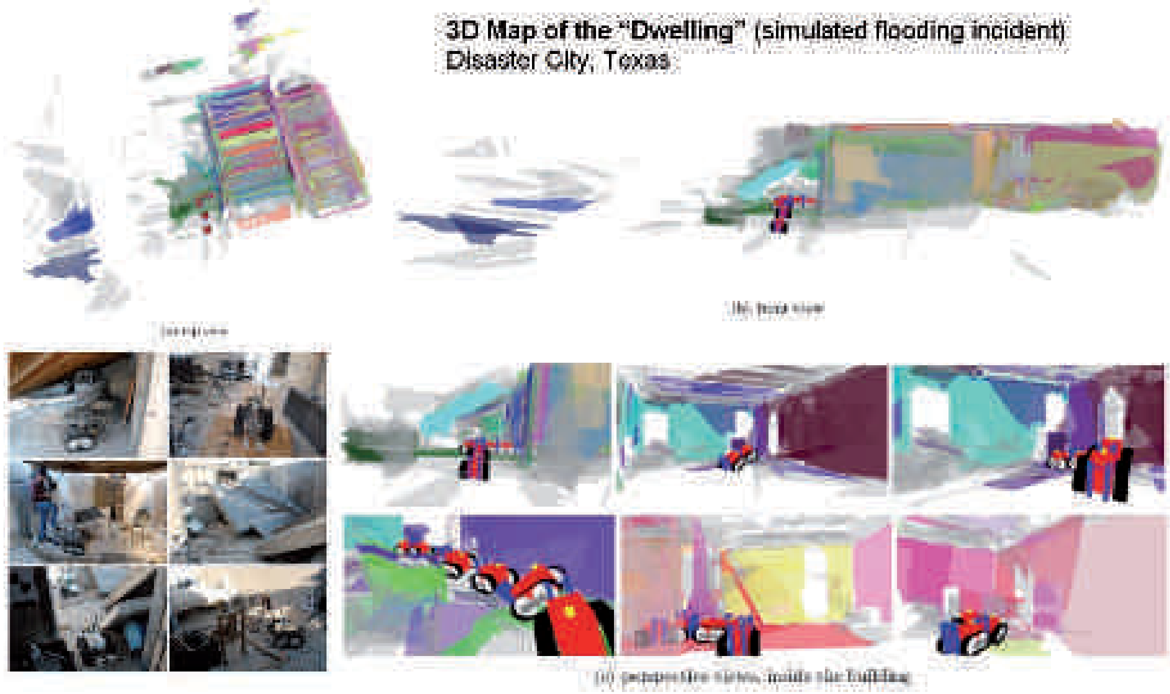
Sensor equipment

Laser:	actuated Sick Laser S-300
Vision:	Panasonic PTZ
GPS:	Garmin
Other sensors:	Xsens Mti

Platform main capabilities

The main capabilities of this robot are the intelligent autonomous functions onboard, especially with respect to 3D perception and mapping, which are an important basis for UGV control in unstructured environments and for mission deliverables. Concretely, Jacobs Robotics group has developed among others a new method for 3D Simultaneous Localization and Mapping (SLAM), which is suited for online generation of 3D maps in highly unstructured environments.

This approach called 3D Plane SLAM features an extraction of planes with uncertainties from 3D range scans. Two scans can then be registered by determining the correspondence set that maximizes the global rigid body motion constraint while finding the related optimal decoupled rotations and translations with their underlying uncertainties. The registered scans are embedded in pose-graph SLAM for loop closing and relaxation. The approach is suited for an online generation of large 3D maps in complex environments. Especially, it is very fast and robust, i.e., no motion or localization estimates from GPS, odometry, or an Inertial Navigation System are needed. The surface representation by large planar patches has the fringe benefit that the generated 3D maps are very compact. The benefits of 3D-Plane-SLAM were already demonstrated in several unstructured scenarios, including operations during the NIST Response Robot Evaluation Exercise (RREE) in Disaster City and the Lunar Robotics Challenge of the European Space Agency (ESA) at the Teide volcanic crater on Tenerife, Spain.



3D maps generated at Disaster City, Texas during the 2008 Response Robot Evaluation Exercise (RREE)

AMOR

University of Siegen

Team name:	University of Siegen
Team leader:	Prof. Dr.-Ing. Klaus-Dieter Kuhnert
Team leader's email:	kuhnert@fb12.uni-siegen.de
Nationality:	German

Use at ELROB 2010: • **Static Display** • **Open Display** • **Scenario**

Basic data

Height (max):	240 cm (including elevated arms and antennas)
Height (min):	180 cm (without arms and antennas)
Width:	120 cm
Length:	260 cm
Weight:	400 kg (including all accessories)
Turning diameter:	700 cm (turns on centre off robot)
Ground clearance:	25 cm
Average noise level:	78 dB(A)
Other:	Metallic coating

Mobility

Climbing performance:	100%
Wheel or track driven:	Wheel 4x4
Propulsion:	Fuel
Endurance:	~6 hrs
Max. speed:	90 km/h
Payload:	60 kg
Locomotion:	4 wheels
Steering:	Ackermann
Tether:	None
Control:	Remote teleoperation, line-of-sight, autonomous
Manipulator:	None
Stairs:	Yes, until 30 degrees, 10 cm
Incline:	35 degrees

Communication equipment

Type:	Breeze ACCESS VL Wimax System
Frequency:	5400 MHz
Possible frequency range:	from 5470 to 5725 MHz
Power:	1000 mW
Number of channels:	12

Type:	Belkin F5D8230-4 Pre-N Router Wifi System
Frequency:	2400 MHz
Possible frequency range:	from 2400 to 2483,5 MHz
Power:	100 mW
Number of channels:	13

Type:	RACOM MD400 Radio Modem
Frequency:	459,530 MHz
Possible frequency range:	from 380 to 470 MHz
Power:	10 W
Number of channels:	2

Sensor equipment

Laser:	3 x Sick LMS 221
Vision:	Digital PTZ Camera
GPS:	DGPS, SirfIII-GPS-Mouse
Other sensors:	Optical Movement Recognition, Ultrasonic sensors

Platform main capabilities

The ground robot AMOR (Autonomous Mobile Outdoor Robot) is built upon a commercial ATV (All Terrain Vehicle) platform by Yamaha. The mechanical platform allows a wide area of operational scenarios as it is robust and has notable cross-country capabilities on the one hand and is able to drive at high speeds while having a big operating range on the other hand. The sensor equipment of AMOR comprises various internal and external sensors enabling the robot to solve different tasks autonomously. The system design is highly modular and thus permits the mastering of many scenarios. Software-sided AMOR is equipped with several modules which enable the robot to perform all actions necessary to act autonomously in a rough and unstructured outdoor environment. Beside the software prerequisites for autonomous navigation like local and global path planning and obstacle detection and avoidance AMOR's software architecture comprises capabilities like vehicle & person following and textured 3D-map generation to mention only a few.

By employing active (laserscanner) and passive sensors (video camera) in the system either robustness is improved or the sensortype can be adapted to the task e.g. if active radiation is undesired.

Different internal models are available for an adequate environment description. While often point clouds are used (which are also available in our system) a surface model delivers a more powerful and easier to interpret representation. These scenes can be easily understood by untrained personal on a 3D screen. They are also much more robustly analysable by algorithms than other representations. Relevant objects like dirt roads, pathways, obstacles and persons are recognised in the scene.

The ground robot AMOR during a trial

3D surface model from real LMS data, gathered in real-time with a low cost scanning system

Armadillo M-UGV

MacroUSA / M-Swiss Consulting S.A.

Team name: MacroUSA Armadillo
Team leader: Cino Robin Castelli
Team leader's email: rcastelli@macrousa.com
Nationality: Italian

Use at ELROB 2010: • **Static Display** • **Open Display** • **Scenario**

Basic data	
Height: Chassis height:	72 mm
Wheel Height:	100 mm
Width:	236 mm
Length:	268 mm (including wheels)
Weight:	2.1 kg (ARMADILLO UGV only)
Ground clearance:	24 mm
Average noise level:	Not measured
Climbing performance:	45 degree
Wheel or track driven:	Tracksorb wheels
Propulsion:	batteries
Endurance:	2 hrs on battery
Max. speed:	10 km/h
Payload:	3 kg
Turning diameter:	0 cm (turns on centre of robot)
Mobility	
Climbing performance:	100%
Wheel or track driven:	Tracksorb wheel
Locomotion:	four wheels
Steering:	skid
Tether:	none
Control:	Remote teleportation, line-of-sight and non LOS
Manipulator:	None
Stairs:	No
Incline:	45 degrees
Communication equipment	
Type:	Digital videolink
Frequency:	1200 or 2400 MHz
Possible frequency range:	from 1200 to 1400 MHz or 2300 to 2500 MHz
Power:	20 dB
Number of channels:	50
Other:	COFDM Modulation
Type:	Telemetry link
Frequency:	902-928 MHz
Possible frequency range:	from 2288 to 2551 MHz
Power:	30 dB
Number of channels:	50
Other:	FSK telemetry Modulation, Hopping
GPS:	DGPS, SirfIII-GPS-Mouse
Other sensors:	Optical Movement Recognition, Ultrasonic sensors

Sensor equipment

Vision:	2 driving cameras (night day)
	4 situational awareness cameras (grant 360° vision)
GPS:	Optional GPS modules available
Navigation:	Digital Magnetic Compass integral to unit
Inertial measurement unit:	Internal Accelerometer

Platform main capabilities

The ARMADILLO UGV is a 4 wheel drive mobile platform UGV, equipped with 5 high resolution colour day, and low light monochrome cameras, with audio / video transmission. It is designed for surveillance, inspection and reconnaissance missions intended to extend operator‘s visual capability and increasing his safety.
The UGV design allows it to negotiate difficult terrain, with the capability to continue operations after overturning due to its capability to operate in any orientation.
The CDS Unit has the basic commands to control the UGV (speed and direction) as well as the secondary functions, with a sunlight readable, colour monitor showing the images captured by the UGV‘s cameras.
The transportation accessories are provided to transport both the UGV with its control station, and all ancillaries offering a robust, lightweight and practical container for transportation and storage.
The ARMADILLO UGV allows inspection into areas difficult to reach (recesses, culverts, tunnels, etc.), or to survey potentially dangerous areas, allowing the observer to keep himself in a safer position. It is also suited for stealth reconnaissance missions in urban environments thanks to the very limited size and noise signature achieved when in “creep” mode.
This device is both an instrument for useful intelligence information gathering and gaining tactical advantage in low intensity conflict scenarios.
A typical use of this system could be represented by patrol missions in urban environments with armoured vehicles where the UGV could be deployed from the vehicle (without need to exit the protection granted by the armour) and driven to crossroads or other dangerous areas to check if they are free of enemy presence before entering the zone with the armoured vehicle.
Another application is represented by close examination of suspicious objects or vehicles. Its relatively small size, compared to other units and its agility allow a safer approach to objects and an improved movement capability in narrow passages.

Armadillo M-UGV

CBRNE robot

Fraunhofer Institute for Communication, Information Processing and Ergonomics

Use at ELROB 2010: • **Static Display** • **Open Display**

Basic data

Height (max):	135 cm (including antennas)
Height (min):	50 cm (without antennas)
Width:	115 cm
Length:	175 cm
Weight:	640 kg (including all accessories)
Turning diameter:	99 cm (turns on centre of robot)
Ground clearance:	15 cm

Mobility

Climbing performance:	80%
Wheel or track driven:	wheel convertible into track driven
Propulsion:	electric (optional diesel generator)
Endurance:	2 hrs
Max. speed:	13 km/h
Payload:	200 kg
Locomotion:	6 wheels (2 tracks)
Steering:	skid
Tether:	not available
Control:	Remote teleportation, semi autonomous, autonomous
Manipulator:	None
Stairs:	not possible
Incline:	45 degrees

Communication equipment

Type:	Proxim WLAN Meshnetwork
Frequency:	5725 MHz
Possible frequency range:	2.4 GHz to 2.4835 GHz and 5.15 GHz to 5.725 GHz
Power:	from 100 mW to 1W
Number of channels:	13+19
Other:	AdHoc Network, dynamic topology
Type:	VTQ Orca Digital Video Link
Frequency:	375 MHz
Possible frequency range:	230 MHz to 390 MHz and 2.3 GHz to 2.47 GHz
Power:	1W
Number of channels:	12+15
Other:	COFDM and low delay digital video link

Sensor equipment

Laser:	Sick Laser LMS 200, Velodyne HDL-64E
Vision:	60° eight camera system or Jentech Zoom Camera
GPS:	Oxford RT300X IMU
Other sensors:	CBRNE Sensors - Thermo Fischer MDS - ICX IdentiFinder - RaeSystems MultiRAE+ - Smith Detection LCD 3.3

Platform main capabilities

We present an unmanned CBRNE robot. The system was iteratively evolutionary built in close cooperation with the ABC/Se school of the Bundeswehr. Within very little time (about 10 months), this robot was built on a wheel-drive platform. The design of the system followed two major principles

1. Modular: Modules can easily be added and replaced for different tasks. Furthermore additional modules for new sensors can be constructed with low effort. The sensors can be removed from the robot for personal use anytime without the need of tools.
2. Only COTS sensors: These systems are usually easier to purchase and less expensive than prototypes or custom solutions. Additionally, it is not necessary to develop new training methods for equipment that is already in use by the force. In the current state the system can detect CRN hazards. In the near future B and E sensors will be equipped when they become available.

At the same time a mobile control station was developed and integrated into a car. The operator controls the robot from this control station, aided by several assistance systems. Readings from the sensors are transmitted to the control station in real time where trained personnel can evaluate them. The soundness of the design has been tested on various occasions, including scenarios with coordinated multi robot systems.

CBRNE robot during a field test in Hammelburg, Germany, 2008

Cheatah VTE-3500

Parosha Innovators b.v.

Use at ELROB 2010: • **Static Display**

Basic data

Lenght:	1133 mm
Width:	683 mm
Height (upperdeck):	361 mm
Underbelly clearance:	110 mm
Track:	600 mm
Mass:	283 kg
Suspension:	Helicoil torsion springs and torsion bars
Spring articulation:	100 mm
Trackwidth:	100 mm

Mobility

Traction batteries:	LiFeSO4 battery-pack 7200 Wh total
Mainfuse (on upperdeck):	Littlefuse 140 A
Power:	2 permanent magnet DC motors 2,5 kW each.
Output shaft torque:	110Nm each motor
Minimum turning circle:	1318 mm
Turning speed:	360°/sec.
Vertical step:	200 mm
Horizontal step:	450 mm
Speed:	7,2 km/h (2m/s) or 3,6 km/h (1m/s) both forward and reverse
Max. Range:	15 km over dry smooth horizontal concrete 7 km Cross Country
Max. gradient:	100%
Max. side slope:	70%
Max. towing force on tracks:	2 kN (1 kN each track)
Payload:	90 kg
Operating temperature range:	-25°C up to 55°C
Operating moisture range:	10% --- 90%
Max. wading depth:	2,5 m

Communication equipment

RC-Transmitter:	Tele-Radio T60TX-06SOL
RC-Receiver:	Tele-Radio T60RX-06ASL
RC-Receiver antenna:	Tele-Radio ¼-433K3 (17 cm)
Range RC-system:	500 – 1200 meter
Frequency RC-system:	433,92 MHz or 900 MHz
Frequency drive camera signal:	2,3 / 2,4 GHz

Sensor equipment

Vision:	Thales RB-46
GPS:	Garmin 2012 Pr-1

Platform main capabilities

CHEATAH VTE-3500 High Mobility Multirole Robot Platform for Unmannend Ground Vehicles (UGV) and Explosive Ordnance Disposal Robots (EOD)

The vehicle is fitted with 100 mm wide fine pitch wear-resistant manganese steel tracks for smooth and quiet running and longlife operation. In contrast with it's counterparts, the platform's track-system is fitted with a fully balanced road-wheel suspension which will ensure a maximum "ride-comfort" for the on-board equipment. Because of its electric power packs, noise production and infra-red radiation image is very low. Each track-sprocket is driven by an electric permanent magnet traction motor and gearbox which is fed by LiFeSO4 batteries via an electronic control unit for speed and direction control. Because of the watertight hull, and the absense of the need for air, driving in dust- and gas-explosion hazardous areas is possible. Deep wading, driving and hiding underwater is possible upto a depth of 2,5 meter.

Provisions are made to accomodate and install day and night video cameras, thermal imaging equipment; an integrated position locating system and laser rangefinder capable of accurately determining the location of targets; acoustic detection system, light vehicle obscuration smoke system, automatic chemical agent detection alarm, AN/VDR-2 nuclear detection system, real-time data-transmitting sys-tem, etc.

The platform provides the back-bone and carrier for SUGV's and robots performing scouting, surveillance and target acquisition; direct fire; bunker and light-armor destruction; obstacle breaching; nuclear, biological and chemical reconnaissance; employment of non-lethal weapons; obscurant delivery; engineer reconnaissance and transporting ammunition, explosives or equipment. The platform is rugged and mechanically very tough and reliable, and needs a minimum of maintenance.

Beyond special equipment for field-reconnaissance operations, the platform provides a carrier with accomodation for installing specialized electro-optical and electro-magnetic equipment such as : camera's, sensors, ground-radar, x-ray equipment and robot-arm manipulators for tracing mines and explosives and bomb disposal operations or other triple D operations (Dull, Dangerous and Dirty). In that roles the platform is remote controlled by radio or glass-fibre.

Cheatah VTE-3500 High Mobility Multirole Robot Platform

Cheatah VTE-3500 High Mobility Multirole Robot Platform with Robot Arm

Cheatah VTE-3600

Parosha Innovators b.v.

Use at ELROB 2010:	• **Static Display**

Basic data

Lenght:	1325 mm
Width:	683 mm
Height (upperdeck):	361 mm
Underbelly clearance:	110 mm
Track:	600 mm
Mass:	312 kg
Suspension:	Helicoil torsion springs and torsion bars
Spring articulation:	100 mm
Trackwidth:	100 mm

Mobility

Traction batteries:	LiFeSO4 battery-pack 9200 Wh total
Mainfuse (on upperdeck):	Littlefuse 140 A
Power:	2 permanent magnet DC motors 7,5 kW each.
Output shaft torque:	110 Nm each motor
Minimum turning circle:	1318 mm
Turning speed:	360°/sec.
Vertical step:	200 mm
Horizontal step:	495 mm
Speed:	7,2 km/h (2m/s) or 3,6 km/h (1 m/s) both forward and reverse
Max. Range:	22 km over dry smooth horizontal concrete 9 km Cross Country
Max. gradient:	100%
Max. side slope:	70%
Max. towing force on tracks:	2 kN (1 kN each track)
Payload:	110 kg
Operating temperature range:	-25°C up to 55°C
Operating moisture range:	10% --- 90%
Max. wading depth:	2,5 m

Communication equipment

RC-Transmitter:	Tele-Radio T60TX-06SOL
RC-Receiver:	Tele-Radio T60RX-06ASL
RC-Receiver antenna:	Tele-Radio ¼-433K3 (17cm)
Range RC-system:	500 – 1200 meter
Frequency RC-system:	433,92 MHz or 900 MHz
Frequency drive camera signal:	2,3 / 2,4 GHz

Sensor equipment

Vision:	Thales RX-76
GPS:	Garmin 2012 Pr-1

Platform main capabilities

CHEATAH VTE-3600 High Mobility Multirole Robot Platform for Unmannend Ground Vehicles (UGV) and Explosive Ordnance Disposal Robots (EOD)

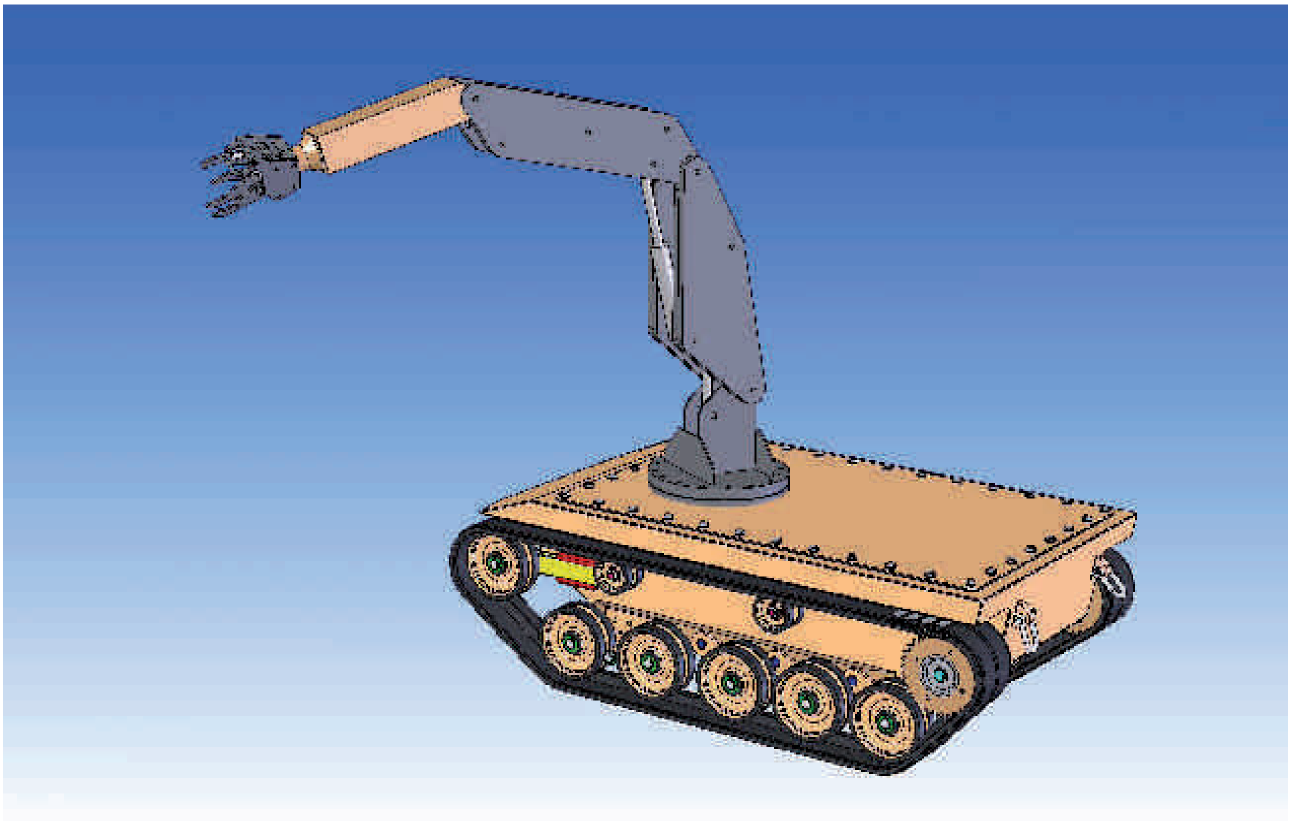
The Cheatah VTE-3600 tracked robot-platform is a bit larger and heavier than the Cheatah VTE-3500 and is developed to privide a more powerfull high mobility multi-purpose platform and a better base for mounting heavy-duty hydraulic powered robot-arms. Like the Cheatah VTE-3500 it is designed, developed and manufactured by Parosha Innovators b.v. of The Netherlands.

From August 2006 the platform has got its enduration trials in which it has driven long distances in the most different parts of the world. The vehicle is fitted with 130 mm wide fine pitch wear-resistant steel-reinforces plastic tracks for smooth and quiet running and longlife operation. Further, it has 10 instead of 8 roadwheels. Intern it provides more space for batteries which results in a longer maximum range in comparisation with the Cheatah VTE-3500.

Like the Cheatah VTE-3500, each track-sprocket is driven by an electric permanent magnet traction motor and gearbox which is fed by LiFeSO4 batteries via an electronic control unit for speed and direction control. Because of the watertight hull, and the absense of the need for air, driving in dust- and gas- explosion hazardous areas is possible. Deep wading, driving and hiding underwater is possible upto a depth of 2,5 meter.

Provisions are made to accomodate and install day and night video cameras, thermal imaging equipment; an integrated position locating system and laser rangefinder capable of accurately determining the location of targets; acoustic detection system, light vehicle obscuration smoke system, automatic chemical agent detection alarm, AN/VDR-2 nuclear detection system, real-time data-transmitting sys-tem, etc.

The platform provides the back-bone and carrier for SUGV's and robots performing scouting, surveillance and target acquisition; direct fire; bunker and light-armor destruction; obstacle breaching; nuclear, biological and chemical reconnaissance; employment of non-lethal weapons; obscurant delivery; engineer reconnaissance and transporting ammunition, explosives or equipment. The platform is rugged and mechanically very tough and reliable, and needs a minimum of maintenance.



Cheatah VTE-3600 High Mobility Multirole Robot Platform with Cheatah VTE-1216 RA Robot Arm

Cheatah VTE-3900

Parosha Innovators b.v.

Use at ELROB 2010: • **Static Display**

Basic data

Vehicle mass empty:	2500 kg
Payload:	1000 kg
Engine:	Yanmar 4TNV88 diesel or Kubota V2203M diesel
Transmission:	Diesel-Hydraulic constant fourwheel drive.
Diff-lock systeem:	Full-automatic
Steering-system:	Articulated steering system hydraulic
Wheel load distribution:	4 x 25%
Traction/Wheeltorque distribution:	4 x 25%
Tyres:	Michelin XZL R16 (adjustable tyre pressure and run-flat system)

Mobility

Max. speed:	5 km/h
Wheel suspension articulation:	250 mm
Hydraulic underbelly adjustment range:	600 mm
Max. range without refuelling:	200 km
Max. towing-force:	12 kN
Ambient temparature range:	-15°C <-------> + 50°C
Max. wading depth (onprepared):	0,7 m
Max. langshelling:	30°
Minimum turning circle:	ø 8,00 m
Max. step:	0,7 m
Transportable in:	CH-47 Chinook, C-130H-30 Hercules, ISO-Container
Transportable op/in:	NATO Flatracks
Transportable as helicopter sling-load:	CH-47 Chinook , AS 532 Mk2 Cougar
Paintsystem / Coating:	According to customer specification
Winches:	Hydraulic 6 tons, front and rear
Towing pitch:	Front and rear

Communication equipment

RC-Transmitter:	Tele-Radio T60TX-06SOL
RC-Receiver:	Tele-Radio T60RX-06ASL
RC-Receiver antenna:	Tele-Radio ¼-433K3 (17cm)
Range RC-system:	500 – 1200 m
Frequency RC-system:	433,92 MHz or 900 MHz
Frequency drive camera signal :	2,3 / 2,4 GHz

Sensor equipment

Vision:	Thales RX-76
GPS:	Garmin 2012 Pr-1

Platform main capabilities

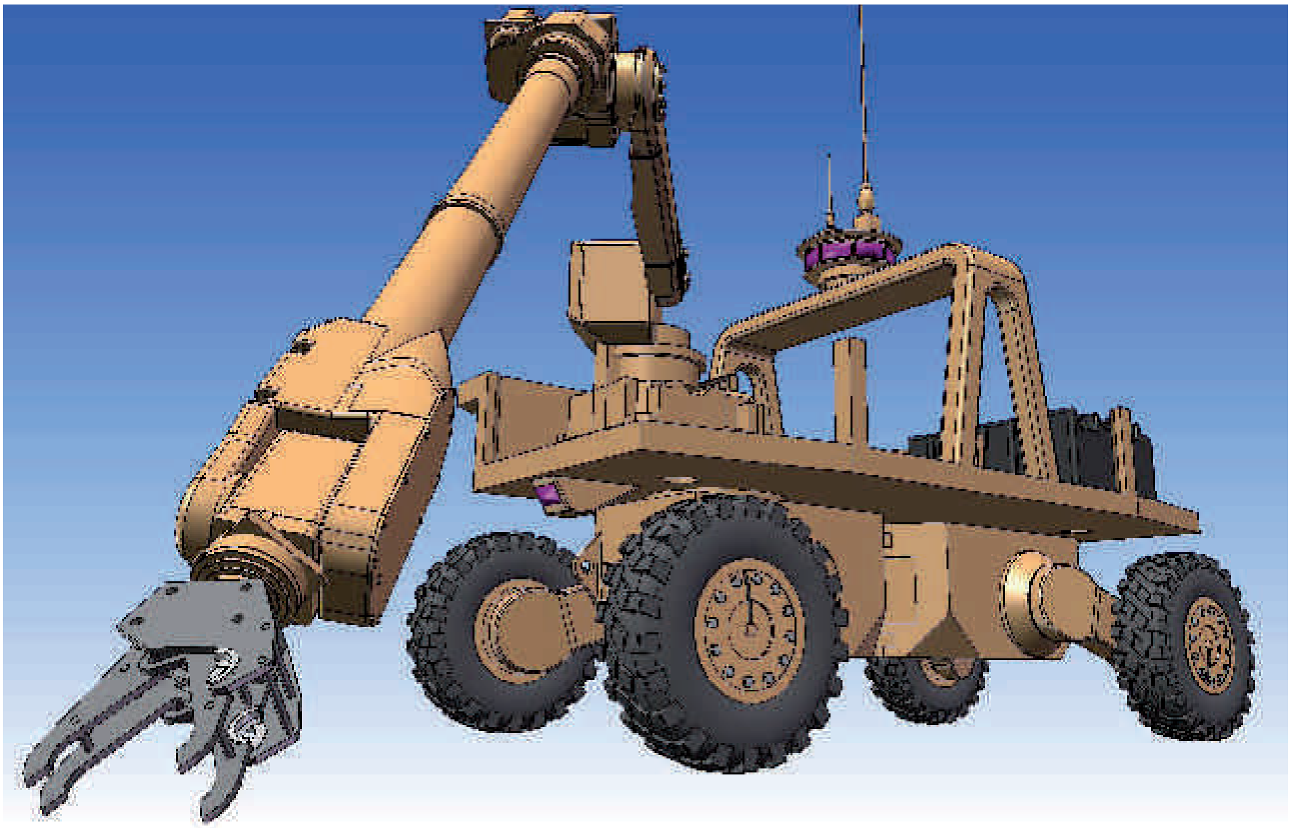
CHEATAH VTE-3900 Multifunction Utility/Logistics Equipment (MULE) Vehicle

The Cheatah VTE-3900 is a four-wheel driven unmanned ground vehicle with a high all-terrain and cross-country capability which is specially designed for roles in high risk areas. It can be fitted with a large load-bed (MULE-role), all-round situational-awareness camera-system and software (Reconnaissance-role), long manipulater/robot-arm (EOD-role), weapon-systems (Combat-role) or relay-station equipment (Relay-station-role). The vehicle is fitted with a roll-bar to provide accomodation for antennas and camera's.

The CHEATAH VTE-3900 is 4245 mm long, 2028 mm wide and 2122 mm high (top roll-bar) The Cheatah VTE-3900 is able to drive along a series of waypoints (autonomous transport) or by remote control with live-video-control-data-link (long distance reconnaissance).

Multi-role :

- EOD
- Long distance reconnaissance, Surveillance, Scouting
- Relay station for UAV's en radio-datalink com-munication
- Long distance transport



Cheatah VTE-3900 Multifunction Utility/Logistics Equipment (MULE) Vehicle

Defender D2

Allen Vanguard Ltd

Team name:	Team Allen
Team leader:	Kieran Nolan
Team leader's email:	kieran.nolan@allenvanguard.com
Nationality:	Irish

Use at ELROB 2010: • **Static Display** • **Scenario**

Basic data

Height (max):	256 cm (including elevated arms and antennas)
Height (min):	115 cm (without arms and antennas)
Width:	72.5 cm
Length:	152 cm
Weight:	275 kg (including all accessories)
Turning diameter:	168.5 cm (turns on centre off robot)
Ground clearance:	10 cm
Other:	metallic coating

Mobility

Climbing performance:	100%
Wheel or track driven:	Wheel
Propulsion:	Electric 2 x 12 v DC Batteries
Endurance:	4-5 hrs (mission dependent)
Max. speed:	3.2 km/h
Payload:	300 kg
Locomotion:	(Six independently driven motors)
Steering:	Skid
Tether:	150 m Ethernet (standard), 300 m Fibre Optic (optional)
Control:	Tele-operation, line-of-sight and non-Line of Sight
Manipulator:	Yes with six freedoms of movement
Stairs:	Yes, 45 degrees
Incline:	45 degrees
Other:	X-Ray and Sensor integration

Communication equipment

Type:	WLAN 802.11g
Frequency:	2400 MHz
Possible frequency range:	from 2400 to 2484 MHz
Power:	from 100 mW to 1W
Number of channels:	14

Sensor equipment

Laser:	Nil
Vision:	Six CCD Cameras
GPS:	Garmin GPS-16
Other sensors:	Nil

Platform main capabilities

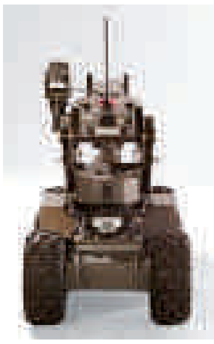
The Defender represents the next generation of large scale Remotely Operated Vehicles. It is designed specifically to deal with the evolving threat of IEDs while retaining the core capabilities of EOD requirements.

The Defender is a strong, robust, versatile, safe and reliable system. It integrates seamlessly with a range of other EOD equipment and accessories to expand its capability, its modularity allows for field re-configuration as well as straight forward maintenance.

The Defender is designed to offer optimum response to VBIED threats. It also extends the range of security functions with ultra-sensitive hazardous material identification.

Defender D2
The Defender incorporates a number of internal modifications and is fitted with a dual disruptor mount; a shotgun mount and on-board firing cable



Ground Robots

Digital Vanguard

Allen Vanguard Ltd

Team name:	Team Allen
Team leader:	Kieran Nolan
Team leader's email:	kieran.nolan@allenvanguard.com
Nationality:	Irish

Use at ELROB 2010: • **Static Display**

Basic data

Height (max):	227 cm (including elevated arms and antennas)
Height (min):	39,5 cm (without PTZ Camera and antennas)
Width:	45 cm
Length:	95 cm
Weight:	56 kg (including all accessories)
Turning diameter:	105 cm (turns on centre off robot)
Ground clearance:	10 cm
Other:	metallic coating

Mobility

Climbing performance:	100%
Wheel or track driven:	Track
Propulsion:	Electric 24 v battery pack
Endurance:	3-4 hrs (mission dependent)
Max. speed:	3.2 km/h
Payload:	200 kg
Locomotion:	(Two motor/gearbox combination)
Steering:	Skid
Tether:	150 m Ethernet (standard), 300 m Fibre Optic (optional)
Control:	Tele-operation, line-of-sight and non-Line of Sight
Manipulator:	Yes with six freedoms of movement
Stairs:	Yes, 45 degrees
Incline:	45 degrees
Other:	X-Ray and Sensor integration

Communication equipment

Type:	WLAN 802.11g
Frequency:	2400 MHz
Possible frequency range:	from 2400 to 2484 MHz
Power:	from 100 mW to 1W
Number of channels:	14

Sensor equipment

Laser:	Nil
Vision:	Six CCD Cameras
GPS:	Garmin GPS-16
Other sensors:	Nil

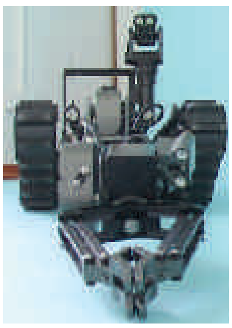
Platform main capabilities

Rugged, adaptable and portable, the Digital Vanguard is the most versatile small ROV in the marketplace.

The Digital Vanguard is robust, versatile and skilled at performing a critical range of law enforcement and military EOD/IEDD functions effectively. Its modular construction and advanced electronic design makes maintenance and support in the field simple and inexpensive, improving the life cycle of the machine.

A new digital command system makes the Digital Vanguard fully interoperable with the Defender ROV. The Command Console is small but rugged, it weighs less than 9 kg and provides capacity for further expansion.

The Digital Vanguard during M-ELROB 2008.
Note fitment of the telescopic Arm to give Vanguard's maximum reach of 2.27 m vertically



Ground Robots

Eye Drive

Glückauf Logistik GmbH & Co. KG

Team name:	Glückauf Logistik
Team leader:	H. Schubert
Team leader's email:	schubert@glueckauf-logistik.de
Nationality:	German

Use at ELROB 2010: • **Static Display** • **Open Display** • **Scenario**

Basic data

Height (max):	11 cm (including elevated arms and antennas)
Height (min):	11 cm (without arms and antennas)
Width:	31 cm
Length:	35 cm
Weight:	3,5 kg (including all accessories)
Turning diameter:	0 cm (turns on centre off robot)
Ground clearance:	3 cm
Other:	metallic coating

Mobility

Climbing performance:	35%
Wheel or track driven:	track
Propulsion:	electric
Endurance:	3 hrs
Max. speed:	37 km/h
Payload:	3,5 kg
Locomotion:	(none)
Steering:	skid
Tether:	no
Control:	Remote teleoperation, line-of-sight
Manipulator:	None
Stairs:	no
Incline:	35 degrees

Communication equipment

Type:	Digital videolink / Digital uplink
Frequency:	2.4 GHz
Possible frequency range:	from 2.4 to 2.4 GHz
Power:	from 100 mW to 250 mW
Number of channels:	8

Sensor equipment

Laser:	Red Dot

Platform main capabilities

EyeDrive™ is an observation and surveillance remote-controlled, lightweight mini-robot that provides continuous real-time 360° audio and video surveillance.

A single operator can easily:
- Carry and deploy the robot
- Maneuver it to an optimal position
- Observe & examine the scene in day, night and all weather conditions
- Track the threat

Each EyeDrive system includes:
- A choice of one or two mini-robots
- Communication Unit
- Laptop (supplied by ODF or customer)
- Charger and additional robot battery
- Tactical operations vest (optional)

With EyeDrive's proprietary Point ,n Go™ navigation feature, deploying these rugged surveillance robots is intuitive and easy.

The operator can remain in safe conditions when deploying and placing the remote-controlled robot. It searches into corridors and rooms prior to entry, searches under vehicles, observes and detects suspicious objects. The robot can be placed in standby mode and activated when required. Unique Point ,n Go navigation directs the robot to any location by touching the location on the panoramic view on the control unit; Since no joystick is required, the operator is able to focus on the mission, rather than on driving the robot.

The robot is equipped with robust ODF proprietary Video Motion Detection (VMD) providing early automatic alerts of significant events based on video and audio detection. Events can be recorded, logged and retrieved for evidence and debriefing and/or sent to remote command centers.

ODF Eye Drive

Forbot

Roboterwerk GmbH

Team name:	Roboterwerk Team (RW)
Team leader:	Mathias Hubrich
Team leader's email:	mh@roboterwerk.de
Nationality:	German

Use at ELROB 2010: • **Static Display** • **Open Display**

Basic data

Height (max):	140 cm (including elevated arms and antennas)
Height (min):	20 cm (without arms and antennas)
Width:	50 cm
Length:	60 cm
Weight:	35 kg (without optional sensors)
Turning diameter:	0 cm (turns completely in the center of the robot)
Ground clearance:	6 cm
Average noise level:	60 dB(A)
Other:	aluminium casing

Mobility

Climbing performance:	100%
Wheel or track driven:	wheels
Propulsion:	Rechargeable battery packs
Endurance:	2.5 hrs
Max. speed:	10 km/h
Payload:	20 kg
Locomotion:	six-wheeled, cross country, all terrain vehicle
Steering:	differential steering
Tether:	optional
Control:	Remote teleportation
Manipulator:	optional
Stairs:	single steps
Incline:	45 degrees

Communication equipment

Type:	Wi-Fi
Frequency:	2.4 GHz
Possible frequency range:	Wi-Fi standard
Power:	20 Watt
Number of channels:	Wi-Fi standard

Sensor equipment

Laser:	optional
Vision:	optional user defined
GPS:	optional user defined
Other sensors:	optional user defined

Platform main capabilities

EThe FORBOT robot is a six-wheeled, cross country, all terrain vehicle. The chassis consists of a base hull made of aluminium. The left and right drive trains are located together in the base hull and screwed in so they can be easily swapped out. Each drivetrain has its own motor. Motors and gears commonly used in the industry can be used as required. Power is transmitted from the engine to the drive wheels by highly durable and effective roller chains. The top cover of the robot serves as a platform for the panning head, lift mast, customer-specified sensors and antennas for radio communications. The cover is also made out of aluminium. When delivered, it is 3 cm in height, meaning that the vehicle has an overall height of 20 cm. The space inside the robot can be expanded as required by adjusting the height of the cover.

Roboterwerk GmbH Forbot field test in Ising/Chiemsee

MACE 1

MIRA Ltd

Use at ELROB 2010:	• **Static Display**

Basic data

Height (max):	1 m
Height (min):	90 cm
Width:	1.5 m
Length:	2 m
Weight:	300 kg (500 kg fully laden GVW)
Turning diameter:	5 m
Ground clearance:	30 cm

Mobility

Wheel or track driven:	wheel
Propulsion:	Hybrid elecrtric
Max. speed:	10 km/h
Payload:	300 kg
Locomotion:	4 wheel drive, 4 wheel steer
Steering:	worm and roller
Tether:	optional
Control:	Fully autonomous
Manipulator:	None
Stairs:	No

Communication equipment

Type:	Digital videolink / Digital point to point control
Frequency:	L band and UHF
Power:	License dependant
Number of channels:	8

Sensor equipment

Laser:	3 x Sick Lidar
Vision:	OPS Optical Position System
GPS:	Omnistar
Other sensors:	Ultra sonic, inertial

Platform main capabilities

MACE 1 is MIRA's first research platform used for the development of autonomous systems.

The MACE 1 platform was used to develop powertrain and power management systems during the MOD DTC research programme, and was separately reconfigured as fully autonomous for the MOD Grand Challenge.

The platform is continually used for the further development of augmented tele-operational capabilities.

MACE 1

MACE 1 GC

MACE 2

MIRA Ltd

Use at ELROB 2010:	• **Static Display**
Basic data	
Height (max):	160 cm
Height (min):	128 cm
Width:	178 cm
Length:	277 cm
Weight:	1300 kg
Turning diameter:	250 cm
Ground clearance:	26 cm
Mobility	
Climbing performance:	45cm step
Wheel or track driven:	wheel
Propulsion:	Diesel
Endurance:	8 hrs
Max. speed:	80 km/h
Payload:	1000 kg
Locomotion:	4 x 4
Steering:	worm and roller 2 wheel steer (fitted for 4 wheel steer)
Tether:	optional
Control:	Remote tele operation, non-line-of-sight
Manipulator:	None
Stairs:	Yes
Incline:	90°
Communication equipment	
Type:	Digital videolink / Digital point to point control
Frequency:	L band and UHF
Power:	License dependant
Number of channels:	8
Sensor equipment	
Laser:	3 x Sick Lidar
Vision:	OPS Optical Position System
GPS:	Omnistar
Other sensors:	Ultra sonic, inertial

Platform main capabilities

MACE 2 is a highly mobile platform for autonomous or augmented tele-operational control. It has been specifically designed and built by MIRA as a modular, versatile platform with extreme capabilities to match some of the potential roles envisaged.

MACE 2 has been, to date 2 years in development and has been based on lessons learned from previous UGV programmes. The objective of MACE 2 was to deliver a UGV with:

- Significantly improved mobility over previous UGVs (IMM)
- Low to high speed (greater than 80 km/h) capability
- Increased payload capability
- Modular capability
- Functional Universal Load Carrier
- Advanced UGV engineering research platform

MACE 2 Climbing

MACE 2 Driving

Manipulator vehicle

Fraunhofer Institute for Communication, Information, Processing and Ergonomics

Use at ELROB 2010: • **Static Display**

Basic data

Height (max):	135 cm
Height (min):	40 cm (without arms and antennas)
Width:	68,5 cm
Length:	135 cm
Weight:	375 kg (included all accessories)
Turning diameter:	146 cm (turns on centre off robot)
Ground clearance:	15 cm
Other:	metallic coating

Mobility

Climbing performance:	25%
Wheel or track driven:	track driven
Propulsion:	electric
Endurance:	4 hrs
Max. speed:	3 km/h
Payload:	350 kg
Locomotion:	2 tracks
Steering:	skid
Tether:	optional
Control:	Remote teleportation, line-of-sight
Manipulator:	Yes
Stairs:	no
Incline:	45 degrees

Communication equipment

Type:	Proxim WLAN Meshnetwork
Frequency:	5725 MHz
Possible frequency range:	2,4 GHz to 2,4835 GHz and 5,15 GHz to 5,725 GHz
Power:	from 100 mW to 1W
Number of channels:	13+19
Other:	AdHoc Network, dynamic topology

Sensor equipment

Laser:	Hokuyo UBG-04LX-F01 (equipped on arm), Ibeo Lux
Vision:	Camera mounted on telescope arm
GPS:	Topcon
Other sensors:	inclination sensor

Manipulator vehicle in early test stage, manipulator not yet installed

Mörri / M3

University of Oulu

Team name:	University of Oulu
Team leader's email:	celrob@ee.oulu.fi
Nationality:	Finland

Use at ELROB 2010: • **Static Display** • **Open Display** • **Scenario**

Basic data

Height (max):	67 cm (including elevated arms and antennas)
Height (min):	33 cm (without arms and antennas)
Width:	62 cm
Length:	70 cm
Weight:	70 kg (including all accessories)
Turning diameter:	0 cm (turns on centre off robot)
Ground clearance:	8,8 cm
Average noise level:	60 dB(A)
Other:	metallic coating

Mobility

Climbing performance:	35%
Wheel or track driven:	wheel
Propulsion:	Electricity, LiPo batteries, 2x bldc, max 2900 kW
Endurance:	5 hrs
Max. speed:	20 km/h
Payload:	100 kg (on top) / 2000 kg (in trailer)
Locomotion:	Six-wheel drive & two detachable tracks
Steering:	skid steering 6x6
Tether:	optional tow ball
Control:	Remote control, waypoint navigation
Manipulator:	None
Stairs:	Yes (with optional tracks)
Incline:	50 deg

Communication equipment

Type:	Analog videolink
Frequency:	2380 MHz
Possible frequency range:	from 2370 to 2390 MHz
Power:	30 dBm
Number of channels:	1
Type:	Satelline 3ASd
Frequency:	869,4125 MHz
Possible frequency range:	from 869,4 to 869,65 MHz
Power:	500 mW
Number of channels:	10

Sensor equipment

Laser:	1 x Sick Laser LMS 100, Hokyuo UTM-30lx, Hokuyo URG
Vision:	Ladybug 2, Flir night vision, 2 analog "bullet" cameras
GPS:	xSens MTi-G
Other sensors:	TBD

Platform main capabilities

Mörri is a multipurpose platform with possibility to quickly change the upper part of the robot for specific applications. The size of the robot is limited so that it can operate also indoors and fit through doorways. Very narrow body provide wider wheels, giving more friction and pull capacity. The robot has designed to be as simple as possibly (to manufacture, maintain, fix in field conditions) providing cheap cost and high performance.

Mörri robot (version 2) in C-Elrob 2009 in Oulu, Finland

MuCAR-3

University of the Bundeswehr Munich

Team name:	MuCAR
Team leader:	Prof. Dr.-Ing. Hans-Joachim „Joe" Wuensche
Team leader's email:	joe.wuensche@unibw.de
Nationality:	German

Use at ELROB 2010: • **Static Display** • **Open Display** • **Scenario**

Basic data

Height (max):	240 cm (including elevated arms and antennas)
Height (min):	205 cm (without arms and antennas)
Width:	193 cm
Length:	480 cm
Weight:	2800 kg (including all accessories)
Turning diameter:	1160 cm (turns on centre off robot)
Ground clearance:	30 cm
Average noise level:	81 dB(A)

Mobility

Climbing performance:	45 degree
Wheel or track driven:	4 wheel drive
Propulsion:	fuel (diesel) (3.0 V6 TDI engine)
Endurance:	8 hrs
Max. speed:	205 km/h
Payload:	250 kg
Locomotion:	2 tracks
Steering:	front wheel
Control:	autonomously, manually
Manipulator:	None
Stairs:	No

Communication equipment

Type:	Radio Modem for D-GPS-Base-Station
Frequency:	448,575 MHz
Possible frequency range:	from 447.575 to 449.575 MHz
Power:	10 W
Number of channels:	80

Sensor equipment

Laser:	Velodyne high definition 3D Lidar System
Vision:	3 CCD cameras with wide-angle & tele-lens, mounted on custom build 2 axis platform inside the vehicle
INS:	OxTS RT3003: Full 6 DOF IMU system with integrated D-GPS System
Other sensors:	MEMS Gyros, odometer

Platform main capabilities

The present autonomous robot car of UniBw MuCAR-3 is based on a stock VW Touareg with a V6 TDI engine equipped with an automatic gearbox and a very powerful generator. The vehicle has full drive-by-wire modifications (throttle, brake, parking brake, gearshift of the automatic gearbox) and appropriate sensors to allow for autonomous driving.

Main computing power is provided by a dual-CPU Intel quad-core Xeon L5420 system, with CPUs specially designed for low energy consumption.
An additional high performance NVidia GPU (8000 series) allowes for highly parallel data processing and can be user-programmed in CUDA, a C-similar language. The system is equipped with 8 GB RAM, Ethernet, Firewire, CAN and RS-232 interfaces and a modular storage system for data logging. Electrical power is provided by a 450 W DC-DC power supply from 12 V vehicle power.

Two hard real-time capable dSPACE computers run the low-level controllers. The AutoBox accesses the vehicle I/O (throttle, brake, steering, gearshift actuator, ...) and provides a steering rate control, a velocity controller and a stop-distance controller. The MicroAutoBox runs the camera platform controllers and accesses the motor controllers (pan and tilt axes).

Up to know our research group participated with MuCAR-3 in three challenging robotic contests:

Civilian ELROB 2007: Within the scenario „Autonomous reconnaissance“ 90% of the very difficult mountain and forest track was driven fully autonomously in the fastest time of all competitors.

Military ELROB 2008: We participated in the scenario „Transport Convoy“ where we were able to present robust and smooth autonomous convoy driving at speeds up to 70 km/h and convoy backward driving.

Civilian ELROB 2009: The scenario „Autonomous navigation“ consisted of a track with a length of 5.2km through dense forest. Only MuCAR-3 finished the race, driving 95% of the complete distance fully autonomously in 70% of the allowed time.

Munich Cognitive Autonomous Robot Car 3th Generation, Experimental vehicle in the third generation

MX3

University of Versailles

Team name: University of Versailles
Team leader: Damien Barillot
Team leader's email: isty.rescue@gmail.com
Nationality: French

Use at ELROB 2010: • **Static Display** • **Open Display** • **Scenario**

Basic data	
Height (max):	60 cm (including elevated arms and antennas)
Height (min):	30 cm (without arms and antennas)
Width:	40 cm
Length:	60 cm
Weight:	30 kg (including all accessories)
Turning diameter:	50 cm (turns on centre off robot)
Ground clearance:	10 cm
Average noise level:	<60 dB(A)
Mobility	
Climbing performance:	50%
Wheel or track driven:	wheel
Propulsion:	batteries
Endurance:	1 hr
Max. speed:	<1 km/h
Payload:	5 kg
Locomotion:	(4 wheels)
Steering:	differential
Tether:	none
Control:	Remote teleportation
Manipulator:	None
Stairs:	Yes, until 45 degrees, 20 cm
Incline:	45 degrees

MX3 during the trial C-Elrob 2009 at Oulu.

Communication equipment	
Type:	Digital videolink / Digital uplink
Frequency:	2457 MHz
Possible frequency range:	from 2412 to 2472 MHz
Power:	from 70 mW to 500 mW
Number of channels:	13
Sensor equipment	
Laser:	1 x Sick Laser URG-04
Vision:	2 x Logitech webcams
GPS:	none
Other sensors:	4 x Range finders, gyro, accelerometer, thermal sensor, motion detector, electronic compass

Platform main capabilities

The mini-UGV is able to move true chaotic environment, thanks to his special wheels. It can be deployed to explore buildings, where biggest UGV can't.

MX4

University of Versailles

Team name: University of Versailles
Team leader: Damien Barillot
Team leader's email: isty.rescue@gmail.com
Nationality: French

Use at ELROB 2010: • **Static Display** • **Open Display** • **Scenario**

Basic data

Height (max):	180 cm (including elevated arms and antennas)
Height (min):	160 cm (without arms and antennas)
Width:	70 cm
Length:	100 cm
Weight:	60 kg (including all accessories)
Turning diameter:	200 cm (turns on centre off robot)
Ground clearance:	30 cm
Average noise level:	<80 dB(A)

Mobility

Climbing performance:	20%
Wheel or track driven:	wheel
Propulsion:	batteries
Endurance:	1 hr
Max. speed:	8 km/h
Payload:	20 kg
Locomotion:	(4 wheels)
Steering:	standard
Tether:	none
Control:	Remote teleportation
Manipulator:	None
Stairs:	none
Incline:	20 degrees

MX4 during a test at the Yvelines Science and Technology Institute.

Communication equipment

Type:	Digital videolink / Digital uplink
Frequency:	2457 MHz
Possible frequency range:	from 2412 to 2472 MHz
Power:	from 70 mW to 500mW
Number of channels:	13

Sensor equipment

Laser:	1 x Sick Laser URG-04
Vision:	2 x Logitech webcams
GPS:	Garmin
Other sensors:	motion detector

Platform main capabilities

The UGV is able to move quickly to a waypoint where it can deploy the MX3 mini-UGV to make a detailed reconnaissance.

Ground Robots

Outdoor MERLIN

University of Würzburg

Team name:	Outdoor MERLIN
Team leader:	Prof. Dr. Klaus Schilling
Team leader's email:	schi@informatik.uni-wuerzburg.de
Nationality:	German

Use at ELROB 2010: • **Static Display** • **Scenario**

Basic data

Height (max):	100 cm (including elevated arms and antennas)
Height (min):	60 cm (without arms and antennas)
Width:	60 cm
Length:	65 cm
Weight:	20 kg (including all accessories)
Turning diameter:	200 cm (turns on centre off robot)
Ground clearance:	10 cm
Average noise level:	n.d. dB(A)
Other:	metallic and plastic coating

Mobility

Climbing performance:	70%
Wheel or track driven:	wheel
Propulsion:	batteries
Endurance:	3 hrs
Max. speed:	25 km/h
Payload:	5 kg
Locomotion:	(2 tracks, 0 flipper arms)
Steering:	Ackermann
Tether:	No
Control:	Remote teleportation, line-of-sight
Manipulator:	None
Stairs:	No

Communication equipment

Type:	WLAN 802.11b
Frequency:	2400 MHz
Possible frequency range:	802.11b
Power:	100 mW
Number of channels:	13

Sensor equipment

Laser:	–
Vision:	network & usb cameras
GPS:	Haicom HI 205 III
Other sensors:	gyroscope: Murata CRS03-02, ultrasonic: Senscomp Sensor 600, infrared: Sharp GP2D1215

Platform main capabilities

Our vehicles used in this trial are called “Outdoor MERLIN”. The MERLIN (Mobile Experimental Robots for Locomotion and Intelligent Navigation) family of rovers is based on a modular data processing and control system, implemented on-board for autonomous reactions and coordinating with tele-operation actions from remote control centres. The Outdoor MERLIN vehicles are built for harsh outdoor environments in severe weather situations. These small tele-operated rovers have been designed for numerous inspection and observation tasks in scenarios like detecting pipeline defects, exploring planetary surfaces or tele-learning.

Outdoor MERLIN during a field test in Hammelburg, Germany, 2006

P-09 BigAnt

BORMATEC unmanned vehicles

Team name:	BORMATEC
Team leader:	Franz Bormann
Team leader's email:	info@bormatec.com
Nationality:	German

Use at ELROB 2010: • **Static Display** • **Open Display**

Basic data

Height (max):	75 cm (including elevated arms and antennas)
Height (min):	30 cm (without arms and antennas)
Width:	76 cm
Length:	105 cm
Weight:	65 kg (including all accessories)
Turning diameter:	105 cm (turns on centre off robot)
Ground clearance:	10 cm
Average noise level:	59 dB(A)

Mobility

Climbing performance:	100%
Wheel or track driven:	wheel + track
Propulsion:	battery
Endurance:	2 hrs
Max. speed:	10 km/h
Payload:	50 kg
Locomotion:	(2 tracks,6 wheels)
Steering:	skid
Tether:	optional
Control:	Remote control
Manipulator:	None
Stairs:	Yes, until 45 degrees, 10 cm
Incline:	45 degrees

Communication equipment

Type:	Radio control
Frequency:	2,4 GHz

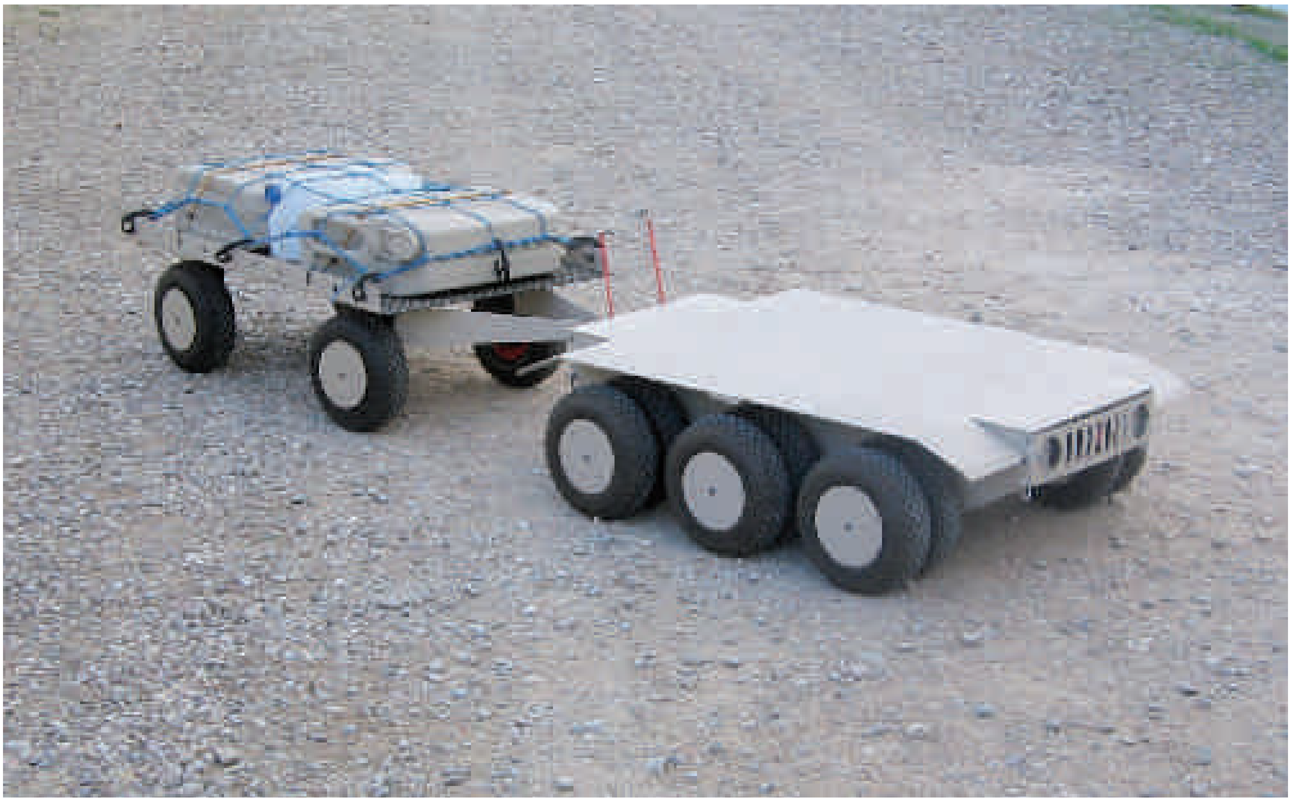
Platform main capabilities

The transport platform P-09 BigAnt is a vehicle with 6x6 drive on which the various devices or appliances on and / or can be built.

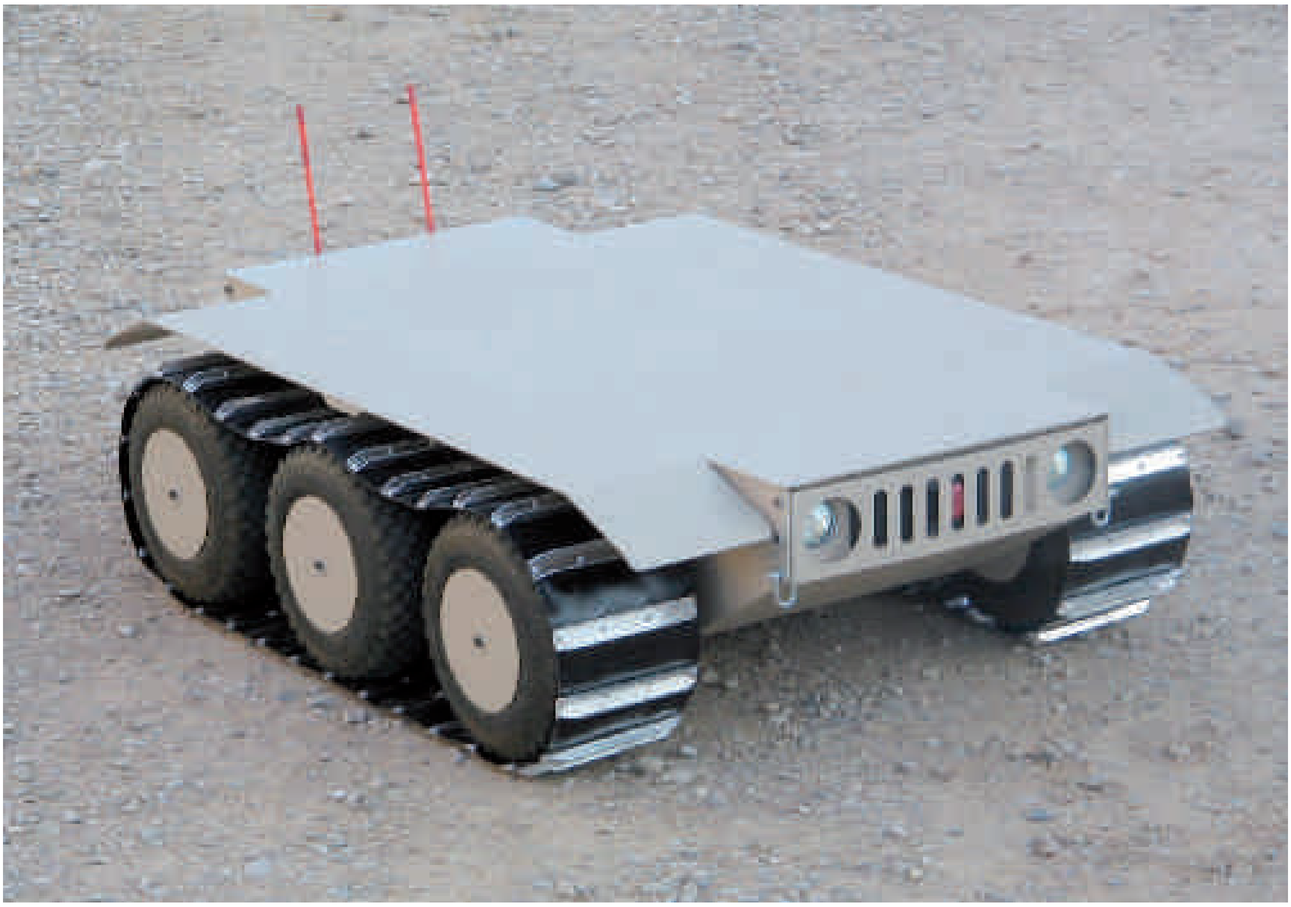
That is within an area from 480 x 330 x 200 mm (about 30 dm³) and outside the platform of 1000 x 800 mm (approx. 0.8 m²) are available.

The robust mechanism is simple and easily operated by anyone. Yes on the application, the performance by increasing the motor and battery capacity can be increased significantly. Also available various items of equipment such as caterpillars, trailer hitch and so on.

By building modules with little construction / replacement parts are required which guarantees a very low-cost maintenance.



P-09 BigAnt



P-09 BigAnt Transport Platform

RAVON

University of Kaiserslautern

Team name:	Team RAVON
Team leader:	Karsten Berns
Team leader's email:	ravon@cs.ini-kl.de
Nationality:	German

Use at ELROB 2010: • **Static Display** • **Open Display** • **Scenario**

Basic data

Height (max):	1.80 m (highest point: GPS antenna)
Height (min):	1.70 m (including sensor tower)
Width:	1.40 m
Length:	2.40 m
Weight:	750 kg
Ground clearance:	0.23 m
Average noise level:	65 dB(A)

Mobility

Climbing performance:	100%
Wheel or track driven:	wheel
Propulsion:	electric (charging accumulators possible using onboard generator)
Endurance:	3 to 4 hrs
Max. speed:	10 km/h
Locomotion:	4 WD
Steering:	two axles independently
Control:	fully autonomous (semi-autonomous and tele-operated possible)
Manipulator:	None
Incline:	45 degrees
Other:	drive: 4 electric motors with 1.9 kW each; steering: two linear motors

Communication equipment

Type:	WLAN 802.11g Cisco Aeronet 340
Frequency:	2400 MHz
Possible frequency range:	2400 - 2483.5 MHz
Power:	max. 500 mW
Modulation:	OFDM
Number of channels:	13

Type:	emergency stop radio link SVS SHT-7
Frequency:	433 MHz
Power:	max. 10 mW
Number of channels:	3

Type:	Freeconnect Mini + BDA25B Amplifier
Frequency:	2.4 GHz Data Transceiver
Possible frequency range:	2400 - 2483.5 MHz
Power:	max. 500 mW
Modulation:	FSK
Number of channels:	8

Type:	Remote Control Logitech Cordless Rumblepad 2
Frequency:	2400 MHz
Possible frequency range:	2400 - 2483.5 MHz
Power:	max. 10 mW
Modulation:	Frequency Hopping Spread Spectrum
Number of channels:	1

Sensor equipment

Laser:	2x Sick LMS 291; 1x Sick S 300
Vision:	Stereo system using 2 PTGrey Dragonfly cameras connected via Firewire (IEEE1394); Stereo system using 2 PTGrey Scorpion highres colour cameras connected via Firewire
GPS:	NAVCOM (John Deere Company) GPS Device
Inertial measurement unit:	custom made
Magnetic field sensor:	custom made
Encoders:	one per wheel, steering unit
Infrared sensors:	Sharp IR-sensors; used to measure position of bumpers (needed for tactile creep)

Platform main capabilities

Mechatronics

Three industrial PCs run the high-level control systems for navigation, image processing, and data collecting. Five DSP boards are attached using two CAN-buses. They execute low-level programmes e.g. for motor control. The power for all systems is delivered by eight accumulators (55 Ah each), which yield an operation time of 3 to 4 hours.

Sensors

RAVON's main sensor system is a panning laser range finder for gathering 3D scans of the area in front of the robot. Two fixed scanners detect obstacles in close proximity. A low-res stereo camera system is the basis for visual odometry and also for obstacle detection. A high-res camera system deals with large-scale terrain traversability estimation. An IMU and two GPS devices are used for localisation. Finally, two bumpers are used to get tactile information about the rigidity of obstacles and to stop the robot in case of a collision.

All information gathered by the sensors is entered into a short-term obstacle memory. This allows for reacting to obstacles beyond the robot's direct sensor view.

Navigation

RAVON's navigation system consists of three layers: The short-range "pilot" is the lowest layer. It deals with tasks like approaching a target. Its anti-collision subsystem accesses sensors indirectly through so-called virtual sensors, represented by sector maps providing abstract interfaces to the obstacle memory.

To improve the navigation in complex environments, the use of so-called passages has been integrated into the second layer, the "mediator". Virtual sensors are used to detect paths between obstacles and to gather further information on their width or orientation. A behaviour-based system guides the robot towards a suitable passage entry.

The top layer ("navigator") is responsible for navigation decisions far beyond the scope of the short- and mid-range navigation components. The global navigation focuses on robot movements from about 10m up to several kilometres using topological maps.

RAVON Robust Autonomous Vehicle for Off-road Navigation

RI A-Bot Standard

RoboticsInventions

Team name:	Robotics Inventions
Team leader:	Marek Sadowski
Team leader's email:	elrob@roboticsinventions.com
Nationality:	Polish

Use at ELROB 2010: • **Static Display** • **Open Display** • **Scenario**

Basic data

Height (max):	125 cm (total height, including antennas)
Height (min):	37 cm (total height from ground to top of the vehicle)
Width:	51 cm
Length:	101 cm
Weight:	100 kg (including all accessories)
Turning diameter:	99 cm (turns on centre off robot)
Ground clearance:	10 cm
Average noise level:	60 dB(A)
Other:	metallic coating

Mobility

Climbing performance:	45 degrees
Wheel or track driven:	track
Propulsion:	batteries
Endurance:	3 hrs
Max. speed:	15 km/h
Payload:	100 kg
Locomotion:	(2 tracks)
Steering:	joystics
Tether:	optional
Control:	Remote teleportation, radio
Manipulator:	None
Stairs:	Yes
Incline:	45 degrees

Communication equipment

Type:	WLAN 802.11b
Frequency:	2400 MHz
Possible frequency range:	2400 – 2800 MHz
Power:	10 mW
Number of channels:	13

Sensor equipment

Laser:	1 x Sick Laser LMS 200
Vision:	2 x Digital Camera
GPS:	2 x GPS
Other sensors:	ultrasonic sensors 12 x

Platform main capabilities

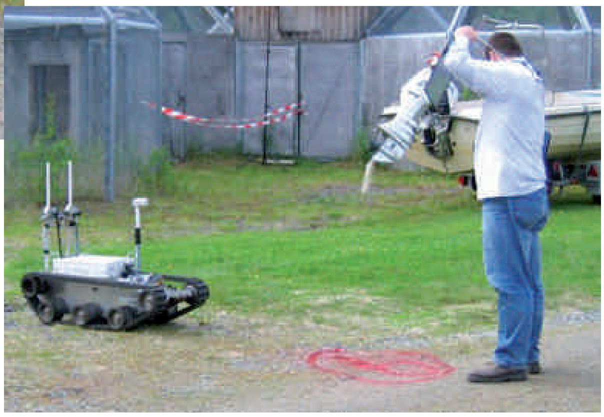
RI A-Bot robot is designed to be a powerful semi-autonomous and fully-autonomous scouting capillary propelled mobile vehicle extensible with an additional 30kg (60 pounds) payload suitable for urban and off-road applications. The robot is capable of following GPS points and omitting the obstacles.
The general applications are monitoring perimeter of a field, building, and military camp announcing the perimeter breech to the operators. The Robot was designed also for missions of searching various terrains and in buildings, mapping, discovering and neutralizing (laser pointing) of the static and moving Objects of Interest.
The construction of the System is modular and easy to be extended with the new modules and capabilities.
RI A-Bot Standard is ready to execute following types of main scenarios (and others):

- scouting and inspection scenario - RI A-Bot undertakes remote sensing of GPS coordinates,
- patrol scenario - RI A-Bot drives the loop of GPS points in a search for possible intruders,
- field support scenario - RI A-Bot acts as a MULE and shuttles with a load on the given GPS pathway,
- intervention scenario,
- mixed scenario - all above mixed with manual control.

The A-Bot robot allows for flexible configuration of modules enabling perfect matching with requirements. The robot's platform can be configured from the following typical components:

- ultrasonic sensors,
- infrared sensors,
- vision autonomous sensors,
- GPS sensor,
- vision cameras,
- extension port,
- silent power source,
- extended power source,
- autonomous module,
- teleoperation module,
- mobile teleoperator suite,
- teleoperator station,
- cargo bay.

RI A-Bot Standard C-elrob 2009



RI A-Bot Standard C-elrob 2009

RoboScout - Systemdemonstrator SD 5.1

BASE TEN SYSTEMS Electronics GmbH

Team name:	RoboScout
Team leader:	Ferdinand Zoller
Team leader's email:	fzoller@BASE10.de
Nationality:	German

Use at ELROB 2010: • **Static Display** • **Open Display** • **Scenario**

Basic data

Height:	280 cm (total height including antennas)
Width:	232 cm
Length:	425 cm
Weight:	3800 kg
Ground Clearance:	40 cm
Wading depth:	60 cm
Average noise level:	Diesel generator 65 dB(A) Accumulator 30 dB(A)

Mobility

Climbing performance:	100 %
Wheel or track driven:	Four (4) wheel drive
Propulsion:	Hybrid with diesel generator, accumulator and wheel hub motors
Endurance:	Diesel 6 h Accumulator 0,5 h
Maximum speed:	60 km/h
Payload (on top):	a) fixed mounted 200 kg b) flexible payload 200 kg
Payload (Trailer coupling):	1500 kg with overrun brake
Payload Platform:	Moveable platform on top of the vehicle
Steering:	Steer by wire, four wheel steering, break by wire
Control:	Remote control, line of sight and non line of sight
Stairs:	Curb up to 40cm
Incline:	45°

Communication equipment

consisting of

a) Terrestrial data/video links between command post and Geckos as well as inter-vehicle communication utilize VHF / UHF IP based radios.

Bandwidth	4.9 MHz
Data/video rate	up to 4Mbit/s
Modulation	COFDM

b) The satellite data/video link utilizes a SOTM antenna mounted on top of the Geckos and an anchor station antenna near the command post with approximately 4.7 m diameter.

Band	KU band
Method	Time division multiple access (TDMA)
Data/video rate	upstream up to 4Mbit/s, downstream 500kbit/s (point to point)
Polarization	horizontal or vertical

Ground Robots

c) Terrestrial service data link based on WLAN

A unique communication computer (ComCom) system located in each Gecko and in the command post automatically selects the best qualified available data link for the operational mission and optimises link quality and data/video rate.

Sensor equipment

Wide angle camera	10	CRVC758/1,65NO1/4“ Colour CCD
Drive camera	2	CCD1000H35/3,6-126 [PAL]1/4“ CCD Colour camera
Infrared camera	2	Zeiss UCM
Scanner systems	6	Ibeo Lux scanners
INS with integrated DGPS	1	IMAR NAV RQH 10023 Laser Gyros and 3 Accelerometers supported by 2 Kalman Filter; 12 Channel GPS L1, L2, P
CCD and IR cameras, LRF	1	Adapted Zeiss Attica System (in payload platform)

Platform main capabilities

Technical Capabilities

The RoboScout System Demonstrator SD 5.1 comprises one moveable command post and two unmanned land vehicles (Geckos).

The system demonstrator is a study to demonstrate the technical feasibility of an extremely agile all terrain robot, controlled via radio or satellite by the RoboScout Control Centre (RCC). The vehicle called Gecko is a four wheel drive, four wheel steering Unmanned Ground Vehicle (UGV) without mechanical differential and track rod. The drive train is strictly electrical, powered by battery and / or a Diesel engine with generator. Comprehensive sensor packages from INU /GPS, IR and daylight cameras to laser scanners allow comfortable remote steering as well as semi autonomous operation. An angle lever system, mounted on top of the vehicle carries payloads such as surveillance or electronic counter measure equipment. Intelligence information is evaluated and interpreted in the RCC and passed to superior institutions if necessary.

The implemented communication systems support the automatical use of relay stations in case of loss of terrestrial radio. The relay station can be stationary, a vehicle (e.g. one Gecko), a plane or a satellite.

Operational Capabilities

The advantages of using robotic equipment are driven by the following aspects:

- Reduction of risk and hazard for the soldiers
- Easy integration into existing and/or future information systems for network centric operations
- Real time data transfer of reconnaissance information to command post and operation centre
- Reduction of necessary operational staff by transfer of routine operations to the robot
- Enhancement of operating time

These benefits predestine the RoboScout system for operational scenarios like reconnaissance patrol, convoy, control missions, advanced post, camp security and logistic support.

In these scenarios, the Gecko can be operated remotely from a stationary command post or a vehicle mounted locomotive control centre. In every configuration, the operator will be supported by semi autonomous functions.

Using terrestrial or airborne relay functions, the operating range can be increased significantly. Utilizing the SOTM satellite link, the operating range is nearly unlimited.

RoboScout - Systemdemonstrator SD 5.1

Robovolc

University of Catania

Team name:	DIEES-UNICT
Team leader:	Prof. G. Muscato
Team leader's email:	gmuscato@diees.unict.it
Nationality:	Italy

Use at ELROB 2010: • **Static Display** • **Open Display**

Basic data

Height (max):	180 cm (including elevated arms and antennas)
Height (min):	120 cm (without arms and antennas)
Width:	80 cm
Length:	130 cm
Weight:	350 kg (including all accessories)
Turning diameter:	150 cm (turns on centre off robot)
Ground clearance:	10 cm
Average noise level:	Very low level (electrical vehicle)
Other:	metallic coating

Mobility

Climbing performance:	20°
Wheel or track driven:	six wheels
Propulsion:	four 42 Ah Sealed Lead-Acid batteries
Endurance:	3 hrs
Max. speed:	4 km/h
Payload:	50 kg
Steering:	skid
Control:	Remote teleportation, line-of-sight; autonomous mode
Manipulator:	SCARA
Stairs:	yes
Incline:	20°

Communication equipment

Type:	WLAN 802.11b
Frequency:	2400 MHz
Possible frequency range:	from 2400 to 2800 MHz
Power:	20 dBm
Number of channels:	16

Type:	Video Radio Link
Frequency:	442.6375 MHz
Possible frequency range:	from 380 to 470 MHz
Power:	1 W
Number of channels:	80

Type:	GPS Correction Data Modem
Frequency:	458.8 MHz
Possible frequency range:	from 450 to 470 MHz
Power:	2 W
Modulation:	GMSK
Number of channels:	10

Sensor equipment

GPS:	Magellan DG14; Ashtech (Magellan) Z-Xtreme
Inertial measurement unit:	Xsens MTI-28A53G35

Platform main capabilities

ROBOVOLC is a new robotic system that has been designed to help scientists in the exploration of volcanoes. It is composed of three main subsystems: a rover platform with six articulated and independently actuated wheels; a manipulator arm to collect rock samples, drop and pick up sensors and sample gas; and a pan-tilt turret with a high resolution camera, video-camera and, infrared camera. The robot use six DC motors with gearboxes and encoders and is powered from two sealed Lead-Acid batteries. Its articulated chassis allows operation in very rough terrains with rocks and sand as it is possible to find on volcanoes.

It is controlled by means of two computer: one for motion and traction control and one (powered from two different sealed Lead-Acid batteries) and one for handling sensors and navigation. It is possible to operate the robot from a remote base station using a WiFi connection.

The Robovolc System during a test on Etna Volcano

RTS - HANNA

University of Hannover

Team name:	RTS - Leibniz Universität Hannover
Team leader:	Prof. Dr.-Ing. Wagner
Team leader's email:	wagner@rts.uni-hannover.de
Nationality:	German

Use at ELROB 2010: • **Static Display** • **Open Display** • **Scenario**

Basic data

Height (max):	300 cm (including antennas)
Height (min):	245 cm (without antennas)
Width:	145 cm
Length:	285 cm
Weight:	800 kg (including all accessories)
Turning diameter:	730 cm
Ground clearance:	17 cm
Average noise level:	70 dB(A) (approximately)
Other:	PARAVAN GmbH drive-by-wire kit, fully street licensed

Mobility

Climbing performance:	100%
Wheel or track driven:	wheel
Propulsion:	diesel engine
Endurance:	>8 hrs
Max. speed:	40 km/h
Payload:	600 kg
Locomotion:	4-wheel, all-wheel drive
Steering:	Ackermann
Tether:	optional
Control:	manual operation, teleoperation, semi-autonomous operation, fully autonomous operation
Manipulator:	None
Stairs:	No
Incline:	45 degrees

Communication equipment

Type:	Satel Satelline – 3Asd Epic Radio Modem
Frequency:	434 MHz
Possible frequency range:	from 380 to 470 MHz
Power:	up to 10 W
Number of channels:	80
Other:	UMTS/GPRS Radio Modem, Lancom OAP-54 WLAN, Emergency Stop

Sensor equipment

Laser:	1 x 3d laser Velodyne HDL-64E, 1 x 3d laser Ibeo Lux 2 x 3d laser RTS ScanDriveDuo
Vision:	1 x Axis 213PTZ
GPS:	1 x Trimble AgGPS 114 DGPS 1 x Navilock NL302 SirfIII GPS
Other sensors:	1 x IMU PerformTech GU3023

Platform main capabilities

Our robot RTS-HANNA is based on an off-the shelf Kawasaki Mule 3010 side-by-side vehicle. Powered by a 24hp diesel engine, the maximum speed of the vehicle is 40km/h with a payload of up to 600kg. A four-wheel drive with differential-lock allows operation in urban as well as in heavy non-urban terrain. Equipped with a drive-by-wire retrofit kit from PARAVAN GmbH, the system enables manual and fully computer control of the vehicle. Nevertheless, the Space-Drive System is fully street licensed and allows manual operation on all public roads. Changing between the operation modes is realized just by turning a switch. Auxiliary features like the headlights, direction lights, horn and the wiper are controllable by the computer as well.

RTS-HANNA is equipped with various sensors for teleoperation, semi-autonomous operation and fully autonomous operation. The main sensors are 3d laser range scanner used for environmental perception. The perceived 3d data are incorporated into the robotic tasks like autonomous obstacle avoidance, object recognition as well as localization and map building.

For vehicle control autonomous driving techniques are used. By pointing into an aerial map, a single or multiple global waypoints are defined by the operator and transmitted to the vehicle. The waypoints are followed by the vehicle fully autonomously. By this means, the operator is removed from the high frequent position control and obstacle avoidance loop. As transmission latencies have no effect on the vehicle control, these waypoints are transmitted via a slow radio channel of limited bandwidth. Using a transfer rate of only 19.2 kilobit a compressed laser scan and a camera image are transmitted from the vehicle to the operator for situational awareness.

Ground Robots

RTS HANNA at the M-ELROB in Hammelburg, Germany

Scorpion S-UGV

MacroUSA / M-Swiss Consulting S.A.

Team name:	MacroUSA Scorpion
Team leader:	Cino Robin Castelli
Team leader's email:	rcastelli@macrousa.com
Nationality:	Italian

Use at ELROB 2010:
- **Static Display**
- **Open Display**
- **Scenario**

Basic data

Height:	125 mm (Total height from ground to top of Chassis, not including Turret cameras if fitted) (approximately)
Height:	170 mm (Total height from ground to top Flapper Wheel)
Width:	386 mm (approximately)
Length:	522 mm (Chassis) (approximately)
Length:	570 mm (including Flapper Wheels)
Wheelbase:	344 mm (approximately)
Weight:	Under 22 kg with all systems
Ground Clearance:	45 mm (approximately)
Average noise level:	Not measured
Turning diameter:	0 cm (turns on centre of robot)

Mobility

Climbing performance:	100%
Wheel or track driven:	flapper wheel
Propulsion:	Lithium Batteries
Endurance:	2 hrs on battery, unlimited on tether
Max. speed:	10 km/h
Payload:	20 kg
Locomotion:	six wheels
Steering:	skid
Tether:	optional, 500 mt Fibre Optic + power
Control:	Remote teleportation, line-of-sight and non LOS
Manipulator:	None
Stairs:	Yes, depending on tread and rise
Incline:	45 degrees
Other:	Has optional Fibre Optic Module and Optional Optics Turret module. Can carry up to 20 Kg of payload attached to Picatinny rail and powered and controlled through payload connector port.

Communication equipment

Type:	Digital video link
Frequency:	4900 MHz
Possible frequency range:	from 4900 to 4999 MHz
Power:	30 dB
Number of channels:	50
Other:	COFDM Modulation
Type:	Telemetry link
Frequency:	2.2-2.4 GHz
Possible frequency range:	from 2288 to 2551 MHz
Power:	30 dB

Number of channels:	50
Other:	COFDM telemetry Modulation

Sensor equipment

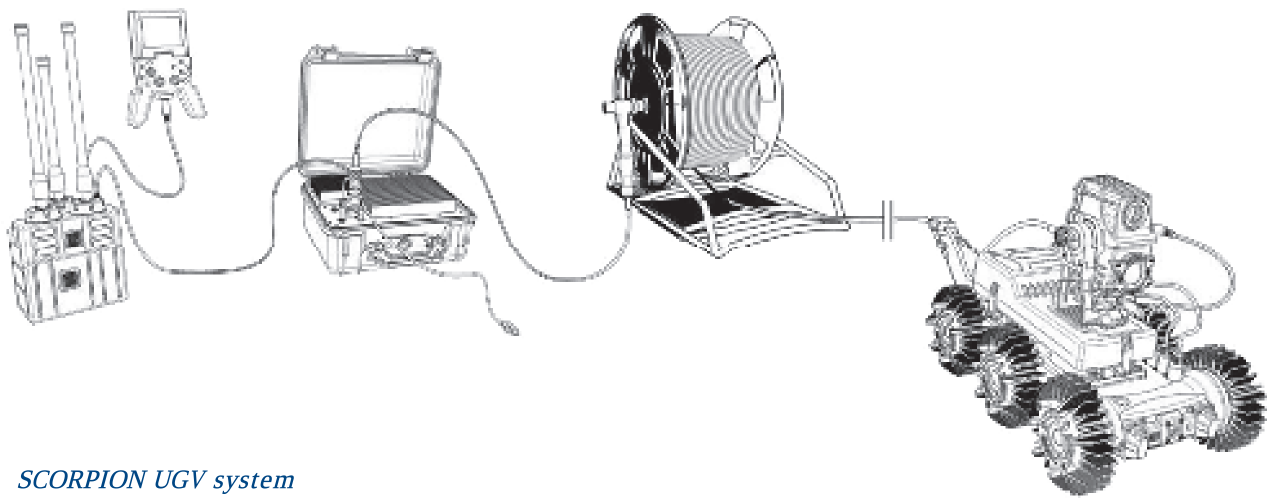
Vision:	2 driving cameras (night day) 1 Colour Zoom Camera in turret (night/day, 27x Optical Zoom) 1 Thermal Imaging Camera in turret (320x240 Pixel, Thermoteknix, 4x digital zoom)
GPS:	Optional GPS modules available
Navigation:	Digital Magnetic Compass integral to unit
Inertial measurement unit:	Internal Accelerometer

Platform main capabilities

The YORK/SCORPION UGV is a 6 wheel drive mobile platform UGV, equipped with 2 high resolution colour day, and low light monochrome cameras, with audio / video transmission as well as a thermal camera and high power zoom camera located in the removable turret assembly. It is designed for surveillance, inspection and reconnaissance missions intended to extend operator‘s visual capability and increasing his safety.
The UGV design allows it to negotiate difficult terrain, with the capability to continue operations after overturning due to its capability to operate in any orientation (only applicable when accessories are not connected).
The Control station has the basic commands to control the UGV (speed and direction) as well as the secondary functions, with a sunlight readable, colour monitor showing the images captured by the UGV‘s cameras.
The transportation accessories are provided to transport both the UGV with its control station,
and all ancillaries offering a robust, lightweight and practical container for transportation and storage.

The YORK/SCORPION UGV allows inspection into areas difficult to reach (recesses, culverts, tunnels, etc.), or to survey potentially dangerous areas, allowing the observer to keep himself in a safer position.
The SCORPION UGV system uses a modular approach to provide sensor back up and redundancy, and a choice of sensors and methods of operation to meet different mission and task scenarios.
It is expected that the System will be used for following mission, and the system described herein is specifically aimed at this mission profile:

- Tunnel and Cave Reconnaissance and Search
- Military operation in urban terrain - Reconnaissance
- House to house building search
- IED Detection
- Intelligence gathering
- Crossroads exploration from inside armoured vehicles in military operations in urban terrain
- Tunnel, culvert, difficult access recesses inspection



SCORPION UGV system

SIM-RACAR-Lambda

SIM Security & Electronic System GmbH

Use at ELROB 2010: • **Static Display** • **Open Display**

Basic data

Height (max):	1300 mm (including elevated arms and antennas)
Height (min):	250 mm (without arms and antennas)
Width:	520 mm
Length:	960 mm
Weight:	95 kg (including all accessories)
Turning diameter:	960 mm (turns on centre off robot)
Ground clearance:	70 mm
Average noise level:	60 dB(A)
Other:	ballistic protection

Mobility

Climbing performance:	85%
Side slope:	40°
Stairs:	Yes, until 40 degrees, max. 19 cm obstruction size
Wheel or track driven:	track
Steering:	superposition
Propulsion:	electric
Endurance:	> 10 hrs
Max. speed:	16 km/h
Payload:	50 kg
Environmental:	-30°C - +60°C, IP68
Control:	Remote teleportation, line-of-sight
Manipulator:	None

Communication equipment

SIM-Milan IP Modem
Digital COFDM TCP-IP Transmission System
Wireless secured HDTV Transmission

High quality IP streaming (up to 20MBit/sec)
COFDM technology for high data rates and long range
Secured transmission (built-in private code)
Diversity technology for optimised transmission quality
RF output power up to 5 W, addi¬tional power amplifier available

Sensor equipment

Laser:	1 x Sick Laser LMS 200
Vision:	OPS Optical Position System
GPS:	Garmin eTrex
Other sensors:	Xsens Mti, Siemens Radar KMY-24

Platform main capabilities

SIM-RACAR-Lambda
Tactical Bullet-proof Surveillance Robot
UGV for Reconnaissance and Combat Applications

Tactical robotic system designed to help first responders make informed decisions from a safe distance. The SIM RACAR system with its UGV of model Lambda has enough space to carry electronic reconnaissance equipment and can be used as platform for tactical equipment.

- all-terrain capability, for outdoor or indoor operations
- Fast and highly manoeuvrable
- Robust chassis, proof against mechanical tampering
- Ballistic and blast protection
- Long operation range and mission time
- Easy to operate, easy to maintain
- Provides enough space to carry electronic reconnaissance equipment
- Can serve as platform for any tactical equipment

Lambda-V003 during a field test., Germany, 2009

Ground Robots

telemax

telerob Gesellschaft für Fernhantierung mbH

Team name:	telerob
Team leader:	Dr. Andreas Ciossek
Team leader's email:	ciossek@telerob.de
Nationality:	German

Use at ELROB 2010: • **Static Display** • **Open Display** • **Scenario**

Basic data

	Dimensions if the vehicle is in stowing position
Height:	75 cm
Width:	40 cm
Length:	80 cm
	Maximum dimensions of the vehicle
Height:	260 cm
Length:	160 cm
Weight:	80 Kg base system
Ground clearance:	depends on configuration

Mobility

Climbing performance:	100%
Track driven:	4 tracks
Propulsion:	battery
Endurance:	up to 4 hrs
Max. speed:	up to 10 Km/h
Payload:	10 Kg

Manipulator

Manipulator with 7 degrees of freedom, Tool-Centre-Point (TCP) control and automatic tool change.

Communication equipment

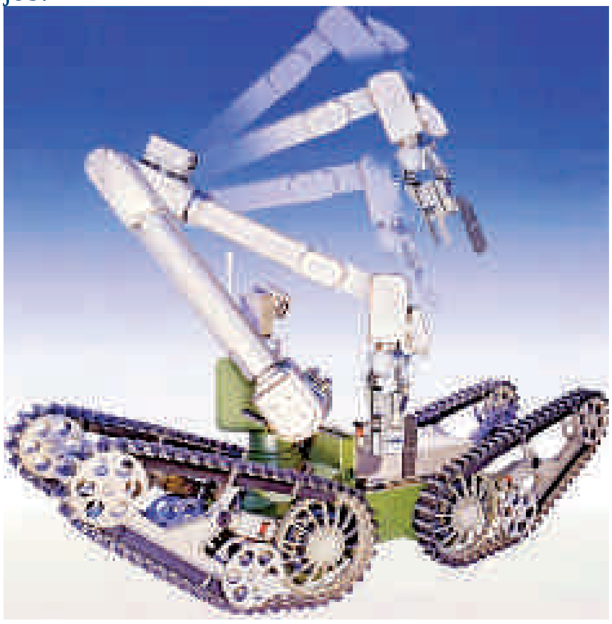
Type:	Analog or Digital videolink
Frequency etc.:	customer specific

Sensor equipment

Customer specific. Sensors can be mounted easily at several places on the vehicle.

Platform main capabilities

What's new about teleMAX is that the user no longer needs to think about which of the seven axes of the manipulator has to be moved into which direction at which speed. The only thing that a user has to do is to look through the gripper camera and move the joystick into the direction he wants to move the gripper. Operating in the background, the system does all the necessary calculations, taking the pressure off the operator and saving time, nerves and a lot sweat. At telerob, we let the robot do the job.



"Don't do it twice if once is enough"

"This would be the perfect moment to have that tool...!" The teleMAX is the only vehicle in its class that has two tool magazines integrated into the chassis. This means that up to two additional tools or sensors can be carried in an operation, eliminating the need to drive back to the base station in order to pick up new equipment and return to the dangerous zone again. The user saves valuable time, permitting him to concentrate on the actual task at hand. At the touch of a button, the manipulator arm automatically picks up an extra tool from the magazine.

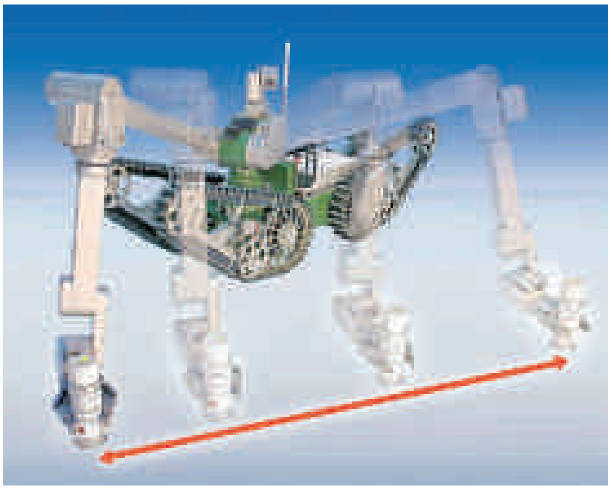
"Be sure an object is as harmless as it looks"

CBRN Detection is most often done by specialists wearing heavy suits to protect them. Nevertheless they are still risking their lives when they inspect suspicious items like dirty bombs. Preferably, a remotely controlled robot should do that job, with the operator sitting well away from the danger zone. To be sure an object is really harmless a close inspection with special sensors is needed. Otherwise one can only tell that the area surrounding the suspicious object is safe, but nothing about the object itself. This is especially true when you are dealing with a chemical and/or biological (CBW) threat. A systematic search is necessary and is best done with an easy-to-use manipulator. This is why the teleMAX can be equipped with a sensor platform that scans the environment, and special sensors that can be used by the manipulator thanks to its innovative and easy-to-use manipulator control technology.

Once Again:

teleMAX. The cameras on the universal interface at the turret, elbow and hand can be easily exchanged. Tool holders on the side of the vehicle can be equipped with several tools like e.g. disruptors.

"Don't send a man to do a robot's job"

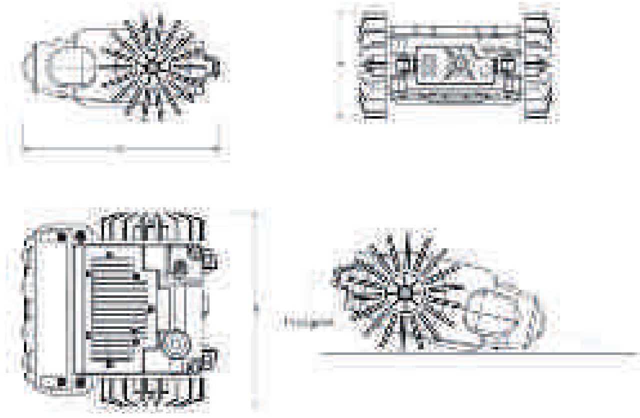


TTC Trowcam M-UGV

MacroUSA / M-Swiss Consulting S.A.

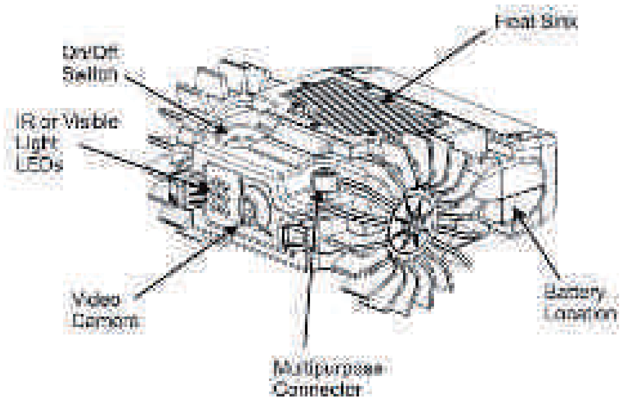
Use at ELROB 2010: • **Static Display** • **Open Display**

Basic data



Height:	72 mm
Width:	130 mm
Length:	132 mm
Weight:	under 500 gr
Ground clearance:	N/A (trails on ground)
Average noise level:	Not measured
Wheel or track driven:	Tracksorb wheels
Propulsion:	batteries
Endurance:	1 hr on battery
Max. speed:	2 km/h
Payload:	None
Turning diameter:	0 cm (turns on centre of robot)

Mobility



Climbing performance:	NA (to be used indoors)
Wheel or track driven:	Tracksorb wheel
Locomotion:	two wheels
Steering:	skid
Tether:	none
Control:	Remote teleportation, line-of-sight and non LOS
Manipulator:	None
Stairs:	No (only down)
Incline:	NA (to be used indoors)
Other:	Complies to multiple MIL-STDs

Communication equipment

Type:	Digital videolink
Frequency:	1200 or 2400 MHz
Possible frequency range:	from 1200 to 1400 MHz or 2300 to 2500 MHz
Power:	20 dB
Number of channels:	50
Other:	COFDM Modulation

Type:	Telemetry link
Frequency:	902-928 MHz
Possible frequency range:	from 2288 to 2551 MHz
Power:	30 dB
Number of channels:	50
Other:	FSK telemetry Modulation, Hopping

Sensor equipment

Vision:	1 driving camera (night day)
Navigation:	Digital Magnetic Compass integral to unit
Inertial measurement unit:	Internal Accelerometer

Platform main capabilities

The Tactical Throwing Camera (TTC) is a man-portable, controllable, transmitting camera to be thrown into forward locations to retrieve video and audio information to achieve the Situational Awareness while engaged in Military Operations in Urban Terrain.
The TTC System is a man-portable, body-worn subassembly of the following sub-parts:

- TTC UNIT (TTC)
- TTC CONTROL DISPLAY UNIT (TTC-CDS)
- TTC ACCESSORIES (TTC-A)

The TTC unit is a novel MACROUSA concept of Throwable camera which presents several advantages over the ball type design that has been present on the market in the recent years. The unit not only has the capability of providing 360° coverage of the area to monitor but, thanks to the novel and innovative MacroUSA motorized disk design, can also be moved within the area to optimize the observation point and enlarge the area that can be monitored. The TTC includes COFDM video transmission and allows reaching a sensor weight in 500 g, including heat sinks.

It has an internal microphone which allows to detect speech up to 5 meter distance as well as IR or visible light LEDs that illuminate up to 7 mt in total darkness (IR or Visible light is a factory setting and cannot be changed on the field).

It uses the same controller as the Armadillo M-UGV (the controllers are interchangeable and can be setup in the field to control either system in a few seconds).

ADVANTAGES OF TTC THROWCAM OVER BALL TYPE THROWING SENSOR

The TTC does not rotate when tossed towards a certain area, and the rubber wheels serve to bring to a halt it, so it has better chances of landing near the desired spot.

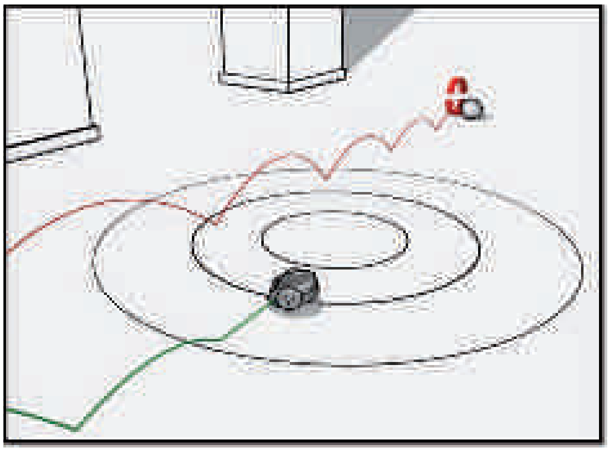
The TTC is very stable on uneven terrain. The TTC will not get stuck on a disadvantageous angle because it can move to a better position.

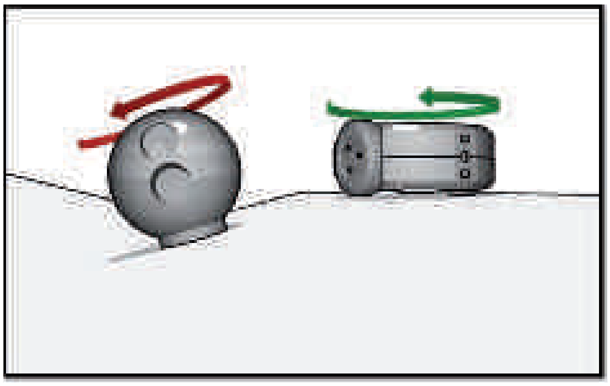
The TTC has the ability to navigate around obstacles if it's thrown and it lands in a disadvantageous position.

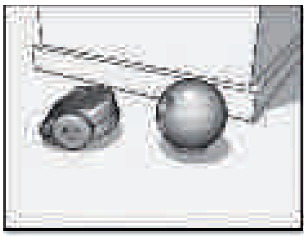
The TTC´s compact format is ideal to carry on pouches and pockets. Its flat surfaces are comfortable to wear.

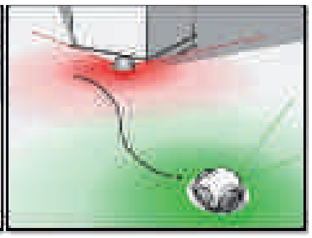
Mission
It is expected that the TTC System will be used for following mission, and the system described herein is specifically aimed at this mission profile:

- House to house building search
- IED Detection
- Intelligence gathering









U-Go Robot

University of Catania

Team name:	DIEES-UNICT
Team leader:	Prof. G. Muscato
Team leader's email:	gmuscato@diees.unict.it
Nationality:	Italy

Use at ELROB 2010: • **Static Display** • **Open Display** • **Scenario**

Basic data

Height (max):	120 cm (including elevated arms and antennas)
Height (min):	80 cm (without arms and antennas)
Width:	60 cm
Length:	120 cm
Weight:	200 kg (including all accessories)
Turning diameter:	100 cm (turns on centre off robot)
Ground clearance:	10 cm
Average noise level:	Very low level (electrical vehicle)
Other:	metallic coating

Mobility

Climbing performance:	40°
Wheel or track driven:	tracks
Propulsion:	Two 200 Ah Sealed Lead-Acid batteries
Endurance:	8 hrs
Max. speed:	2 km/h
Payload:	200 kg
Steering:	skid
Control:	Remote teleportation, line-of-sight; autonomous mode
Manipulator:	None
Stairs:	no
Incline:	40 degrees

Communication equipment

Type:	WLAN 802.11b
Frequency:	2400 MHz
Possible frequency range:	from 2400 to 2800 MHz
Power:	20 dBm
Number of channels:	16

Type:	Data Radio Link
Frequency:	442.6375 MHz
Possible frequency range:	from 380 to 470 MHz
Power:	1 W
Number of channels:	80

Type:	GPS Correction Data Modem
Frequency:	458.8 MHz
Possible frequency range:	from 450 to 470 MHz
Power:	2 W

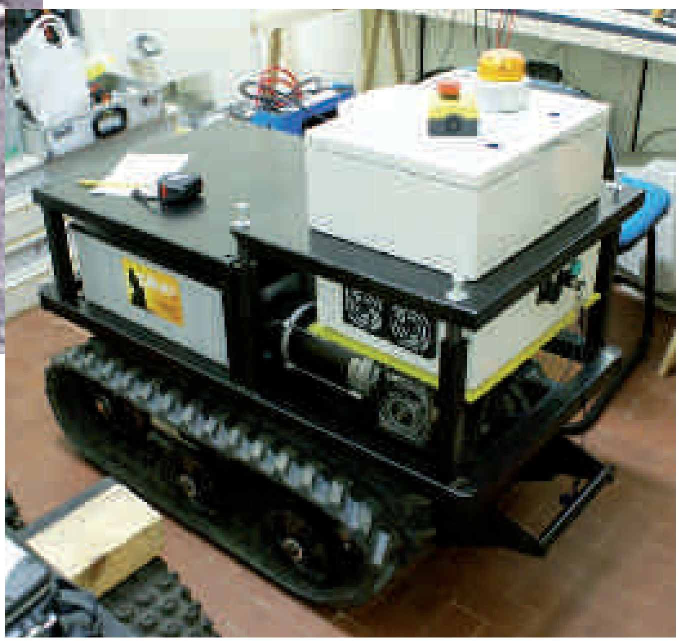
Modulation:	GMSK
Number of channels:	10

Sensor equipment

Laser:	1 x Sick Laser Scanner LMS 291
Vision:	STH-MDCS2-VAR Stereo camera 1.3 megapixel 30 Hz (640x480) with IEEE 1394 interface
GPS:	Magellan DG14; Ashtech (Magellan) Z-Xtreme
	Inertial measurement unit: Xsens MTI-28A53G35

Platform main capabilities

The U-Go Robot is a battery powered tracked vehicle. It use two 600W permanent magnet DC motors with unidirectional gearboxes and rubber tracks. The robot chassis is a very simple and robust one. This kind of structure normally is used in agriculture environment. The robot has been equipped with the power control subsystem, a dual core Pentium PC, a stereo camera, a laser scanner and a WiFi connection. Moreover the robot has a ruggedized radiomodem for teleperation and is also equipped with a 6DOF inertial measurement unit and a DGPS receiver. Algorithms for autonomous navigation are under testing. The software is developed in Microsoft Robotic Studio Environment. Till now, different tests with teleoperation and autonomous navigations in a very harsh volcanic environment have been done. Among the others, the robot has been used for materials and equipment transportation (about 200 kg) on the top of the main crater of the Etna Volcano (3330 m osl) starting from the highest point reachable by cars (about 2 km of very rough terrain).



U-Go Robot during a field test in volcano island, Italy and in the lab

VIPeR®

TELEFUNKEN Radio Communication Systems GmbH & CO. KG

Use at ELROB 2010: • **Static Display** • **Open Display**

Basic data

Height:	40 cm (total height from ground to top, including antennas etc.) without payload
Height:	25 cm (total height from ground to top of the vehicle)
Width:	47 cm
Length:	50 cm
Weight:	15 kg
Ground clearance:	10 cm
Average noise level:	very low (never measured)
Climbing performance:	55 degree
Wheel or track driven:	Track & Wheel
Propulsion:	batteries
Endurance:	4 hrs
Max. speed:	8 km/h
Payload:	8 kg

Communication equipment

Type:	COFDM
Frequency:	2400 MHz & 800 MHz
Possible frequency range:	from 2400 MHz to 2500 MHz
Power:	100 mW
Modulation:	QPSK
Number of channels:	2

Sensors equipment

Vision:	Different Commercial TV cameras
GPS:	Yes
Inertial measurement unit:	Yes

The VIPeR® is designed to carry different sensors: Cameras, NBC detectors, Tear gas dispenser etc.

VIPeR®

Aerial Robots

at

M-ELROB 2010

AirRobot AR 100-B / AR 150

AirRobot GmbH & Co. KG

Team name:	Air Robot Master Team (AMT)
Team leader:	Burkhard Wiggerich
Team leader's email:	info@airrobot.de
Nationality:	German

Use at ELROB 2010: • **Static Display** • **Open Display** • **Scenario**

	AR 100-B / AR 150
Basic data	
Height (max):	50 cm / 70 cm (including elevated arms and antennas)
Height (min):	25 cm / 50 cm (without arms and antennas)
Width:	100 cm / 170 cm
Length:	100 cm / 170 cm
Weight:	1.5 kg / 5 kg (including all accessories)
Turning diameter:	0 cm (turns on centre off robot)
Ground clearance:	2 cm / 10 cm
Mobility	
Climbing performance:	2 m/s / 4 m/s
Wheel or track driven:	rotors
Propulsion:	electric
Endurance:	20 min / 40 min
Max. speed:	36 km/h / 50 km/h
Payload:	0.2 kg / 1 kg
Locomotion:	4 engines / 3x coaxial = 6 engines
Steering:	propulsion speed
Control:	Remote control, waypoint navigation
Communication equipment	
Type:	Digital videolink / Digital uplink
Frequency:	2.4 GHz / 868 MHz
Possible frequency range:	from 1.2 to 5.8 GHz / 200 to 900 MHz
Power:	from 100 mW to 2 W
Number of channels:	256
Sensor equipment	
Laser:	yes
Vision:	dual color / sensitive bw / hires IR / digital still
GPS:	yes
Other sensors:	yes

Platform main capabilities

AirRobot AR100-B
1 km range, 20 min flight time, 200 g payload, stair and hover, 8 m/s wind

AirRobot AR150
4 km range, 40 min flight time, 1 kg payload, stair and hover, 12 m/s wind, CA

FANCOPTER

EMT Ingenieurgesellschaft Dipl.-Ing. Hartmut Euer mbH

Team name: EMT
Team leader: Dr. Bernhard Keidel
Team leader's email: Bernhard.keidel@emt-penzberg.de
Nationality: German

Use at ELROB 2010: • **Static Display** • **Open Display**

Basic data
Height (max): 44 cm (including elevated arms and antennas)
Width: 73 cm
Length: 73 cm
Weight: 1,5 kg (including all accessories)
Other: VTOL-UAV

Mobility
Propulsion: electric
Endurance: 25 min
Max. speed: 12 m/s
Payload: 250 g
Control: teleoperation/semi-autonomous

Sensor equipment
various paylous
- daylight
- dawn/near-IR
- infrared
- photo
- video zoom

Platform main capabilities
Rotary-wing micro-drone, in production phase
Range 1000 m
Endurance 25 min
Weight < 1.5 kg

FANCOPTER

SKYLARK® I-LE, SKYLARK® II, HERMES 90

TELEFUNKEN Radio Communication Systems GmbH & Co. KG

Use at ELROB 2010:	• **Static Display**
	SKYLARK® I-LE / SKYLARK® II / HERMES 90
Basic data	
Wing Span:	290 cm / 650cm / 480cm
Weight:	6,5 kg / 65kg / 105kg (including all accessories)
Average noise level:	extremely low acoustic signature
Mobility	
Propulsion:	electrical, electrical, advanced modern 2 stroke engine
Endurance:	3 hrs / 4 hrs / >15 hrs
Range:	15 km / 60 km / 60 km
Payload:	1,5 kg / 8 kg / 25 kg
Locomotion:	autonomous each
Steering:	joystick
Control:	Ground Control Unit (Mini)
Operator:	1 each
Crew:	2 / 2-4 / 2-4
Recovery:	automatic precise recovery/landing,
Communication equipment	
Type:	Digital videolink / Digital uplink
Frequency:	2.3 - 2.4 GHz
Number of channels:	16
Sensor equipment	
Camera Day:	Color CCD (NTSC or PAL standard) video
Camera Night:	Uncooled thermal image camera, standard monochrome NTSC or PAL video
GPS:	GPS Navigation

SKYLARK® I-LE

Platform main capabilities

The demonstration system SKYLARK® I-LE implements an optimal working point for a man portable UAS system allowing high quality, stabilized day or night payload outputs while maintaining a compact, light weight and easy to operate system configuration. It is optimized for deployment and use by a small crew in combat as well as in peace time, in conflict scenarios as well as in civil operation.

High Quality Imagery - The SKYLARK® I-LE system was designed at a working point that optimizes payload quality under portability and rapid deployment constrains. Unlike similar systems, the SKYLARK® I-LE payloads are gimballed and stabilized in the roll and pitch axis, significantly contributing to the quality of the provided imagery and the flexibility of the air vehicle and payload operation.

Autonomous and Automatic System Operation - The SKYLARK® I-LE system is highly autonomous. The air vehicle is capable of fully autonomous flight from take-off to landing with the operator required to control only the payload. The operator can command the air vehicle to follow selected autonomous flight modes such as fly by camera guide and fly by route. This capability relieves the operator of having to control the air vehicle and allows him to focus on the mission and in addition, enables a safe operation of the air vehicle within the given air space.

Simple to Operate - The SKYLARK® I-LE system is advanced and capable yet simple and easy to operate in day and night conditions. Starting from air vehicle assembly, through mission planning performed by a friendly, simple and intuitive graphic user interface, air vehicle autonomous launch, and up to automatic air vehicle landing, system operation requires only basic operator training.

Rapid Deployment - A complete SKYLARK® I-LE system can be carried by two men using specially designed back packs or can be situated inside a small vehicle. The system is assembled and ready for operation in five to ten minutes including mission planning and the turn around time between launches is about two minutes. The system is simple to tear down and re-pack.

Covert - The SKYLARK® I-LE air vehicle is electrically propelled and features extremely low acoustic and visual signatures.

Robust - All SKYLARK® I-LE system components are designed to withstand harsh field conditions.

HERMES 90 (left side), SKYLARK® II (right side)

MAJA

BORMATEC unmanned vehicles

Team name:	BORMATEC
Team leader:	Franz Bormann
Team leader's email:	info@bormatec.com
Nationality:	German

Use at ELROB 2010: • **Static Display**

Basic data

Height (max):	45 cm (including elevated arms and antennas)
Height (min):	45 cm (without arms and antennas)
Width:	180 cm
Length:	120 cm
Weight:	3 kg (including all accessories)

Mobility

Propulsion:	battery
Endurance:	1 hrs
Max. speed:	120 km/h
Payload:	1.5 kg
Control:	RC 2.4 GHz

Communication equipment

Type:	RC
Frequency:	2.4 GHz

MAJA

MAJA with P-09 BigAnt Transport Platform

Platform main capabilities

MAJA was developed as economical platform. The advantages of this system are in its simple and thought construction out. The used materials, which are used also in the automobile industry, exhibit a small weight and are extremely durable.

MAJA is appropriate an unmanned small aircraft (UAV) for the following tasks:

- Aerial photography
- Surveying
- Air observation
- Environmental protection

Minimissile M3D

LFK Lenkflugkörpersysteme GmbH

Use at ELROB 2010: • **Static Display** • **Open Display**

Basic data	
Height (max):	70 cm (including elevated arms and antennas)
Height (min):	70 cm (without arms and antennas)
Width:	30 cm (incl. arms 50 cm)
Length:	30 cm (incl. arms 50 cm)
Weight:	1 kg (including all accessories)
Turning diameter:	35 cm (turns on centre off robot)

Mobility	
Climbing performance:	100%
Propulsion:	electro motor
Max. speed:	45 km/h
Payload:	100 g
Steering:	3D
Control:	Remote
Manipulator:	2

Communication equipment	
Type:	Analog videolink / Digital up/downlink
Frequency:	video 2.4 GHz, telemetry 868 MHz
Number of channels:	4
Other:	onboard data recording via SD card

Sensor equipment	
Vision:	daylight camera 520 lines, 0.01 lux
GPS:	10 Hz update frequency
Other sensors:	IMU, barometric pressure sensor, ultrasonic distance sensor, magnetometer

Minimissile M3D

Platform main capabilities

The Modulare Minimissile M3D is a light but robust, remote controlled unmanned aerial vehicle for military applications, which can carry sensor equipment and in addition a small but effective warhead as payload. M3D is designed for vertical take off and landing. It has a cruise speed of up to 45 km/h. Due to its design, M3D as well has the capability to hover, e.g. for reconnaissance purposes.

Photomapping Airrobot

Jacobs University of Bremen

Team name:	Jacobs Robotics Team
Team leader:	Andreas Birk
Team leader's email:	a.birk@jacobs-university.de
Nationality:	German

Use at ELROB 2010: • **Static Display**

Basic data

Height (max):	50 cm (including elevated arms and antennas)
Height (min):	25 cm (without arms and antennas)
Width:	100 cm
Length:	100 cm
Weight:	1 kg (including all accessories)
Turning diameter:	0 cm (turns on centre off robot)
Average noise level:	1 dB(A)
Other:	plastic coating

Mobility

Wheel or track driven:	quadcopter
Propulsion:	battery
Endurance:	30 min
Max. speed:	12 m/sec
Payload:	300 g
Locomotion:	quadcopter
Steering:	differential
Control:	remote tele-operation / full autonomy (both options)

Communication equipment

Type:	Digital videolink / Digital uplink
Frequency:	2400 MHz / 35 MHz , 40 MHz
Power:	100 mW

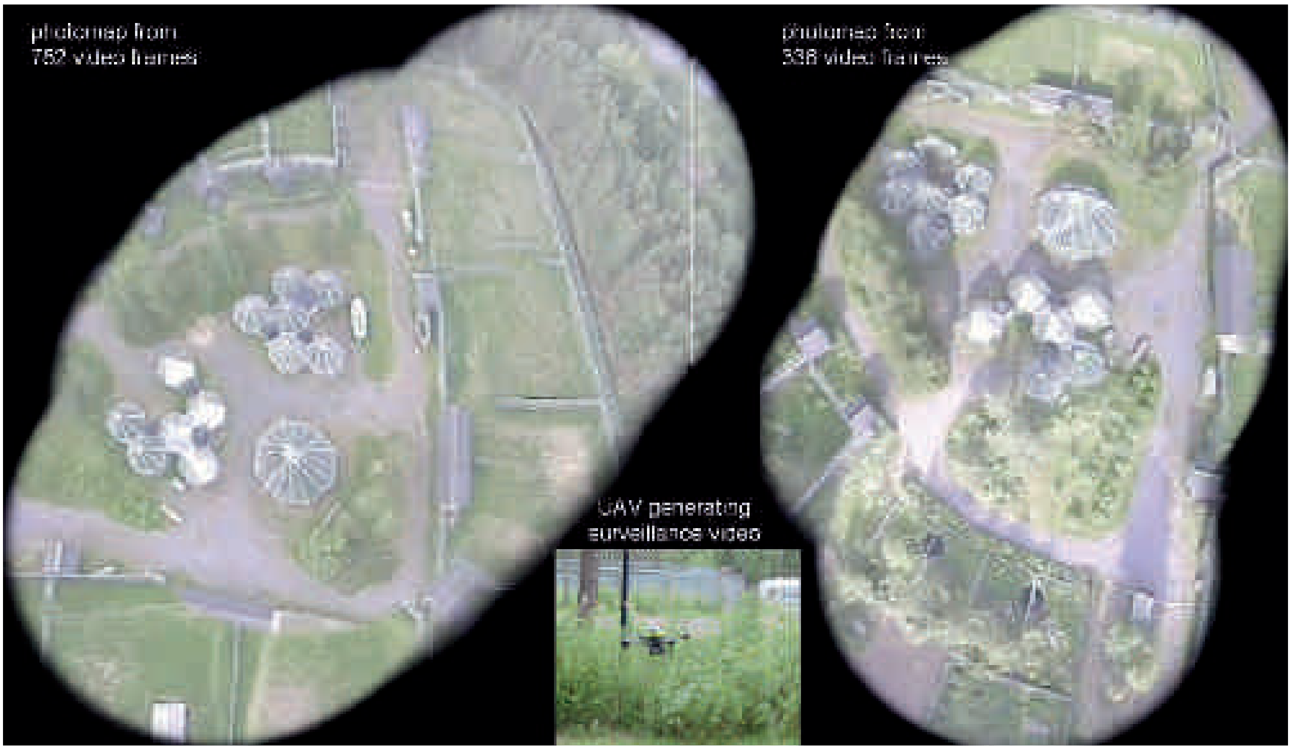
Sensor equipment

Vision:	tilt-camera
GPS:	prop.

Platform main capabilities

The robot is a commercial Unmanned Aerial Vehicle (UAV) from the company Airrobot. It is used by Jacobs Robotics for research on intelligent autonomous functions. Especially, a digital video stream from the vehicle is used to create photo maps - also known as mosaicking - in real time at the operator station. According maps are interesting for several reasons. First of all, they help in the mission execution itself; the operator gets an overview of the operation area and the video stream is stabilized as a fringe benefit. Furthermore, photomaps are interesting mission deliverables.

From a simple viewpoint, regions of overlap between two consecutively acquired images have to be found and suitably matched for photomapping, which is related to visual odometry as it also allows estimating the motion of the vehicle. This process of finding a template in an image is also known as registration. But the task at hand is more difficult than mere template matching as the region of overlap is unknown and it usually has undergone non-trivial transformations due to the robot's movements. This is comparable to image stitching, which is for example used to generate panoramic views from several overlapping photographs. The approach of Jacobs Robotics uses a fast and robust method for visual odometry based on the Fourier-Mellin Invariant (FMI). This improved FMI or iFMI extends previous approaches in two ways. First, a logarithmic representation of the spectral magnitude of the FMI descriptor is used. Second, a filter on the frequency where the shift is supposed to appear is applied. The iFMI is embedded in Simultaneous Localization and Mapping (SLAM) based on a pose-graph to allow for large but nevertheless accurate maps.



Photomaps generated at ELROB 2009 in Oulu, Finland

PSYCHE

University of Siegen

Team name:	University of Siegen
Team leader:	Prof. Dr.-Ing. Klaus-Dieter Kuhnert
Team leader's email:	kuhnert@fb12.uni-siegen.de
Nationality:	German

Use at ELROB 2010: • **Static Display** • **Open Display** • **Scenario**

Basic data

Height:	20 cm (including elevated arms and antennas)
Width:	92 cm
Length:	92 cm
Weight:	< 0,9 kg (including all accessories)
Average noise level:	63 dB(A)
Other:	synthetic coating

Mobility

Wheel or track driven:	Quadrocopter
Propulsion:	Electrical
Endurance:	0,5 hrs
Max. speed:	15 km/h
Payload:	< 0,2 kg
Locomotion:	4 rotors
Control:	Remote teleoperation, line-of-sight, autonomous
Other:	Max. altitude ca. 150m

Communication equipment

Type:	Multiplex Evo Royal 9 Remote Control
Frequency:	35 MHz
Possible frequency range:	from 35 to 36 MHz
Power:	100 mW
Number of channels:	9

Type:	D-Link DWA 160 Wifi
Frequency:	2400 MHz and 5000 MHz
Possible frequency range:	2400 - 2462 MHz, 5150 - 5350 MHz, 5725 - 5825 MHz
Power:	100 mW
Number of channels:	12

Sensor equipment

Vision:	Stereo CMOS Image Sensors
GPS:	uBlox
Other sensors:	IMU, Compass, Sonar, Radar, Optical movement recognition

Platform main capabilities

Our MUAV PSYCHE is used to substantially support the ground operation of its sweetheart AMOR. It is based on a commercial Quadrocopter, the MD4-200 from Microdrones, but for real operation a MD4-1000 will be used which can also be deployed at strong wind.

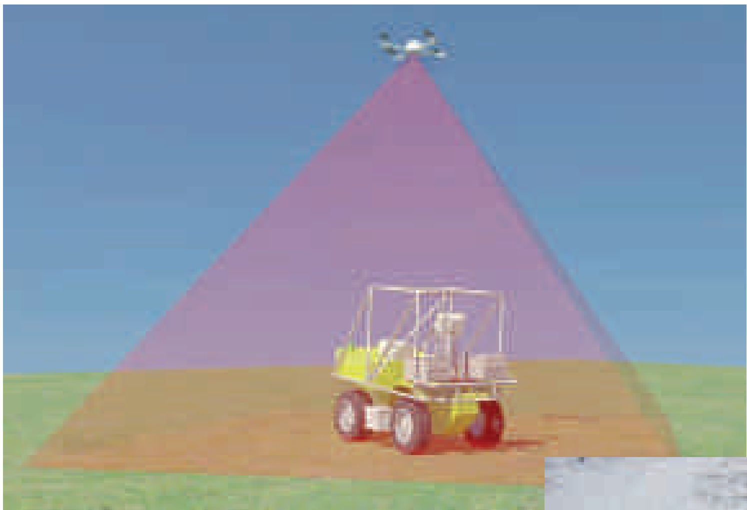
The original system is primary intended for remote controlled operation and has only a minor level of autonomy. Now an additional microcontroller can control the MUAV and gets the telemetry data with all the necessary informations to do flight operations. In our experiments we are using sonar, radar and a custom made optical flow sensor which measures the absolute movements of the MUAV over ground.

At the software side the VSAL architecture was ported from AMOR to the new target. The VSAL was originally developed for our UGVs and realized a highly flexible infrastructure to access sensors and actuators through a CAN bus or Ethernet. The VSAL client is created from an XML description file of the robot through code generation technology and offers a comfortable C++ programming interface to the user.

In the field of autonomous flying we are working on: position hold without GPS, autonomous indoor and outdoor flying, autonomous precision landing and optical localization. The main topic in this context is to support the UGV by the UAV.

Ground support by UAV

This research focuses on combining ground and aerial vehicles to perform complex tasks which the robots wouldn't have been able to perform each on their own. An application of ground-air cooperation in robotics was published by our institute recently and deals with the absolute localization of a GPS-less ground vehicle. The aerial robot is used to acquire live video imagery which the ground robot uses to realize a registration with geo-referenced orthophotos from a geo-database. This finally enables the ground robot to do a highly precise and absolute self-localization. The system has been successfully demonstrated with our robots AMOR and PSYCHE. Currently we are working on various other scenarios which incorporate the combined use of ground and aerial robots.



Combination of AMOR and PSYCHE to combine the strengths of both systems

The Robot PSYCHE

Robotic Airship

Distance University of Hagen

Use at ELROB 2010: • **Static Display** • **Open Display**

Basic data	
Width:	2.3 m
Length:	9.0 m
Weight:	27 kg (including all accessories)
Turning diameter:	0 m
Other:	2-layered hull structure: top coat tearproof, bladder gas-tight
Mobility	
Propulsion:	electrical actuation
Endurance:	2-4 hrs
Max. speed:	45 km/h
Payload:	10 kg
Locomotion:	2 front rotors with adjustable thrust vector
Steering:	rotors and rudders
Tether:	optional
Control:	Remote teleoperation, line-of-sight
Manipulator:	None
Other:	stationary hovering above ground
Communication equipment	
Type:	Videolink / Radio link/ controller uplink
Frequency:	2400 MHz radio, UMTS, WLAN
Number of channels:	> 12
Sensor equipment	
IMU:	gyroscope, acceleration sensors, inclinometer, altimeter, pitot tube, GPS
Vision:	On-board camera system

Platform main capabilities

The robotic airships acts as a remote airborne sensor platform for stationary hovering above ground or preplanned flight missions in low altitude. Advanced on-board controllers and multi-sensorics allow semi-autonomous flight maneuvers and thus reduce the burden for human teleoperators.

The airship can be equipped with any desired additional sensor systems for measurement, surface monitoring and surveillance. On-board links for external sensorics can be provided by the airships' power supply system and communication infrastructure.

The maximum payload for the current airship type is approximately 5-7 kg. The total hovering time of this flight system during mission is 2-4 hours (dependent on flight maneuvers). The entire system and its ground infrastructure can be hauled easily and is operable with 60 minutes after inflating the hull with filling gas (helium).

Robotic Airship during a field test in Hemer, Germany, 2009

Wall Climbers

ELROB

at

M-ELROB 2010

Alicia-VTX

University of Catania

Team name:	DIEES-UNICIT
Team leader:	Prof. G. Muscato
Team leader's email:	gmuscato@diees.unict.it
Nationality:	Italy

Use at ELROB 2010: • **Static Display** • **Open Display**

Basic data

Height (max):	10 cm (including elevated arms and antennas)
Height (min):	10 cm (without arms and antennas)
Width:	25 cm
Length:	25 cm
Weight:	1.5 kg (including all accessories)
Turning diameter:	30 cm (turns on centre off robot)
Ground clearance:	0.3 cm

Mobility

Climbing performance:	0° - 180°
Wheel or track driven:	wheels
Propulsion:	Two 4 Ah LiPo batteries
Endurance:	4 hrs
Max. speed:	0.3 km/h
Payload:	0.5 kg
Steering:	skid
Control:	autonomous mode

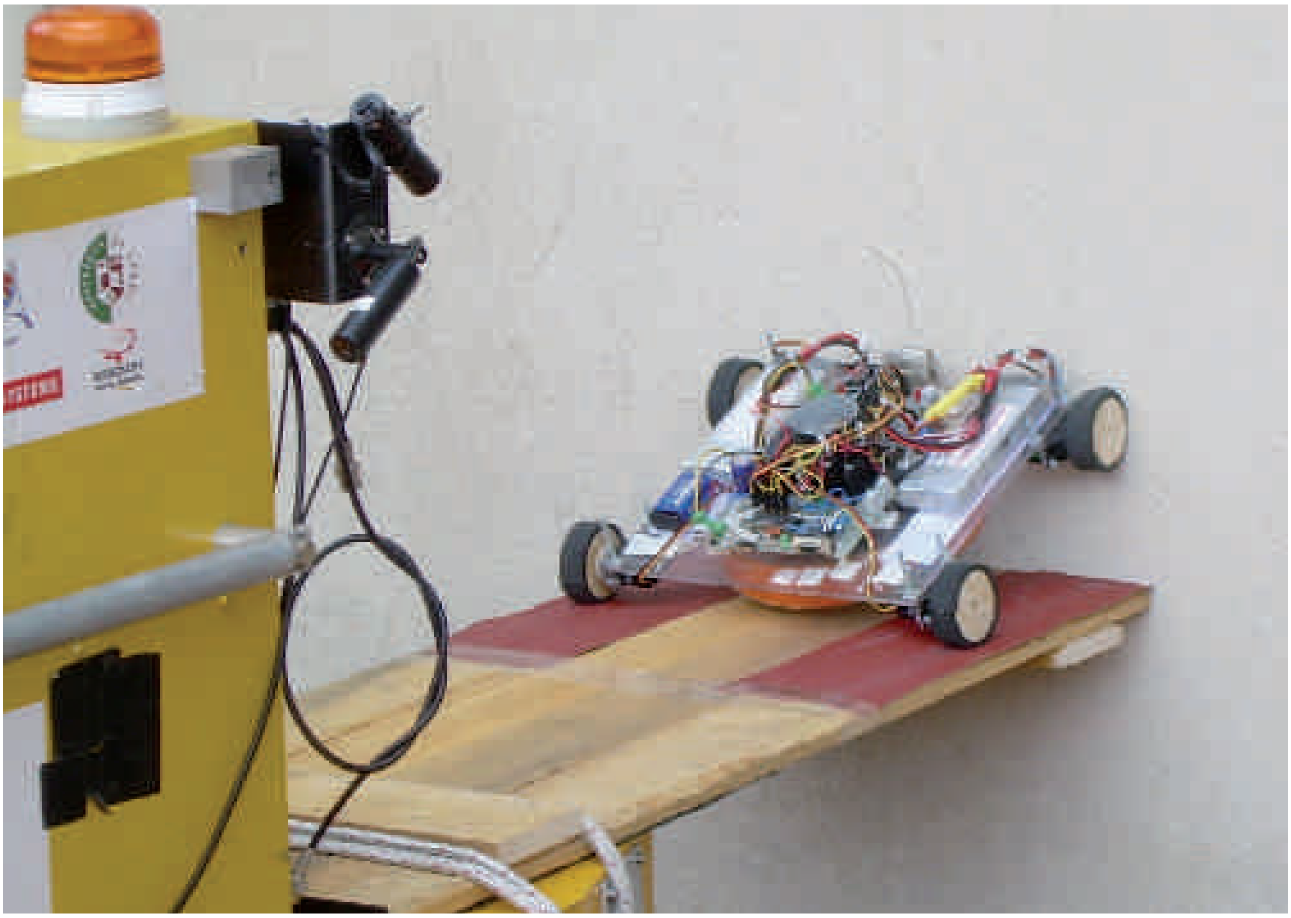
Sensor equipment

Inertial measurement unit:	Analog Device MEMS accelerometer

Platform main capabilities

The Alicia VTX robot is one of the latest systems developed at DIEES Robotic Laboratory. The Alicia VTX has been designed to slide over any kind of surfaces with arbitrary slope and material using the innovative adhesion system called “vortex active suction cup”. This active suction cup uses a special centrifuge fan that, by mean of its rotation, produces a vortex in the central part of the cup. This vortex finally generates a normal force that allows the robot to adhere to the surface it is in contact with. The cup and the fan were built so that the air aspirated from the centre of the fan doesn’t exit from the top of the cup, but is recycled inside, creating a lateral and very thin high pressure area. No exhaust air flow is generated, and consequently the process is more efficient by about three times compared with suction cups, where an air aspirator is used instead to generate the vacuum. By using this principle, it is possible to use a low power brushless DC motor to actuate the fan (about 50W). This kind of vacuum cup can adhere to different kinds of rough surfaces because it doesn’t use any lateral sealing. A strong adhesion force is achieved even when a considerable free gap (<0.01 m) between the robot and the surface is present. This allows reducing to zero the friction between the cup and the wall during motion, to save energy and to increase robot speed. Moreover it allows the robot to move over small obstacles or irregularities and to climb from floor to a wall. The movement of the robot, while attached to the wall, occurs through four servo motors with gearbox, each of which is directly connected to a wheel. Different tests were done also in order to ensure a sufficient grip on the wheels, allowing the robot to move easily across different type of surfaces. An accelerometer is also used to calculate orientation, when the robot is attached on the wall and to calculate its slope during floor – wall transition, to turn on the fan at the right moment. Some tests showed that it suffers from the vibrations due to the rotation of the fan. To reduce the effect of these vibrations, a mechanical damper has been used. The robot has been tested over many different surfaces with good results.

The robot is powered by means of two 11V – 4 Ah LiPo battery packs. The cup weighs about 0.6 kg. The robot is managed by an 8-bit microcontroller. A wireless CCD colour camera is also mounted onboard for surveillance purposes.



Alicia-VTX robot during a field test in Nicolosi, Catania, Italy

Amphibic Robots

ELROB

at

M-ELROB 2010

Doris

University of Siegen

Team name:	University of Siegen
Team leader:	Prof. Dr.-Ing. Klaus-Dieter Kuhnert
Team leader's email:	kuhnert@fb12.uni-siegen.de
Nationality:	German

Use at ELROB 2010: • **Static Display** • **Open Display**

Basic data

Height (max):	150 cm (including elevated arms and antennas)
Height (min):	115 cm (without arms and antennas)
Width:	160 cm
Length:	303 cm
Weight:	900 kg (including all accessories)
Turning diameter:	100 cm (turns nearly on the centre of robot)
Ground clearance:	20 cm
Average noise level:	80 dB(A)
Other:	Synthetical coating, downside steel

Mobility

Climbing performance:	55 degrees
Wheel or track driven:	Wheel
Propulsion:	Fuel
Endurance:	20 hrs
Max. speed:	45 km/h on land; 25 km/h on water
Payload:	400 kg on land and on water
Locomotion:	8 wheels
Steering:	Skid
Tether:	Front
Control:	Steer by wire, remote teleportation, autonomous
Stairs:	Yes, until 40 degrees, 15 cm
Incline:	55 degrees

Communication equipment

Type:	Breeze ACCESS VL Wimax System
Frequency:	5400 MHz
Possible frequency range:	from 5470 to 5725 MHz
Power:	1000 mW
Number of channels:	12

Type:	Belkin F5D8230-4 Pre-N Router Wifi System
Frequency:	2400 MHz
Possible frequency range:	from 2400 to 2483,5 MHz
Power:	100 mW
Number of channels:	13

Sensor equipment

Laser:	1 x Sick LMS 221
Vision:	3DVLS (3 Dimensional Visual Localisation System)
GPS:	DGPS, SirfIII-GPS-Mouse
Other sensors:	IMU, Ultrasonic

Platform main capabilities

Our new amphibic robot DORIS (Dualmedia Outdoor Robotic Intelligent System) is a second generation outdoor robot quite ripe for the applications. The electronics have been shrinked down to a 6HE 19‘ rack while safety and robustness are improved.

The robot is able to operate on solid ground with up to 45km/h and in water up to 25km/h but also in very heavy mixed terrain. Due to the large payload of up to 400 kg in water it can be used by several persons and also for load intensive autonomous tasks; an example would be the mule shuttle for heavy operation equipment.

The new 3DVLS delivers precise surface data in real-time which are used for the navigation.

This new area of research focuses on bridging the gap between mobile robotics on land and at sea. We build the world‘s first amphibious robot which can traverse land, water, as well as quicksand-like mud with appropriate high speed. The complicated task of changing autonomously from ground to water driving is being solved at the moment.

An amphibic vehicle with 8 low pressure tires and jet impeller engine is used as the mechanical platform. Because it is able to carry substantial payloads on land and in water, it is well suited for researching the basic operation principles of autonomous amphibic systems as well as a bunch of applications like:

1. General reconnaissance and surveillance operation also in very heavy terrain
2. Autonomous in-water search and surveillance operations in littoral waters
3. Maintenance of plants in coastline areas
4. Applications such as detection of mines, biological, chemical or radioactive threats in water-based and land-based environments
5. Exploring aquatic environments such as coral reefs or swamps

Second generation autonomous amphibian robot for heavy duty

Sensors and More

at

M-ELROB 2010

ARDS, SAR-Lupe

Reconnaissance Satellites

OHB-System AG

Use at ELROB 2010: • **Static Display**

ARDS

The Aerial Reconnaissance Data System (ARDS) is a modular solution for the secure real-time transmission of images, video and sensor data in aerial reconnaissance missions. ARDS consists of four main modules: a wavelet-based image compression, a high rate data link with an optional encryption module and a secure command link.

This solution provides a raw data rate of 274 Mbit/s and has been flight proven at ranges exceeding 200 km and can achieve more than 300 km in relay mode.

Bremen DRF300 ROI marked

SAR-Lupe

The first satellite-based radar reconnaissance system in Germany, SAR-Lupe, had been developed with OHB-System as the main contractor. Five identical small satellites are used by the German Armed Forces to monitor the entire earth independent of weather and time of day. All satellites in the SAR-Lupe system have been orbiting the earth since July 2008 and deliver superb images.

SAR Satellit under Radom

CT-DCOM

COFDM Audio-, Video- and Data Transmission

CT-Video GmbH

Use at ELROB 2010: • **Static Display**

Communication equipment

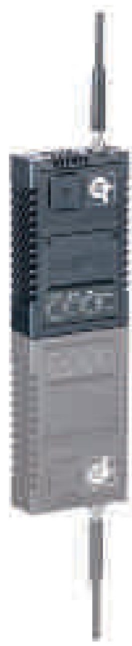
Type:	CT-DCOM TX 500 mW + PA
Frequency:	2.3 GHz
Possible frequency range:	1.1 GHz – 2.4 GHz
Power:	0.1 W to 25 W
Modulation:	COFDM
Number of channels:	16 + 10, 8 additional user configurations

Additional power supply
Accu cases with up to 90 Amps Lithium Polymer accumulators. Prepared for cascading. Designed for rough outdoor use. Maximum capacity by minimum weight.

Additional information is available under CTV.Info@CeoTronics.com

Accu Case

DCOM RX Case



DCOM TX

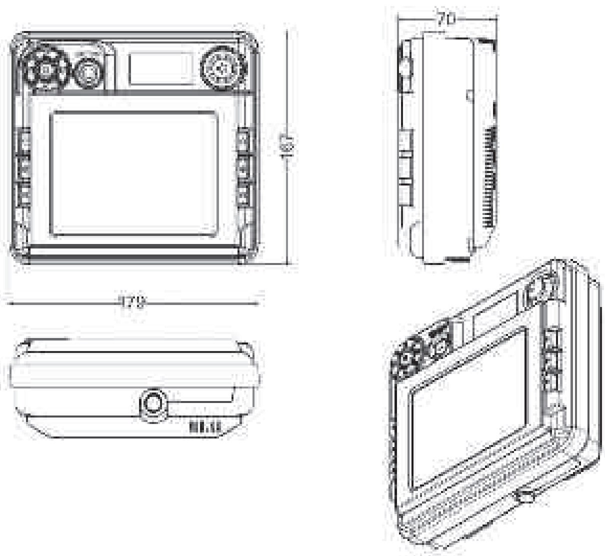
Controller for UGVs

M-Swiss Consulting S.A. / MacroUSA Corp.

Team name:	MacroUSA Armadillo
Team leader:	Cino Robin Castelli
Team leader’s email:	rcastelli@macrousa.com
Nationality:	Italian

Use at ELROB 2010: • **Static Display** • **Open Display** • **Scenario**

Basic data



Physical Characteristics

Thickness:	70 mm
Width:	179 mm
Height:	167 mm
Weight:	1.1Kg

Materials:

Chassis:	High Resistance Impact Plastic
Screen Protector:	EMC-Shielded Polycarbonate
Joystick and buttons:	Polyurethane Rubber

Environmental Characteristics

IP level:	IP67
Temperature range:	-20° C + 60° C

Electrical

Battery Type:	High C rate Lithium ion batteries.
Battery Duration:	2.1 hours

Communication equipment

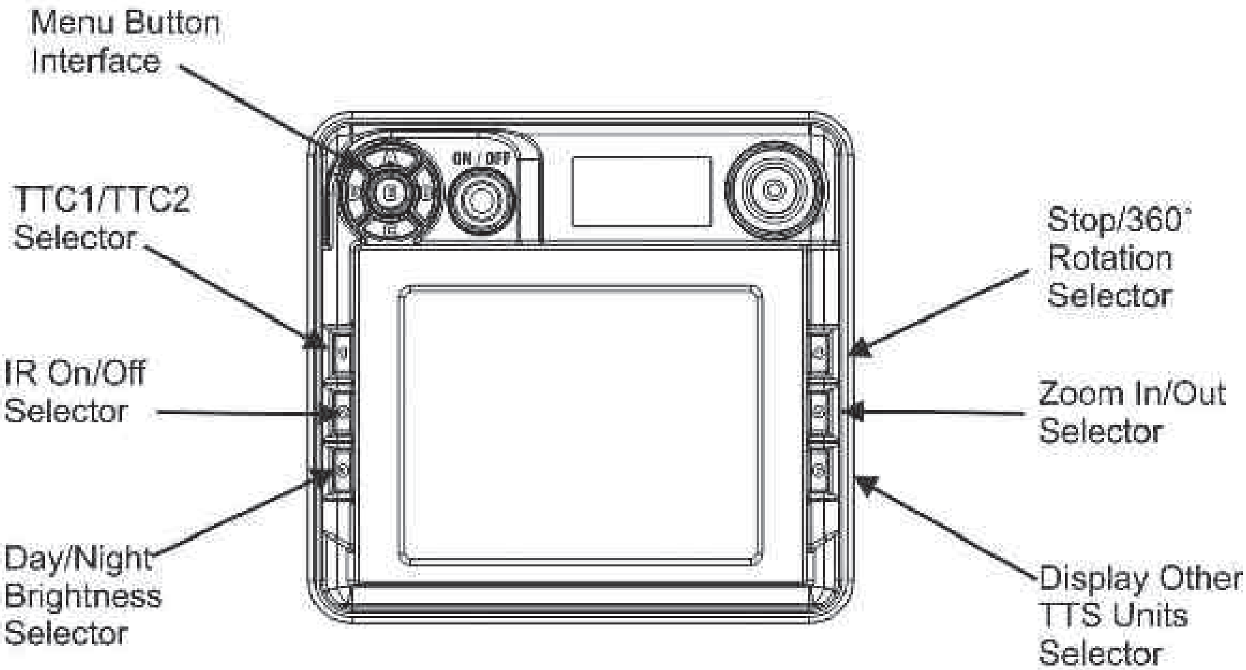
Type:	Digital videolink
Frequency:	1200 or 2400 MHz
Possible frequency range:	from 1200 to 1400 MHz or 2300 to 2500 MHz
Power:	20 dB
Number of channels:	50
Other:	COFDM Modulation

Type:	Telemetry link
Frequency:	902-928 MHz
Possible frequency range:	from 2288 to 2551 MHz
Power:	30 dB
Number of channels:	50
Other:	FSK telemetry Modulation, Hopping

Platform main capabilities

The CDS is a multipurpose controller for Armadillo, TTC and any other MacroUSA unit (can be used for Scorpion and any other wireless device with compatible video and telemetry transmitters).

It has a fully sunlight readable monitor (1000 nits) and is configurable in different setups depending on the device to be controlled and displayed.



MacroUSA Armadillo M-UGV with Controller

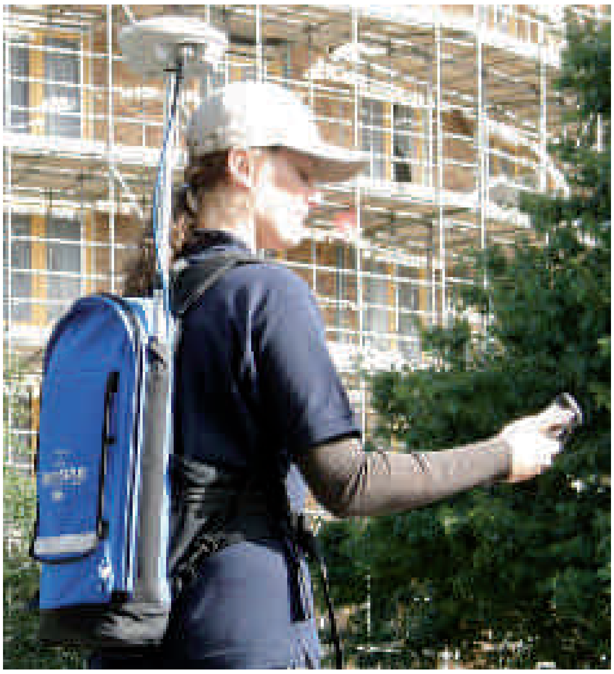
DGNSS Services

OmniSTAR B.V.

Use at ELROB 2010: • **Static Display**

Platform main capabilities

OmniSTAR delivers commercial DGNSS services worldwide by satellite and via internet and is leading in the design and development of Differential GNSS positioning technology. With approximately 100 reference stations, 6 high power satellites and 2 global Network Control Centres, OmniSTAR delivers consistent and highly reliable positioning services worldwide, 24 hours a day, 365 days a year. OmniSTAR's other advantages include worldwide coverage, consistent high accuracy, high reliability and robustness.



Hardware only for display purposes

OmniSTAR
The Global Positioning System

Sensors and More

Diesel-Electric Power Unit

Hörmann IMG GmbH

Use at ELROB 2010: • **Static Display**

Basic data

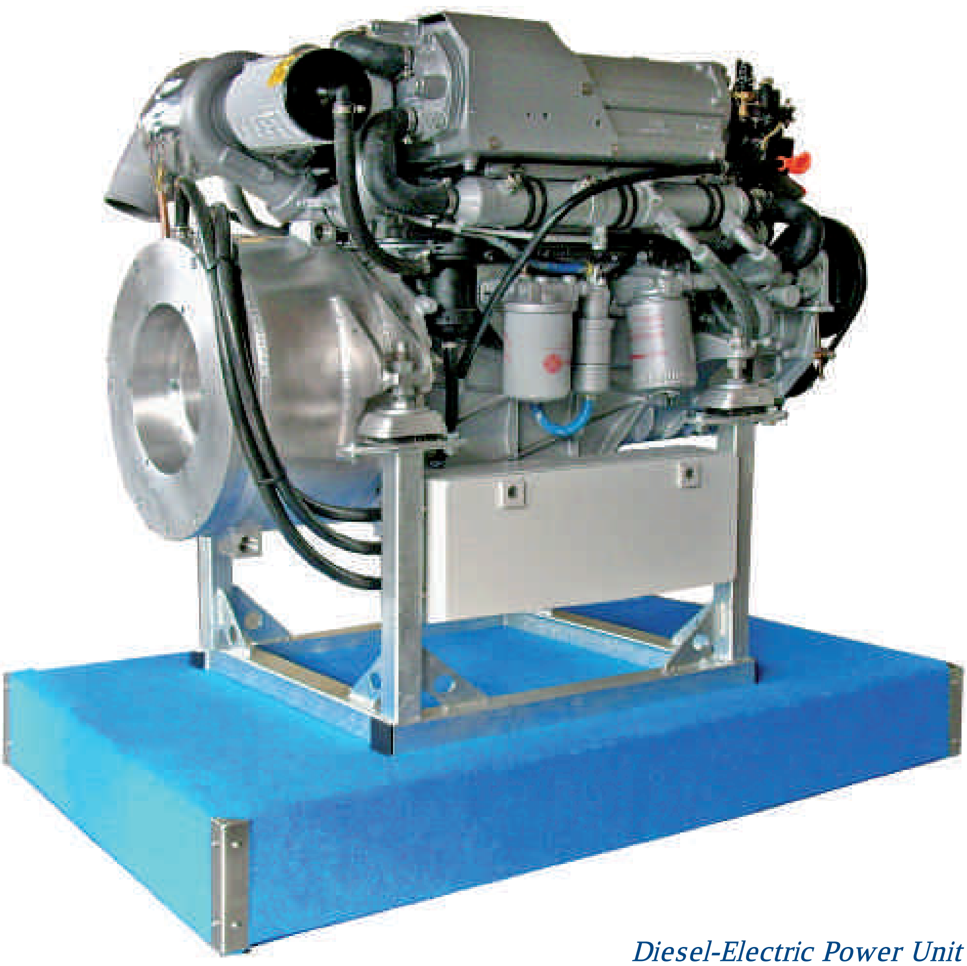
Height (max):	120 cm
Width:	86 cm
Length:	120 cm
Weight:	500 kg

Platform main capabilities

Currently Hörmann IMG GmbH focuses hybrid electrical propulsion systems. The diesel-electric power unit is a part system. It consists of a diesel engine from Steyr Motors, a generator and a power electric unit. We also use combustion engines from other manufacturer, for example Volkswagen, BMW, MAN.

We supply hybrid drive and energy systems for mobile applications according to customer wishes and requirements.

Hörmann IMG GmbH is a system supplier and develops customized solutions!



Diesel-Electric Power Unit

Digital Video Transmission

O.R.C.A. COFDM Digital Systems

VTQ Videotronic GmbH

Team name:	VTQ Videotronic GmbH
Team leader:	Steffen Neumann
Team leader's email:	S.Neumann@vtq.de
Nationality:	German

Use at ELROB 2010: • **Static Display**

Communication equipment

Type:	Digital videolink
Frequency:	2.3 GHz
Possible frequency range:	868 MHz or 2.2-2.5 GHz
Power:	from 100 mW to 10 W
Number of channels:	16

Platform main capabilities

The digital video transmission system O.R.C.A (OFDM Radio Communication Appliance) provides you with a lot of useful features and technical innovations, which are unique on the world market.

The O.R.C.A systems have many different connectors for video and audio, which makes it compatible to the most terminal equipment. The system are available in different types of housings for stationary, mobile or outdoor use. The application variety is huge. The entire system consists of single components. which may easily be combined with each other and may be extended at any time. Starting with stationary transmitters and receivers to the power amplifiers up to the small and handy mobile transmitters you will most certainly find the suitable transmission system for your application. Typical applications are surveillance systems in the professional security branch, video transmission systems for private, industrial or scientific use as well as the transmission of high quality videos for TV stations, military and authority applications or events.

Our digital video systems will convince you with its high sensitivity, small dimensions and a lot of features for your special application.

1W Transmitter and 8W Booster. Please note the dimensions of 97x70x35 mm for the Transmitter and 98x70x40 mm for the Booster

R&S® High Data Rate (HDR) Radio Demonstrator

Radio Equipment

Rohde & Schwarz Vertriebs GmbH

Use at ELROB 2010: • **Static Display**

Platform main capabilities

The Rohde & Schwarz High Data Rate (HDR) Radio Demonstrator is the platform carrying the Rohde & Schwarz HDR1 (High Data Rate) Waveform. It is based on the latest software defined radio technology (SDR) and the waveform supports high data rate, IP-capability for Voice over IP and exceptional flexibility for network services, without compromising any of the well known, proven voice capability of the current military radio generation.

The Rohde & Schwarz HDR1 Waveform is characterized by following advantages and capabilities:

- Waveform implementation compliant to Software Communications Architecture (SCA)
- Parallel IP voice- and data-transmission (VoIP)
- Adaptive HDR1 waveform for optimized communication capabilities (225 to 400 MHz)
- High data rate of up to 1060 kbit/s which gives the user a transparent IP communication for voice, data and video with integrated adaptivity
- IP-router with (communication node) with integrated Multicast and MANET capability
- User-friendly monitoring configuration via web interface
- Exceptional flexibility for networking services via RF networks on air

Setup of R&S® HDR Demonstrator

Sensors and More

HuntIR, RangIR, µCAM 640, UCTIM 640

Infrared Devices

AIM Infrarot Module GmbH

Use at ELROB 2010: • **Static Display**

Platform main capabilities

After 25 years of successful work with IR components for the Bundeswehr and allied nations, AIM developed a thermal sight to meet the requirements for the German “Infanterist der Zukunft” (IdZ). A close coordination between industry, the German Infantry School and procurement authorities ensured, that the device was tailored to perfectly match the needs of the soldiers.

The unique feature of the so called HuntIR sight was to combine day/night surveillance and targeting. With two fields of view, 2.3° x 3.0° for range performance and 6.8° x 9.1° for panoramic view it provides an identification range of 1,700 metres as required for long-range sniper rifles or crew served support weapons like the 40mm automatic grenade launcher (AGL). Since 2004 HuntIR is standard equipment in all missions of the Bundeswehr.

For the „Enhanced System“ of the IdZ (IdZ-ES), AIM has boosted the capabilities of HuntIR by adding a laser range finder (LRF), a 3-axis digital magnetic compass (DMC) and a link for the wireless transmission of data and images within the infantry section and set with this new device – RangIR – a new standard of performance .

The LRF and DMC provide input data for the fire control computer to achieve highest first round hit probability and accurate pin pointing of a threat for fire support. The fire control solution takes into account the accurate orientation in space to avoid levelling of a weapon and also provides flight time data for air burst AGL ammo (ABM).

RangIR thus significantly enhances our forces core capabilities protection and effectiveness by clear day/night surveillance for improved situational awareness and precise engagement of remote

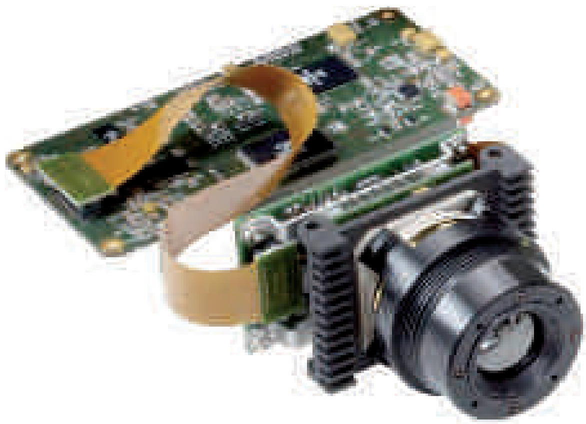
HuntIR

µCAM 640 MW/UCTIM-640 – cooled and uncooled Thermal Sight for small UAVs

Airborne reconnaissance during day and night
- Ruggedized Design
- Low weight
- Good orientation in terrain even under severe weather conditions by high thermal sensitivity
- Short exposure times for sharp images from unstabilized platforms
- Digital and analog interface
- Subsequent update with customer specific image processing software possible

µCAM 640 Camera

- Cooled IR-technology
- Detector: 640 x 512 MCT MW 15 µm Pitch
- DFOV: NFOW 5° x 11° WFOV 14° x 10°
- Identification range (*): 1300m (NFOV)/ 560m (WFOV)
- Detection range (*): 2,500m (NFOV)/ 1000m (WFOV)
- Weight: 2,2kg



UCTIM-640 Camera

- Uncooled IR-technology
- Detector: 640x480 a-Si 25 µm Pitch
- Field of view: 45° x 34°
- Identification range (*): >200m
- Detection range (*): >400m
- Weight: < 200g

(*) Tank target, STANG 4347, TRM3, atm ext coeff 0.2/km

Rugged Mobile Computing

Notebook, Tablet PC, UMPC, PDA

roda computer GmbH

Use at ELROB 2010: • **Static Display**

Platform main capabilities

Rocky II+, III+ and IV+ are the rugged Notebooks with 13'', 15'' and 17'' displays for use in harsh environment.

Panther, the rugged tablet PC with 8,4'', 10,4'' und 12'' display is very small, light weight, serves high performance and a lot of connections.

The new rugged UMPC DB06 with 5'' display, pivot function, multi touch, based on Intel Atom is fitting into nearly every pocket.

Rugged PDA DA05+ shows high capabilities through its improved hardware and light weight.

The 19"/2 form factor enables modular construction within standardized width, heights and mounting methods. Low weight, small size, low energy consumption and less heat are automatically achieved.

Rugged Displays available in sizes between 15'' and 46''. All displays can also be equipped with touch screen.

Most of the roda products have been already certified to SDIP 27 Class B and are certified to MIL-STD 810F and MIL-STD 461E.

Display DP860

Rocky III+ (15" Notebook)

DA05+ (4" PDA)

Tablet PC Panthere DK886EX

DB06 (5" UMPC)

Software Architecture for Robotics

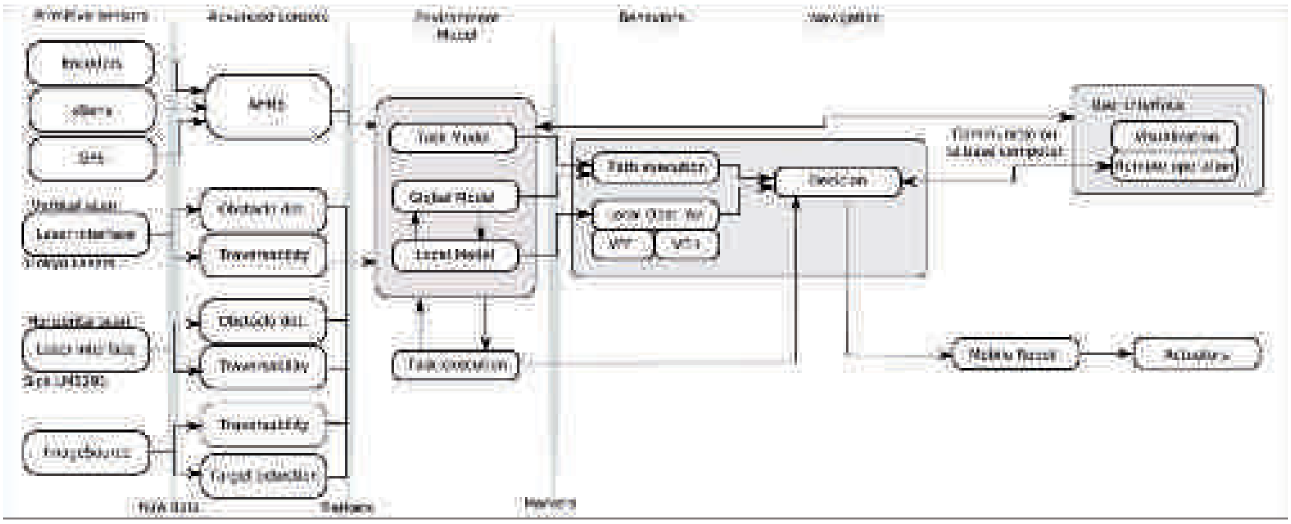
University of Oulu, Robotics Group

Team name: University of Oulu
Team leader's email: celrob@ee.oulu.fi
Nationality: Finland

Use at ELROB 2010: • **Static Display** • **Open Display** • **Scenario**

Platform main capabilities

Robot's software architecture based on Property Service Architecture, and key features are modularity, dynamic configuration, and unified data format (called Markers). Modules can be distributed to various processes and to several computers on the robot. Each „advanced sensor“ modules contain various data processing method for detecting desired targets and obstacles from environment. These modules provide data in generalized format to environment model-module, that makes data fusion. In behaviour level, model is used by various path planning and reasoning algorithms that control the movement of the robot.



Mörri Software Architecture

SLS-01

Stationary or Moving Laser Fluorescence Scanner and Mock up Fluorescent Biosensors

GeoTec Exploration mineralischer Rohstoffe GmbH

Team name:	AirBorneMineScan (ABMS)
Team leader:	Dr. Heinrich Meurer
Team leader's email:	meurer@airborneminescan.com
Nationality:	German

Use at ELROB 2010: • **Static Display** • **Scenario**

Basic data

Height (max):	100 cm (including elevated arms and antennas)
Height (min):	30 cm (without arms and antennas)
Width:	50 cm
Length:	150 cm
Weight:	25 kg
Average noise level:	< 50 dB(A)

Communication equipment

Type:	Digital video link , TX41
Frequency:	2414 MHz
Possible frequency range:	2414 MHz
Power:	< 5 W
Number of channels:	1
Other:	area should be free from wlan and radios transmitting in the same band

Sensor equipment

Laser:	1 x ILT 532 nm, < 100 mW average power
Vision:	TX41 1/4" CCD colour camera, with integrated 2.4 GHz transmitter
GPS:	16 channels bluetooth GPS receiver, net-book, moving map navigation with logging function

Platform main capabilities

Detection of activated live biosensors and mock up biosensors at distances up to 10 m, line scan, scan width 3 m at 5 m distance, night capability

Crop duster for dispersal of biosensors (not used)

Scanning ILT Laser „SLS-01" used for detection in stationary display and possibly scenarios

Mock up fluorescent biosensors used for detection in stationary display and possibly scenarios CRNE-Recon, consisting of Algin spheres of various diameters with fluorescent biosensor protein „tdTomato"

SOTM: SatCom on the Move

Equipment for Satellite Communication for Landmobile Robots

ND SatCom GmbH

Use at ELROB 2010: • **Static Display**

Platform main capabilities

Robots and landmobile systems require real time, agile communication for voice, data, images and videos. The satellite on the move terminals depicted are designed to meet all these requirements. Both terminals are low profile, ruggedised, vehicle roof-mounted Ku-Band systems.

The antenna's low profile and dimension make it suitable for installation on a wide range of landmobile vehicles.

Applications:

– Full duplex multimedia communications
– Intelligence, Surveillance, Reconnaissance
– Remote sensing and control
– Broadcast

Different types of SOTM antennas

TATP-Sensor

Fraunhofer Heinrich Hertz Institut

Use at ELROB 2010: • **Static Display** • **Open Display**

Platform main capabilities

The current topics of our R&D activities are:
Miniaturized fiber optic photoacoustic sensors for highly sensitive gas diagnostics and gas analytics in:

- the controlling of industrial processes (for example, for the early identification of fires, methane detection in mines)
- safety engineering (e.g. highly sensitive and selective detection of volatile explosive substances and acetylene detection in high-performance transformers)
- bio-med analyses (e.g. analysis of respiratory gas, measuring of oxygen or acetone) using photoacoustic spectroscopy (PAS), cavity ring-down spectroscopy (CRDS) and multipass absorption spectroscopy (MAS).

The system consists of 4 parts:

1. Sensor setup (in 19” Industry-Housing)
   Height : 60 cm
   Width: 60 cm
   Length: 60 cm
   Weight: 15 kg

2. Display (TFT-Monitor 21”)

3. Puppet (for presentation)
   Height: 200 cm
   Width: 50 cm
   Length: 50 cm
   Weight: 5 kg

4. Table (for presentation including two chairs)

The system is used for screening a luggage

Telestat

TELEFUNKEN Radio Communication Systems GmbH & Co. KG (TELEFUNKEN RACOMS)

Use at ELROB 2010: • **Static Display**

Basic data

Height (max):	ca. 350 cm (including elevated arms and antennas)
Height (min):	ca. 180 cm (without arms and antennas)
Width:	ca. 200 cm
Volume	6 m^3 (Helium)
Length:	400 cm
altitude of operation:	< 100 m
Average noise level:	0 dB(A)

Mobility

performance:	no engine
Endurance:	2 h (at battery power)
Payload:	3 kg
Locomotion:	static
Steering:	only camera
Tether:	yes
Control:	only camera

Communication equipment

Type:	WLAN
Frequency:	2.4 GHz
Possible frequency range:	fixed frequency
Power:	100 mW

Sensor equipment

camera:	28 mm, 135mm (on equivalent 35mm picture cam)
Vision:	aerial imaging

Platform main capabilities

Telestat, the Aerostat System of TELEFUNKEN RACOMS is used for real time video surveillance and situation awareness from above. Typical scenarios are large planned and unplanned events as well as civil and natural disasters.

The Telestat system consists of a base control station (communication and data system) at one hand and an aerial station (aerostat balloon with payload) at the other hand. The payload itself consists of a radio communication system and a video sensor system. As it is an aerostat system it is fixed to ground via a tether and winch.

The aerostat (balloon of about 6 qbm) is filled with helium and extended by some kite elements. This patented combination leads to excellent aerodynamic characteristics also in harsh weather conditions.

The system is easy to transport and fast to deploy for multiple situations.

Telestat

Training System Robotic Vehicle

Simulation

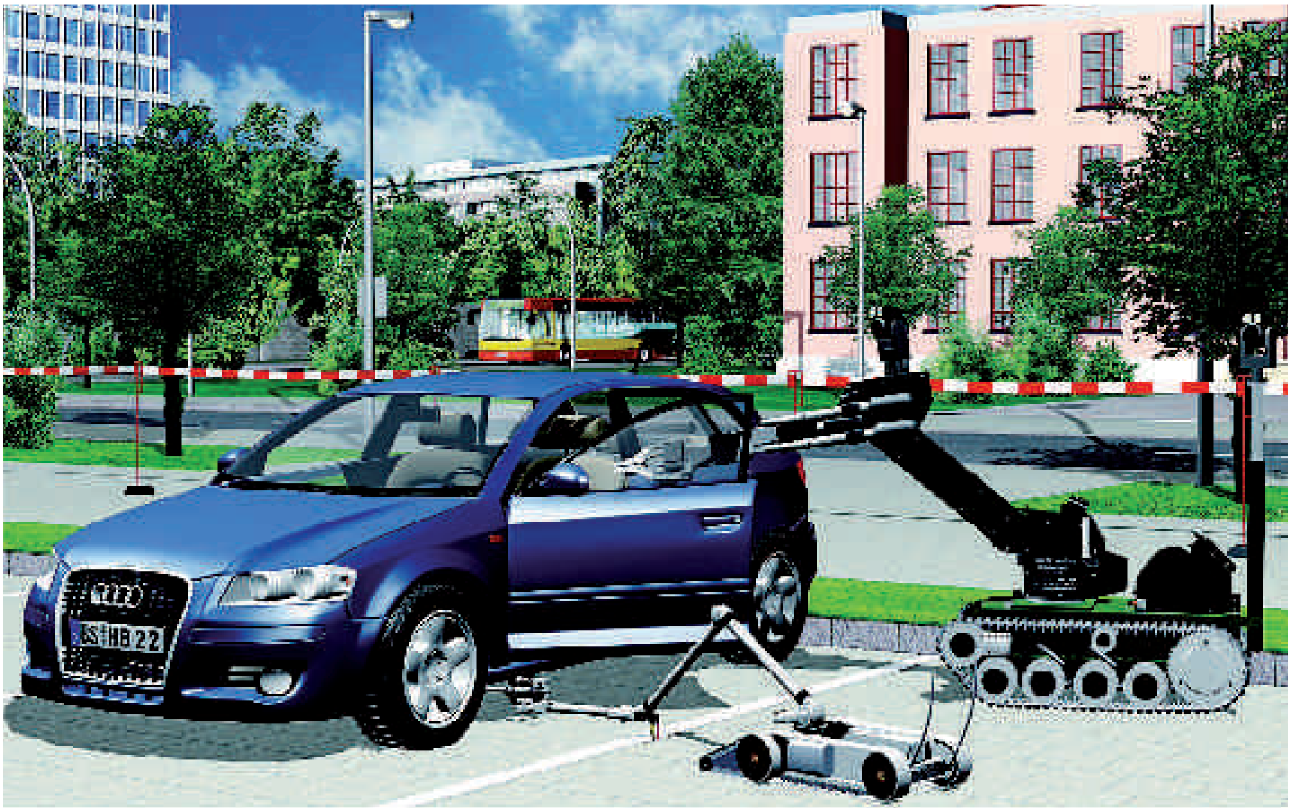
szenaris GmbH

Use at ELROB 2010: • **Static Display**

Platform main capabilities

The „Robotic Vehicle Operator Training System“ is a PC based virtual reality simulation for robot vehicles like tEODor and PackBot EOD, using virtual reality in multiple scenarios (13, see appendix) like car, autobus, aircraft, buildings, different terrains with the original control devices. The application simulates all vehicles functions, malfunctions and has different EOD procedures and different levels of difficulty.

The „Robotic Vehicle Operator Training System“ is the worldwide first and only scalable system using the original control devices to control robot vehicles in virtual scenarios. It is portable to any robot vehicle which is remote-controlled.



Scene from the training system for robotic vehicles „tEODor” and „PackBot”

Sensors and More

UMML Universal Multi Media Link (UGV Link) / KESS (Radio Propagation and Mission Planning tool)

Thales Defence Deutschland

Use at ELROB 2010: • **Static Display**

System Description

UMML

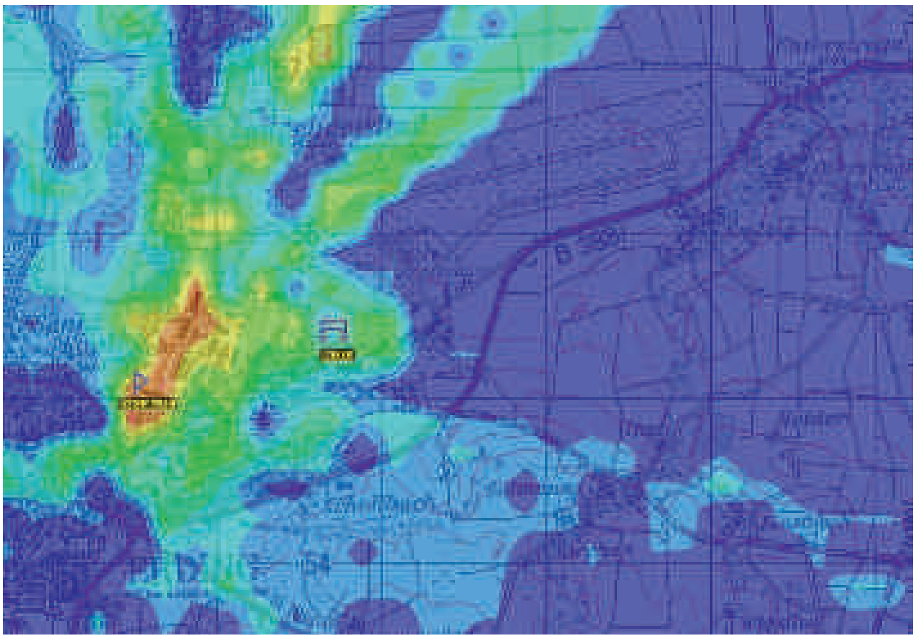
The UMML is a robust COFDM based high speed UGV data link, especially designed for demanding non – Line of Sight Multipath propagation scenarios.

The IP based link system enables QOS based control data, video transmissions and parallel payload data. In difficult radio radio propagation areas the automatic relay function via terrestrial or satellite link increases the usable radio link range. The Frequency range is 170 to 1000 MHz in sub bands, e.g. the 225 to 400 MHz UHF military sub band with a transmitter power of 1 to 10 W avg., which results in a typical range of 4 km in a rural environment.

Tuned cosite filters assure the coexistence of transmitters and receivers as well as other communication equipment on the same vehicle even in dense RF environments.

KESS

An essential part of the control station is the radio propagation calculation tool KESS. KESS allows the calculation of the radio coverage for the control and video link to the remote controlled robot vehicle. By this the most favourable locations for the control station as well as the possible “dead spots” for the radio link can be estimated without time consuming or dangerous tests in the deployment area. KESS determines where relay stations should ideally be placed – by indicating optimal sites and simply displacing the relay station on-screen using the mouse. KESS is an innovative tool for situation depiction, analysis, evaluation, simulation and assessment in geographical and radio engineering terms within any optionally definable area. The software makes use of new, three-dimensional techniques for modelling radio wave propagation. KESS is easy and intuitive to use and needs no knowledge of programming languages, operating systems or similar. KESS is an integrated tool concerning all kinds of radio planning and allows system integration in all C4I, BMIS and Electronic Warfare systems.



Field intensity calculation with KESS

Sensors and More

vicCAM

Smart HDR CMOS Camera

voice INTER connect GmbH

Use at ELROB 2010: • **Static Display**

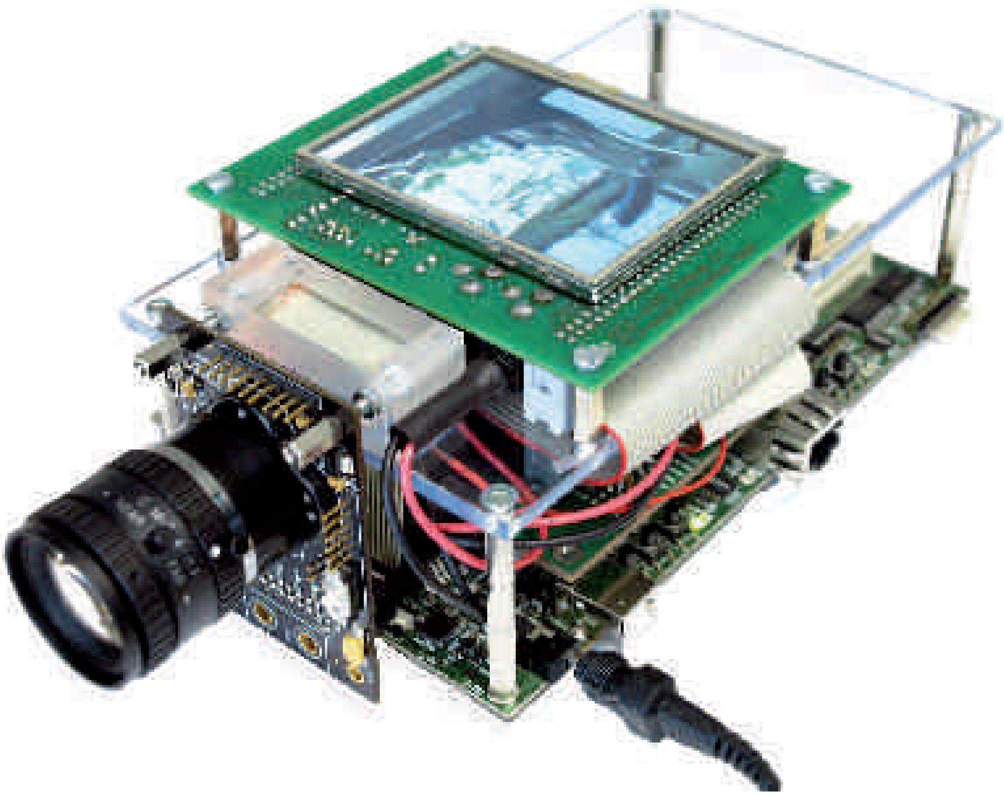
Basic data

Height (max):	10 cm
Width:	15 cm
Length:	30 cm
Weight:	500 g

Platform main capabilities

vicCAM is a hardware camera platform with smart preprocessing algorithms, which ensures optimal picture control even in harsh environments. HDR algorithms (high dynamic range) allow the processing of real world sceneries with high dynamic range of brightness and changing illumination conditions.

The smart algorithms contained in vicCAM are recognizing simple objects (scene modelling) and control the sensor parameters accordingly in order to ensure optimal picture quality related to the objects classified found.
The demonstrator offers different image control algorithms which can be viewed and evaluated by the corresponding touch screen display.



vicCAM Smart HDR Camera Platform

vicCOM Fullduplex Communications

Hardware Speech Processor Chip

voice INTER connect GmbH

Use at ELROB 2010: • **Static Display**

Basic data

Height (max):	4 mm
Width:	30 mm
Length:	60 mm
Weight:	10 g

Platform main capabilities

vicCOM is a miniaturized, hardware based speech processor chip for typical speech communications applications. It offers noise reduction, echo cancellation and full-duplex processing for hands free communication applications. It is designed for integration into a communication device or even into a headset.

vicCOM offers a complete selection of patented state of the art algorithms for signal detection, control, and different filters. vicCOM improves the audio quality even in acoustically difficult environments. Its small size and power consumption make it suiteable for all kinds of mobile applications.

vicCOM can be controlled and configured by a serial control protocol.

vicCOM Speech Processor

vicControl

Hardware Speech Control Unit

voice INTER connect GmbH

Use at ELROB 2010: • **Static Display**

Basic data

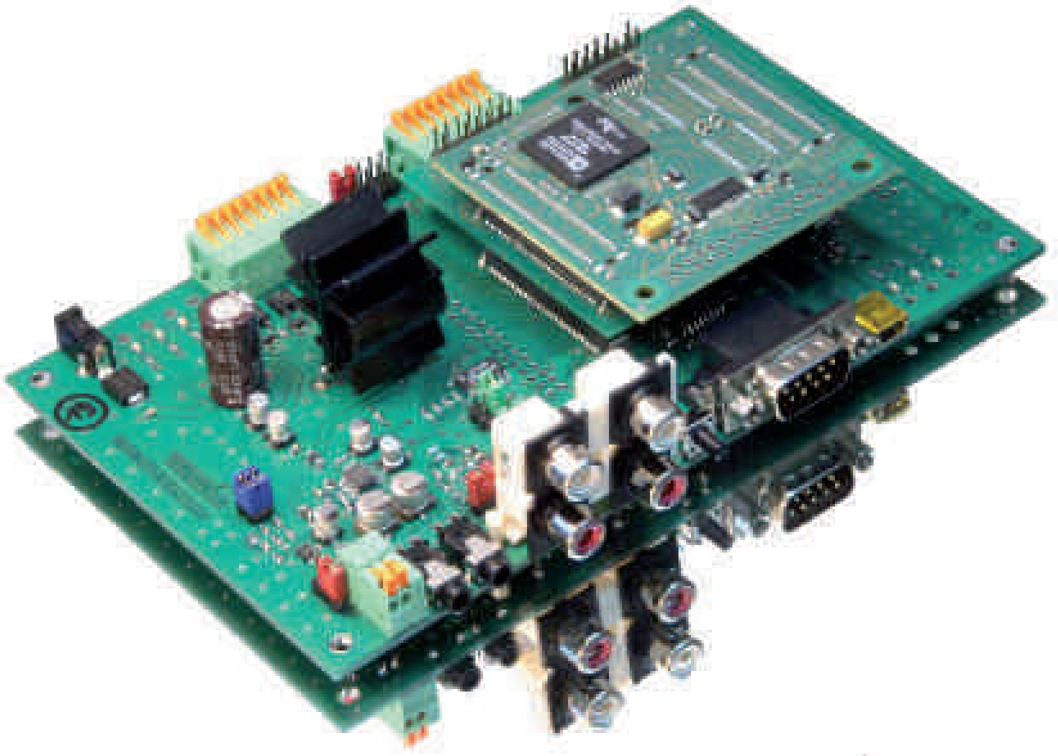
Height (max):	22 mm
Width:	160 mm
Length:	100 mm
Weight:	45 g
Supply Voltage:	12 - 24 V
Supply current:	200 mA (max) @ 12 V

Platform main capabilities

vicCONTROL is a miniaturized, hardware based speech control platform for the control of technical devices, i.e. mobile robots. Speech control is an essential tool for fast and intuitive control of a mobile robot, since it acts handsfree and allows a natural dialogue with the machine.

vicCONTROL is robust against environmental noise (automotive proven!), speaker independent and needs no training. Speech vocabulary is designed with the according speech dialog design tools from text lists of command. All European languages are available upon request.

vicCONTROL offers a serial control protocol, that can be connected to almost every kind of application.



vicControl-Hardware Speech Control

Video Transmission Systems

COFDM and Telemetry Receivers and Transmitters, Antennas and Accessories

Broadcast Microwave Services Europe GmbH

Use at ELROB 2010: • **Static Display**

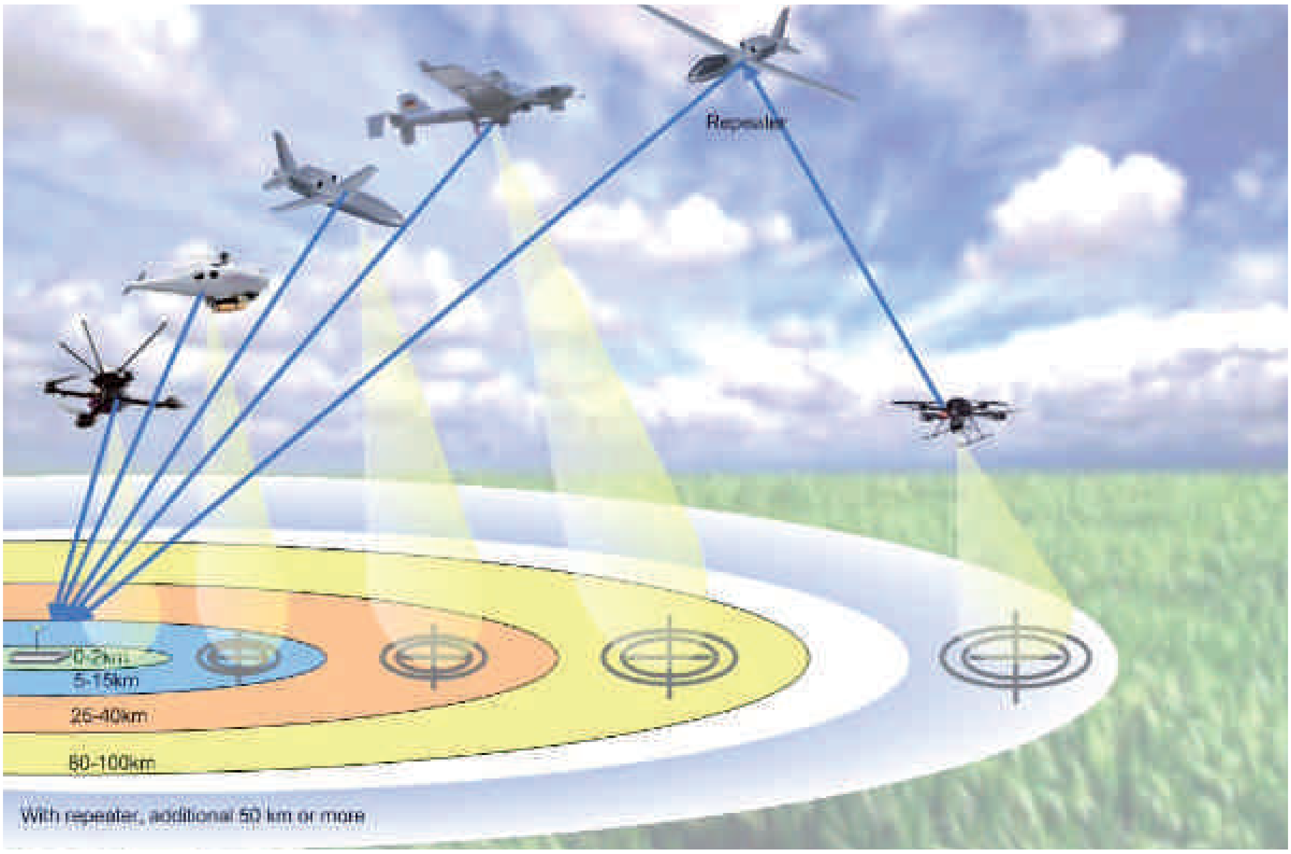
Platform main capabilities

Our systems are for use on aircraft, maritime and ground vehicles to collect critical information from safe distances. Video cameras mounted on unmanned aerial vehicles record information behind enemy lines and transmit the video and location coordinates back to command centers and tactical ground troops. Ground personnel can quickly analyze and respond to suspicious, volatile, or perilous situations. Access to this critical information fosters well-informed decisions, providing a major tactical advantage to ground troops while minimizing casualties.

The applications range from electrical-powered, ultra light short-range UAV-systems to long ranges of up to 100km including tracking (GPS-independent). OEM-solutions from low power to high power, frequency ranges from 100MHz to 7GHz give full flexibility to meet your needs.

Areas of interest:

- Telemetry Systems (GPS; Control Data; ...)
- Wireless Video transmissions (SD/HD; Video over IP)
- Unmanned airborne applications
- Unmanned ground applications



Video transmission from short-range to long-range with BMS OEM Solutions

Video, Audio and Telemetry

Surveillance System and Examples of Engineering Support in Robotics

BFFT GmbH

Use at ELROB 2010: • **Static Display**

Communication equipment

Type:	Digital video, audio and data link
Frequency:	482 MHz, up to 8 MHz bandwidth
Power:	up to 40W peak, ~4W average
Number of channels:	1

Sensor equipment

Vision:	CCD-Camera
GPS:	U-BLOX with EGNOS
Other sensors:	compass, accelerometer, temperature, microphone

Exhibit MMI

Platform main capabilities

- Audio, video and telemetry surveillance platform
- Digital audio and video transmission
- Encrypted transmission
- Range ~20 km
- Telemetry transmission with 115 kbit/s
- Light weight design
- Low power consumption
- Low cost design

BFFT Engineering examples of MMI Interfaces and a bus distribution unit

General Information

at

M-ELROB 2010

An overview of the ELROB 2010 scenarios

The participating systems of ELROB 2010 are faced with various challenges. There are two main scenarios containing different sub-scenarios. The main scenarios are “Reconnaissance and Surveillance” and “Transport”.

“Reconnaissance and Surveillance” is divided into two subject areas: “Approach” and “In the target area”. The latter itself is split into three additional tasks: “Reconnaissance, Surveillance and Target Acquisition” (RSTA), “Nuclear, Biological and Chemical Reconnaissance” (NBC recon) and “Explosive Ordnance Reconnaissance” (EOR).

The main scenario of “Transport” is divided into the parts “Movements” and “MULE” (Multifunctional Utility Logistics and Equipment).

Reconnaissance and Surveillance Scenario – Approach
A target point set up at a distance of up to 3,000 metres has to be reached. The environment is non-urban. There may be dynamic and static obstacles, dead ends, sharp turns, minefields and narrow passages. Enemy presence along the route may be expected. The objective is to approach the given coordinates as autonomously as possible. Ultimately, a picture must be taken of a village.

Reconnaissance and Surveillance Scenario – RSTA
The setting is an urban area within a valley. The task is to explore and monitor a defined area for dynamic and static threats. There may be suspicious persons, vehicles, arms, ammunition and barricades outside, inside or behind buildings. Heat sources and acoustic signals have to be reckoned with. The distance may vary from 50 to 1,000 metres. If anything suspicious is found an image has to be secured. Afterwards the image and the position of the object have to be transmitted to the control station.

Reconnaissance and Surveillance Scenario – NBC Recon
This scenario takes place in an urban area. The mission: perform NBC-reconnaissance with the highest degree of autonomy. Seek for threats inside and outside buildings at a distance ranging from 50 to 700 metres. There may be chemical agents, toxic industrial chemicals, radiation and explosives. If anything suspicious is found, secure images, measure CBN and take a sample, if possible. Report data to the control station.

Reconnaissance and Surveillance Scenario – EOR
Perform reconnaissance along a route with the highest possible degree of autonomy. Suspicious objects such as wires, shells or explosives may indicate an IED. The unmanned ground vehicle has to secure images of such objects and transmit them to the control station along with data of the location in question. Under no circumstances must the objects be touched.

Transport Scenario – Movements
A packet of at least two vehicles has to deliver some supplies to a camp between 7 to 14 km away. There may be dynamic and static obstacles on the road. Enemy presence may be expected. The transport has to be executed without undue risk for own personnel. Therefore only one vehicle can be manned. There are three levels of difficulty. One has to master one level to qualify for the next one.

Transport Scenario – MULE
There are two camps at a distance of about 2,000 metres from one another. Load has to be transported between the camps. The unmanned ground vehicle serves as MULE. It has to follow a guide to the turning point where it drops off its load and returns autonomously to the starting point. It then has to shuttle between the camps using its full payload. There are dynamic and static obstacles on the course.

Schedule

Monday, 17 May 2010

by 1200 hrs	Arrival of visitors at the reporting point
1230 hrs	Opening addresses by Chief of Staff, Army, and Director General of Armaments
followed by:	Open air presentation of all participating systems Opening and tour of the static display
in the evening:	Reception for invited guests

Tuesday, 18 May 2010

by 0800 hrs	Arrival of visitors at the reporting point
0800-1700 hrs	Reconnaissance trial during daytime parallel to static display

Wednesday, 19 May 2010

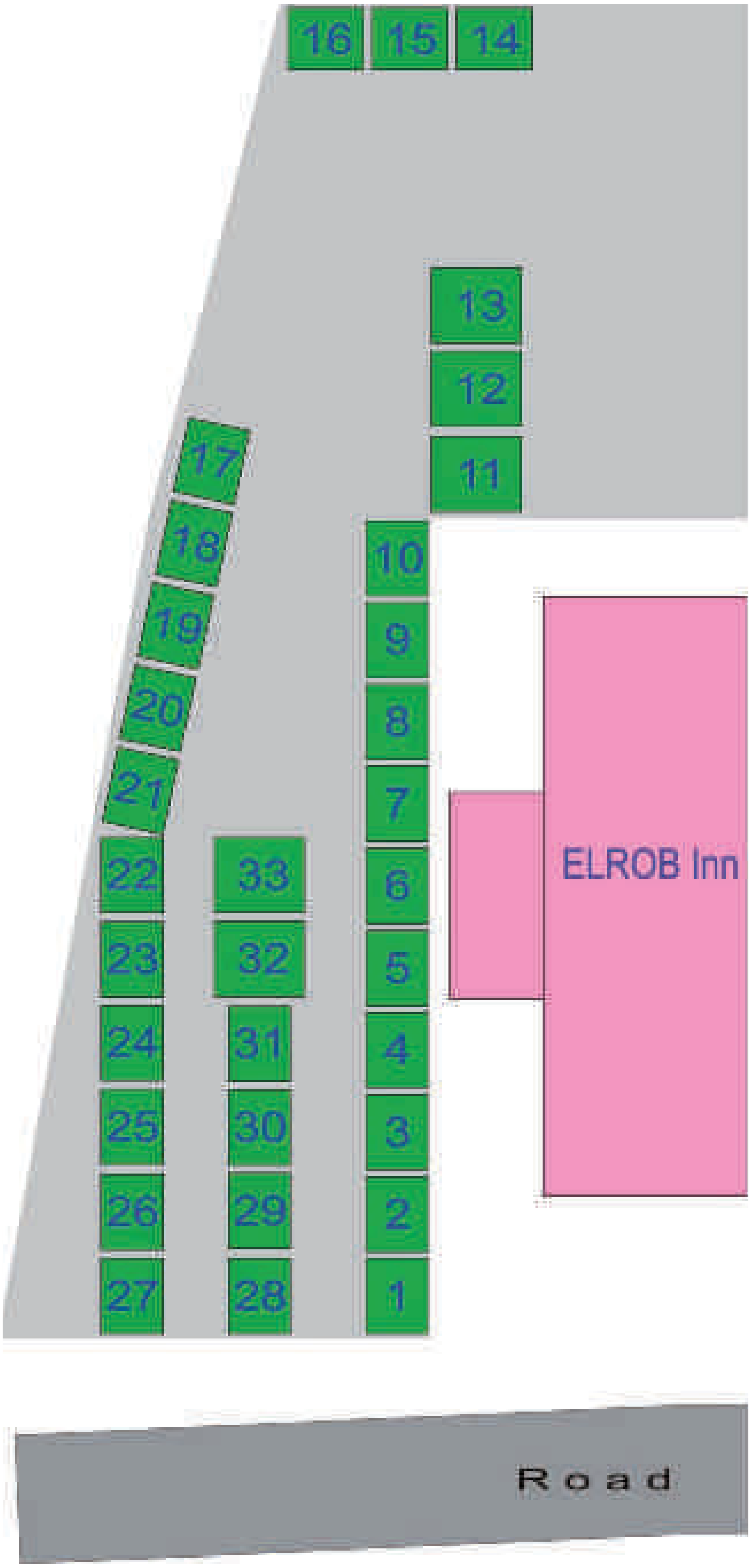
by 0800 hrs	Arrival of visitors at the reporting point
0800-1300 hrs	Transport trial, movement parallel to static display
1330-1800 hrs	Open Display
2200-0500 hrs	Reconnaissance trial at night

Thursday, 20 May 2010

by 0800 hrs	Arrival of visitors at the reporting point
0800-1300 hrs	Transport trial, MULE followed by: Closing event

Source: Amt für Geoinformationswesen der Bundeswehr 2008

Static Display Area



Exhibitors are subject to change

1 Allen Vanguard Ltd
2 Robotics Inventions
eurosimtec GmbH
3 Parosha Innovators b.v.
4 AIM INFRAROT-MODULE GmbH
5 VTQ Videotronik GmbH
Carl Zeiss Optronics GmbH
6 EMT Ingenieurgesellschaft
Dipl.-Ing. Hartmut Euer mbH
OmniSTAR b.v.
7 Broadcast Microwave Services
Europe GmbH
BFFT Gesellschaft für
Fahrzeugtechnik mbH
8 BORMATEC unmanned vehicles
9 Glückauf Logistik GmbH & Co. KG
AirRobot GmbH & Co. KG
10 TELEFUNKEN Radio Communication
Systems GmbH & Co. KG
11 SIM Security & Electronic System
GmbH
12 Roboterwerk GmbH
13 University of the Bundeswehr Munich
14 Hörmann IMG GmbH
Autoflug GmbH
15 Base Ten Systems Electronics GmbH
ND SatCom Defence GmbH
16 OHB-System AG
Thales Deutschland Defence
Solutions & Services
17 telerob Gesellschaft für Fern-
hantierungstechnik mbH
18 GeoTec Exploration mineralischer
Rohstoffe GmbH
19 MacroUSA Corp.
20 MIRA Ltd.
21 ROHDE & Schwarz Vertriebs-GmbH
22 roda computer GmbH
23 szenaris GmbH
ELP GmbH
24 voiceINTERconnect GmbH
25 MBDA Missile Systems
26 CT-Video GmbH
Defence R&D Canada and Simon
Fraser University
27 Fraunhofer Heinrich Hertz Institut
28 Distance University of Hagen
29 University of Kaiserslautern
30 University of Hannover
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31 University of Catania
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32 University of Siegen
33 Fraunhofer Institute for Communication,
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