euRathlon

An outdoor robotics challenge for land, sea and air

euRathlon 2013

23-27th September

Berchtesgaden, Germany

Funded by the European Union

FP7 Challenge 2 - Cognitive Systems and Robotics

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Eurathlon

Foreword

The Eurathlon project is funded by the European Union (EU) Seventh Framework Programme for Research and Technological Development (FP7).

The EU has been funding research into Cognitive Systems & Robotics since May 2004 and helping Europe to become a world-leader in this field. The EU's Cognitive Systems & Robotics programme supports over 120 research projects, involving several hundred of Europe's top researchers from academia and industry, with a funding of nearly € 600 million in the last five years. It aims to make robots more intelligent, more autonomous and more capable of assisting humans in everyday tasks.

Eurathlon was selected under the 9th Call of the FP7 in Communication and Information Technologies which had the goal of speeding up progress towards smarter robots through targeted competitions.

Benchmarking and evaluation activities are essential to science and technology excellence. They allow the assessment of the performance of systems, their testing in a reproducible way and ultimately the comparison of research results. These activities are useful both to the scientific community (helping to focus efforts, exchange results, drive research and allow tangible progress) and to the industrial community (to assess quality, meet users' needs, and speed up development and testing time). They contribute to shortening the lab-to-product time and to optimising the technology-transfer lifecycle. Benchmarks and metrics also provide end-users with a means of expressing their needs in terms of robotics scenarios: tasks and environment definition and robotic systems specifications.

The Eurathlon competitions are a perfect example of such activities, demonstrating how robots can efficiently support humans in search and rescue activities, providing realistic and useful scenarios to researchers to test and evaluate their results, and contributing to a wider benchmarking culture in robotics. They are also a unique opportunity for young European researchers to meet and to share experience, and for the public who will attend the event to witness how science can contribute to well-being and progress in our daily lives.

This event could not take place without the hard work and commitment of the project members, the help of the local organisers, the patronage of the end-users and the support of the sponsors.

As the EU project officer for Eurathlon, I have the opportunity to follow its development and its findings closely. I am convinced that this first competition will stimulate a great deal of interest in the work carried out and I wish all the participants and visitors an exciting, challenging and memorable event.

Anne Bajart, PhD

Project Officer

Robotics, Directorate General Communication Networks, Content and Technology,

European Commission

Welcome to euRathlon 2013.

euRathlon 2013 is the first of three annual outdoor robotics competitions in which the focus is robots for disaster response. At present robots are not included in the standard equipment of first responder emergency services, like fire brigades. But robotics technology is coming close to the point where they could be and, in our view, should be part of that equipment. One of the aims of euRathlon is to provide robot developers with an opportunity to competitively challenge their robots in realistic mock disaster scenarios and prove that their robots are ready for the real world. Thus euRathlon will, we hope, speed up the development and adoption of smarter robots by first responder emergency services.

The focus of euRathlon 2013 is land robots, and we have created five scenarios, each consisting of a series of tasks, which these terrestrial robots must complete. The scenarios cover a number of the key competencies needed in outdoor disaster response, including mapping the disaster site, searching for objects of potential interest (e.g. survivors), turning off valves (i.e. a gas leak), finding hazardous materials and making them safe, and navigating autonomously from one place to another. In the euRathlon 2013 scenario descriptions we have specified each scenario in sufficient detail for teams to prepare their robots, but we have not prescribed the robots themselves. Teams are free to come up with whatever robot designs they think capable of tackling the scenarios. Furthermore we have not provided teams with detailed plans or videos of the scenario locations, so they cannot optimise their robots to fit. Instead the robots must enter the scenarios ‘unseen’ and cope with the layout or hazards they encounter, just as they would if going into a real world disaster.

An autonomous robot is a robot capable of deciding which action to take next in order to achieve its mission without human intervention or guidance, and one of the central aims of euRathlon 2013 is to test the intelligence and autonomy of the competing robots. We have developed a scoring scheme that awards points for each task successfully completed, but also deducts points each time a team member has to intervene to correct or guide their robot’s behaviour. Thus, the winning robots in each scenario will be the ones that successfully complete the largest number of tasks with the least human intervention. A wider goal of euRathlon is to contribute to the development of benchmarks: performance tests that allow different robots to be compared while undertaking carefully specified standardised tasks.

Funded by the European Commission, euRathlon is an international competition that welcomes university, industry or independent teams from any country. But entering a team requires considerable preparation, energy and commitment. The teams at euRathlon 2013 have each undergone a multi-stage qualification process to make it to Berchtesgaden. That process required them to each write a Scenario Application Paper (SAP) setting out how they propose to address the technical challenges of the competition. Those papers were carefully reviewed, and comments returned to the teams. The primary task of the SAP reviewers was to check that the solutions proposed have a realistic chance of meeting the significant demands of the competition scenarios.

We are delighted by the number and diversity of teams who have qualified for euRathlon 2013, and we would like to congratulate teams for making it to Berchtesgaden, as well as wishing them every success in the competition ahead.

The longer term vision of euRathlon is a competition scenario in which no single type of robot is, on its own, adequate. Inspired by the Fukushima accident of 2011, the euRathlon ‘grand challenge’ will require cooperating groups of land, sea and flying robots to investigate the scene, collect environmental data, then identify – and stabilise – critical hazards. euRathlon 2013 is thus the first of three events. The focus of euRathlon 2014 will be underwater robots, and then euRathlon 2015 will add flying robots, to cover all three domains. Given the very significant technical difficulty of engineering cooperative multi-robot systems of land, sea and flying robots we encourage teams competing in euRathlon 2013 and 2014 to collaborate and form consortia for euRathlon 2015.

I am very fortunate to be leading the euRathlon project, which is formed of a consortium of 7 institutions from 5 countries. My colleagues within the consortium have internationally leading expertise in robotics combined with long experience of staging successful robotics competitions, in particular the European Land Robotics Trials (ELROB) and the Student Autonomous Underwater Robot Challenge – Europe (SAUC-E). Organising outdoor robot competitions, and the supporting workshops, is a complex undertaking and I want to thank my euRathlon colleagues for their enthusiasm, commitment and contribution to this endeavour. I am especially grateful to Dr. Frank E. Schneider and his team at the Fraunhofer FKIE for leading the local organisation of euRathlon 2013. I also want to acknowledge the European Commission for supporting euRathlon financially as well as the outstanding encouragement and advice of our Project Officer Dr. Anne Bajart.

If you are attending euRathlon 2013 as a competitor, we wish you every success and hope you find the experience of competing rewarding as well as enjoyable. If you are here as a spectator we hope you are inspired by what you see. And if you are here as an industry or end user observer we hope you will be encouraged by the robot trials that you witness here in Berchtesgaden, and that you will be persuaded to support and collaborate with teams to speed up the adoption of intelligent robots in real world disaster response applications.

On behalf of the euRathlon consortium

Professor Alan Winfield, BSc, PhD, MIET, MIEEE, CEng

Bristol Robotics Laboratory and Science Communication Unit

University of the West of England, Bristol, UK

Grußwort Landkreis Berchtesgadener Land und Wirtschaftsförderungsgesellschaft

Sehr geehrte Teilnehmerinnen und Teilnehmer der EURATHLON 2013

für den Landkreis Berchtesgadener Land und die Wirtschaftsförderungsgesellschaft ist es eine große Ehre, Gastgeber der EURATHLON 2013 zu sein.

Das Berchtesgadener Land ist bekannt für eine attraktive Tourismus- und Freizeitregion und diese hohe Lebensqualität macht die Region auch für Unternehmen außerhalb des Tourismus interessant. Viele Menschen wissen aber nicht, dass eine Reihe hochinnovativer, mittelständischer Firmen hier angesiedelt sind, die nicht selten in ihrem Bereich Technologie-, Innovations- und nicht zuletzt Marktführer und weltweit erfolgreich tätig sind, wie z.B. die sich seit zwei Jahren am Markt befindliche progenoX GmbH, die sich auf die Entwicklung hochwertiger navigationsgestützter Roboter für den Einsatz in schwierigen Situationen spezialisiert hat. „Made in BGL" findet sich aber in Form von Komponenten und Dienstleistungen auch in einer Vielzahl von weiteren Hightechprodukten in der Automobil-, Elektro-, Medizin- und Produktionstechnik sowie der Feinmechanik.

Ihre Spitzenstellung behaupten diese mittelständischen Unternehmen durch permanente Innovation, Investition und Weiterbildung. Der Landkreis selbst investiert große Anstrengungen in das neue Zukunftsfeld der Satellitennavigation mit dem weltweit einzigartigen, in Berchtesgaden gelegenen, Testgebiet für das neue europäische Navigationssystem Galileo. Die EURATLHON 2013 findet daher auch mitten im Galileo Testgebiet GATE statt. Mittlerweile ist hier ein europaweit anerkanntes Netzwerk von Unternehmen und Wissenschaftseinrichtungen zu diesem Thema entstanden, in dem neue zukunftsweisende Ideen und Produkte im Bereich Mobilität und Logistik, Sicherheit und Rettungswesen, Gesundheitswirtschaft und Tourismus, Energie. Landwirtschaft und Umwelt sowie erweiterten Dienstleistungen unter Nutzung von Satellitennavigationstechnologien entwickelt und vermarktet werden.

Insbesondere das Engagement der europäischen Raumfahrtagentur ESA in Zusammenarbeit mit dem bayerischen Wirtschaftsministerium über ein spezielles Gründerprogramm für Hightech-Gründungen im Landkreis möchte ich hier als besonders beachtenswert nennen.

Die landkreiseigene Wirtschaftsförderungsgesellschaft hat wichtige regionalwirtschaftliche Schwerpunkte im Bereich innovativer Themenfelder, wie SatNav, moderne technologieorientierte Gesundheitsprodukte, der Nutzung regenerativer Energien oder innovativer Logistikkonzepte und der Robotertechnik.

Deswegen engagieren wir uns mit unserer Wirtschaftsförderungsgesellschaft bei der diesjährigen EURATHLON. Hier verbinden sich Unternehmen mit Bildungseinrichtungen, universitäre und ausseruniversitäre Forschungseinrichtungen mit den nationalen und internationalen Partnern.

Es soll auf diese Weise in der Region ein innovatives Netzwerk für Robotertechnik entstehen, das nach innen dem Informationsaustausch dient und nach außen die Leistungen der einzelnen Netzwerkpartner, in erster Linie natürlich auch der Betriebe, weiterentwickelt.

Wir stehen auch als Ansprechpartner für Unternehmen zur Verfügung, die sich in diesem technologischen Umfeld bei uns weiterentwickeln wollen oder auf der Suche nach Netzwerken und Partnern sind. Bei uns finden Sie Hilfe wenn es um Fördermittel geht genauso wie bei der Vermittlung von geeigneten Produktionsstandorten oder beim Zugang zu Unternehmen und Netzwerken mit Technologietransfer, die wir oft in eigener Regie führen.

Das Berchtesgadener Land ist ein hervorragender Standort für Unternehmensgründungen, mit seiner Lage zwischen hochrangigen Universitäten in München, Rosenheim, Salzburg und Urstein, seiner Nähe zur Stadt Salzburg und ihrem Flughafen, sowie der guten Verkehrsanbindung über Autobahn und Schiene. Aber auch mit einem Umfeld von vielen innovativen mittelständischen Unternehmen die in der Zulieferung von Komponenten oder in der Nutzung von Lösungen und Verfahren der Robotertechnik eine wichtige Rolle spielen können. Hinzu kommt ein Lebensumfeld von höchster Qualität, das beste Voraussetzungen für kreative und innovative Entwicklungsprozesse bietet.

Ich wünsche der Tagung und Ihren Teilnehmern viel Erfolg während der Tagung und der Entwicklung ihrer Robotersysteme und freue mich, wenn wir mit vielen von Ihnen in Verbindung bleiben können.

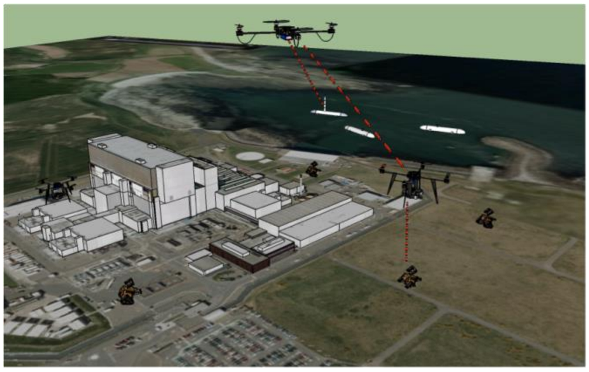
Dr. Thomas Birner

Geschäftsführer

Wirtschaftsförderungsgesellschaft Berchtesgadener Land

EURATHLON 2013, Berchtesgaden

EURATHLON will provide real-world robotics challenges for outdoor robots in demanding scenarios. The trials and scenarios are chosen with regards to an important research topic of the European Union: "Restoring security and safety in case of crises." This field of research addresses all major robotics goals such as cognition, autonomy, adaptivity and robustness. Ideally, autonomous flying, land and underwater robots should act together to survey the situation, collect environmental data, and identify potential hazards.



To combine the land, sea and air robotics domains in one joint competition, EURATHLON brings together partners experienced in two well-established outdoor robotics competitions: the European Land Robot Trials (ELROB) and the Student Autonomous Underwater Challenge - Europe (SAUC-E). The experiences gathered in these events will transferred into EURATHLON, and together with the key scientific objectives targeted in EURATHLON 2013 (autonomous navigation & control and robust sensing & acting) they build the ground work to a large joint competition.

In 2015 EURATHLON will finally culminate in a grand challenge: air, land and sea robots collaborating in a post-disaster situation similar to the one encountered in Fukushima. Flying robots will map the area of intervention and collect environmental data. Underwater vehicles would sense for chemical spillage at sea. The land robots might gather close-in data and enter buildings. Thus, EURATHLON will create a not only European but world leading robotics event, yielding a boost in scientific progress as well as an increasing public awareness and acceptance of smart robots. For further information concerning the future development of EURATHLON have a look at www.eurathlon.eu.

The EURATHLON trials will be co-designed alongside a set of performance benchmarks, evaluating intelligence, autonomy, robustness etc. in the context of particular real-world scenarios and environments. The benchmarks will be proposed and developed in an open process, adapting existing best practices in the robotics community.

Although all system and hardware designs, algorithms etc. of robots entered for trials will, of course, remain the property of their teams, the organizers strongly encourage teams to allow publishing of data collected during trials. These data sets will provide other teams with the means for detailed comparative analysis.

Several workshops with a focus on EURATHLON trials and benchmarks will take place, intended primarily for student / researcher competitors, or teams planning to compete in EURATHLON. Major aim of these workshops is both, building a shared understanding of the challenges of real-world robotics and cross-fertilising ideas across (often detached) research communities in land, water and flying robotics.

Content

Competition

Chief Judge Team

Dr.-Ing. Michael Gustmann

Operations Manager of Kerntechnische Hilfsdienst GmbH

Dipl.-Ing. Thomas Zawadke

CEO, Feuerwehr-Fahrzeugtechnik Zawadke

Prof. Dr. Juha Röning

Head of Dept. of Computer Science and Engineering, University of Oulu, Finland

Kenneth A. Pink

MBE, C.Eng C.MarEng M.I.M
echE M.I.MarEST A. I, ExpE
Snr. Project Engineer and Technical Lead for QinetiQ's Project GHOST

Dr. Frank E. Schneider

Head of EuropeanRobotics
Chair of NATO RTG-052/IST-107

Competition Teams

ELP
E15
NAMT
Robotics Inventions
IAIR
Telerob
ARTOR
RIS
ENSTA Bretagne
MuCAR
SpaceApps
Fraunhofer FKIE
SCentRo

ELP

Team Information

Team name:	ELP	
Team leader:	Colin Weiss	
Team leader's email:	cweiss@elp-gmbh.de	
Nationality	Germany	
Website	http://www.elp-gmbh.de	
Location:	Wuppertal	
Institution/Company:	ELP GmbH, European Logistic Partners	
Adress:	Nützenberger Straße 359 42115 Wuppertal, Germany	
Tel.:	+49 202-698940	
Fax:	+49 202-6989410	

Competition

Competition	Reconnaissance and surveillance in urban structures
	Mobile manipulation for handling hazardous material
	Search and rescue in s smoke filled underground structure
	Autonomous navigation using GPS, GLONASS and GALILEO
	EOR/EOD/IEDD/CIED (for professionals only)

Team Description

ELP GmbH is distributing iRobot's range of robotic systems within German-speaking Europe and provides Service and Training for these systems within all of Europe. In addition, ELP is developing accessories and additional capabilities for the iRobot equipment.

Vehicle

Picture of vehicle	
Name of vehicle	PackBot EOD 510

Basic data

Height (max):	2210 cm (Total height from ground to top, arm extended)
Height (min)	40,7 cm
Width:	40,6 cm
Length:	69 cm
Weight:	33,3 kg
Turning diameter:	
Ground clearance:	7,62 cm
Average noise level:	
Climbing performance:	43 degree
Wheel or track driven:	Track
Propulsion:	Batteries
Endurance:	12 -15 hrs
Max. speed:	9,3 km/h
Payload:	35 kg

Communication equipment

Device 1	
Type:	WLAN 802.11 b/g; Alternative: 802.11a
Frequency	2,4 GHz (Alternative 4.9 GHz)
Possible frequency range:	
Power:	0.4 Watts max.
Modulation:	OFDM
Number of channels	11, fixed to channel 6; Alternative: 15

Sensor equipment

Vision	4 Colour Cameras, 1 with 312x zoom and low light mode one input for an auxiliary camera (FLIR or Wide-Angle as per mission requirements)
GPS	Optional, depending on system configuration
Inertial measurement unit	Built-in, includes magnetic compass, pitch and roll sensors
Joint position and movement	Absolute and relative encoders
Other sensors (auxiliary	Y-Ray imaging (Real-time and Image-Plate, HazMat Sensor kit (Radiation, Chemical Warfare Agents, Toxic industrial chemicals, Oxygen concentration, temperature, humidity), Explosives detection kit

Computing equipment on vehicle

Number of computers	1 fixed (Main Computer), second modular (User Assist Payload)
Number of CPUs	1 each
Type of CPU	Intel Core2Duo
Operating system(s)	Linux

Basic data about control station

Pictures of control station:	
Number of operators(mandatory/optional)	1
Number of computers	1
Number of CPUs	1
Type of CPU	Intel Core2Duo Mobile T5500, 2 x 1.66 GHz
Operating system	Linux
Space needed for control station(LxWxH)	352 x 284 x 64 cm
Weight of control station	6 kg
Power source needed	110/230V, 150W when operating on mains

E15

Team Information

Team name:	E15	
Team leader:	Michael Eisele	
Team leader's email:	Michi.eisele@web.de	
Nationality	Germany	
Website	http://www.ftag-esslingen.de	
Location:	Esslingen am Neckar	
Institution/Company:	University of Applied Sciences Esslingen	
Adress:	Kanalstraße 33, 73728 Esslingen am Neckar, Germany	
Tel.:	+49 160-96445135	
Fax:	+49 7121-161872	

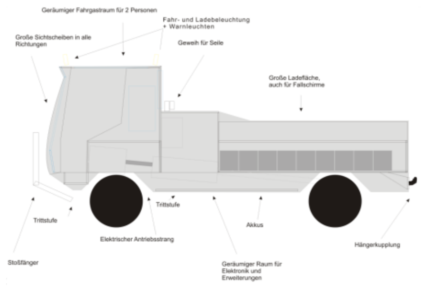
Competition

Competition	Mobile manipulation for handling hazardous material
	Search and rescue in s smoke filled underground structure
	Autonomous navigation using GPS, GLONASS and GALILEO

Team Description

We are a group of 16 Students, studying at the university of applied sciences Esslingen. Our aim is to build an autonomous vehicle which can be used for different jobs on a small airfield and off road material handling.

Vehicle

Picture of vehicle	Monique	
Name of vehicle		

Basic data:

Height (max):	250 cm
Height (min)	225cm
Width:	175 cm
Length:	490 cm
Weight:	1800 kg
Turning diameter:	
Ground clearance:	22 cm
Average noise level:	87 dB(A)
Climbing performance:	43 degree
Wheel or track driven:	4 Wheels
Propulsion:	Batteries
Endurance:	5 hrs
Max. speed:	45 km/h
Payload:	650 kg

Communication equipment

Device 1

Type:	WLAN
Frequency	2400 MHz
Possible frequency range:	from 2400 to 2485 MHz
Power:	100 mW
Modulation:	OFDM
Number of channels	13

Sensor equipment

Laser	Ibeo ALASCA, 240° horizontal field of view, 3,4° vertical field of view, 12,5 Hz, resolution: 4 cm distance, 0,125° angle, range: 200 m
Ultrasonic	10 sensors for emergency stop function, parking and slow movement, located around the vehicle, range 8 m, resolution 1 cm
Vision	5 High resolution cameras (5 mounted on the roof with night vision capabilities, 1 mounted on the front bumper, and 2 on the rear bumber), 2 lower resolution camera (1 mounted on the roof, 1 mounted behind the drivers cabin) for manual remote control, if necessary.
GPS	1 FV-M8 5Hz 32 channel DGPS (accuracy ~ 5 m), 1 EM-406A 1Hz 20 channel (accuracy ~ 10m)
Radar	3 Bosch SR3 70GHz Doppler, 1 mounted on the roof (turning), 1 mounted on the front bumper, 1 mounted on the read bumper
Inertial measurement unit	3 Axis accelerometer +/- 11g, 3 axis turn rate sensor, 3 axis magnetic field sensor

Computing equipment on vehicle

Number of computers	5
Number of CPUs	5
Type of CPU	Several consumer CPUs
Operating system(s)	Arch Linux, Embedded Windows 8

Basic data about control station

Pictures of control station:	
Number of operators(mandatory/optional)	0/1
Number of computers	1
Number of CPUs	1
Type of CPU	Intel Core i7 3615QM
Operating system	Windows 7
Space needed for control station(LxWxH)	100x45x50 mm
Weight of control station	4 kg
Power source needed	230V with 500W

NAMT

Team Information

Team name:	NAMT	
Team leader:	Igor Kudryashov	
Team leader's email:	igor8484.1084@mail.ru	
Nationality	Russia	
Website	http://www.	
Location:	Nizhny Novgorod	
Institution/Company:	Nizhny Novgorod Automotive Technical School (NAMT)	
Adress:	Lenin avenue, 111, 603004 Nizhny Novgorod	
Tel.:	+7 831-295-91-22	
Fax:		

Competition

Competition	Autonomous navigation using GPS, GLONASS and GALILEO

Team Description

The «NAMT» Team entry into the ELROB2013. The team consisting of students and staff of the two institutions:

- Nizhny Novgorod Automotive Technical School
- Moscow State Technical University named after N.E. Bauman

Vehicles

Picture of vehicle		 
Name of vehicle	CyberMobile	

Basic data

Height (max):	100 cm (Total height from ground to top, including antennas etc.)
Height (min)	72 cm (Total height from ground to top of the vehicle)
Width:	80 cm
Length:	116 cm
Weight:	120 kg
Turning diameter:	
Ground clearance:	15 cm
Average noise level:	60 dB(A)
Climbing performance:	12 degree
Wheel or track driven:	Wheel
Propulsion:	Batteries
Endurance:	1,5 hrs
Max. speed:	25 km/h
Payload:	60 kg

Communication equipment

Device 1

Type:	Wi-Fi access point
Frequency	2400 MHz
Possible frequency range:	From 2400 to 2472 MHz
Power:	0.63 Watts
Modulation:	DSSS
Number of channels	12

Sensor equipment

Vision	IP-Camera Smartec STC-IP3301/A1
GPS	Included in Strapdown Inertial Navigation System CompaNav-2T
Radar	HOKUYO UTM-30LX-EW, HOKUYO UBG-04LX-F01
Inertial measurement unit	Strapdown Inertial Navigation System CompaNav-2T

Computing equipment on vehicle

Number of computers	2
Number of CPUs	5
Type of CPU	X86
Operating system(s)	Windows 7, VxWorks

Basic data about control station

Pictures of control station:	
Number of operators(mandatory/optional)	1/2
Number of computers	1
Number of CPUs	1
Type of CPU	Intel Core 7
Operating system	Windows 7
Space needed for control station(LxWxH)	Notebook
Weight of control station	3,4 kg
Power source needed	110-220V, 150W

Robotics Inventions

Team Information

Team name:	RI Spirit	
Team leader:	Marek Sadowski	
Team leader's email:	eurathlon@roboticsinventions.com	
Nationality	Poland	
Website	http://www.roboticsinventions.com	
Location:	Warsaw	
Institution/Company:	Robotics Inventions	
Adress:	Marynarska 14, 02-674 Warsaw, Poland	
Tel.:	+48 888333627	
Fax:	+48 224658453	

Competition

Competition	Reconnaissance and surveillance in urban structures
	Mobile manipulation for handling hazardous material
	Search and rescue in s smoke filled underground structure
	Autonomous navigation using GPS, GLONASS and GALILEO

Team Description

Robotics Inventions is a New Product Development company delivering in 6 months preproduction prototypes (including Bill of Material), excelling in fully-and semi-autonomous robots, vision systems, the autonomy module RI SPIRIT, the robot swarm management system RIFLEET, innovative user interfaces and various components, having a dedicated production facility, as well as the robotics professional services. Our mission is to design and manufacture semi-and fully-autonomous robots and its parts to allow human telepresence in harsh and extraterrestrial 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. Robotics Inventions is going to present its cornerstone terrestrial products for Industrial, Prevention and Public sectors: A-BOT robot light and standard configurations. The A-BOT robot is designed to be a powerful semiautonomous mobile vehicle suitable for urban and offroad applications. Robotics Inventions' robots are suitable for autonomous patrol, reconnaissance and mule missions.

Vehicle 1

Picture of vehicle		
Name of vehicle	R1 A-Bot light	

Basic data

Height (max):	40 cm (Total height from ground to top, including antennas etc.)
Height (min)	40 cm (Total height from ground to top of the vehicle
Width:	55 cm
Length:	55 cm
Weight:	35 kg
Turning diameter:	
Ground clearance:	5 cm
Average noise level:	50 dB(A)
Climbing performance:	25 degree
Wheel or track driven:	Wheel
Propulsion:	Batteries
Endurance:	5 hrs
Max. speed:	10 km/h
Payload:	5 kg

Communication equipment

Device 1	
Type:	WLAN 802.11b
Frequency	2400 MHz
Possible frequency range:	From 2400 to 2800 MHz
Power:	10 mWatts(20dbm)
Modulation:	--
Number of channels	13

Sensor equipment

Vision	2 x Digital Camera
GPS	1x
Ultrasonic sensors	8x
Lidar	1x

Computing equipment on vehicle

Number of computers	2
Number of CPUs	2
Type of CPU	ARM
Operating system(s)	Linux

Basic data about control station

Pictures of control station:	
Number of operators(mandatory/optional)	!/1
Number of computers	1
Number of CPUs	1
Type of CPU	Intel Pentium Mobile 2GHz
Operating system	Linux
Space needed for control station(LxWxH)	300 x 400 x 250 cm(LxWxH)
Weight of control station	2 kg
Power source needed	230V with 600W

Vehicle 2

Picture of vehicle		
Name of vehicle	A-BOT Standard	

Basic data

Height (max):	125 cm (Total height from ground to top, including antennas etc.)
Height (min)	37 cm (Total height from ground to top of the vehicle
Width:	51 cm
Length:	101 cm
Weight:	100 kg
Turning diameter:	
Ground clearance:	10 cm
Average noise level:	60 dB(A)
Climbing performance:	35 degree
Wheel or track driven:	Track
Propulsion:	Batteries
Endurance:	2 hrs
Max. speed:	15 km/h
Payload:	90 kg

Communication equipment

Device 1	
Type:	WLAN 802.11b
Frequency	2400 MHz
Possible frequency range:	From 2400 to 2800 MHz
Power:	10 mWatts(20dbm)
Modulation:	--
Number of channels	13

Sensor equipment

Vision	2 x Digital Camera
GPS	2x
Ultrasonic sensors	12x
Lidar	1x

Computing equipment on vehicle

Number of computers	2
Number of CPUs	2
Type of CPU	ARM
Operating system(s)	Linux

Basic data about control station

Pictures of control station:	
Number of operators(mandatory/optional)	!/1
Number of computers	1
Number of CPUs	1
Type of CPU	Intel Pentium Mobile 2GHz
Operating system	Linux
Space needed for control station(LxWxH)	300 x 400 x 250 cm(LxWxH)
Weight of control station	2 kg
Power source needed	230V with 600W

IAIR

Team Information

Team name:	IMM-IAIR	
Team leader:	Janusz Bedkowski	
Team leader's email:	januszbedkowski@gmail.com	
Nationality	Poland	
Website	http://www.gpuformobilerobot-github.com	
Location:	Warsaw	
Institution/Company:	Institute of Mathematical Machines with the collaboration of Institute of Automatic Control and Robotics	
Adress:	Ul. Krzywickiego 34, 02-078 Warsaw, Poland	
Tel.:	+48 501090020	
Fax:		

Competition

Competition	Reconnaissance and surveillance in urban structures
	Search and rescue in s smoke filled underground structure

Team Description

After successful CELROB 2011 we decided to improve our mobile platform (IAIR team). It is equipped with rotated LMS 100, therefore it can navigate in 3D environment. The novelty in proposed approach is based on GPGPU computation for 3D cloud of points processing. Robot can filter, sub sample and register 3D data on line. It can build consistent map based on 6DSLAM algorithm[1]. The new approach is related to use semantic information for loop closing detection. Semantic information is also sent to base station and it can be used for further decision support.

[1] Janusz Marian Bedkowski, Andrzej Maslowski, Geert De Cubber, (2012) "Real time 3D localization and mapping for USAR robotic application", Industrial Robot: An International Journal, Vol. 39 Iss: 5

Vehicle

Picture of vehicle		
Name of vehicle	MSAS	

Basic data

Height (max):	70 cm
Height (min)	70 cm
Width:	60 cm
Length:	80 cm
Weight:	25 kg
Turning diameter:	
Ground clearance:	7 cm
Average noise level:	60 dB(A)
Climbing performance:	20 degree
Wheel or track driven:	Wheel
Propulsion:	Batteries
Endurance:	2 hrs
Max. speed:	1,5
Payload:	5 kg

Communication equipment

Device 1	
Type:	WLAN
Frequency	2,4 GHz
Possible frequency range:	
Power:	20 Watt
Modulation:	
Number of channels	

Sensor equipment

Laser	Rotated SICK LMS100
Vision	CCD camera
GPS	XSense MTI-G
Radar	None
Inertial measurement unit	InertialCube 3

Computing equipment on vehicle

Number of computers	1
Number of CPUs	1
Type of CPU	Intel i7
Operating system(s)	Windows 7

Basic data about control station

Pictures of control station:	
Number of operators(mandatory/optional)	1
Number of computers	1
Number of CPUs	1
Type of CPU	Intel i7
Operating system	Windows 7
Space needed for control station(LxWxH)	Laptop
Weight of control station	7 kg
Power source needed	230V
Additional Information	

Telerob

Team Information

Team name:	Telerob	
Team leader:	Dr. Andreas Ciossek	
Team leader's email:	ciossek@telerob.de	
Nationality	Germany	
Website	www.telerob.de	
Location:	Germany	
Institution/Company:	Telerob Gesellschaft für Fernhantierungstechnik mbH trading as Cobham Mission Equipment	
Adress:	Vogelsangstrasse 8, 73760 Ostfildern, Germany	
Tel.:	+49 71134102115	
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Mobil:	+49 1727498689	

Competition

Competition	Reconnaissance and surveillance in urban structures
	Mobile manipulation for handling hazardous material
	Search and rescue in s smoke filled underground structure
	EOR/EOD/IEDD/CIED (for professionals only)

Team Description

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). A highly qualified, highly motivated staff provides our worldwide client base not merely with innovative products developed and manufactured in accordance with the very highest standards but also with the training and instruction needed to ensure their effective use. telerob is an official NATO supplier and development partner (NATO supplier code: C 5152). Furthermore we conform to the requirements of AQAP

Vehicle

Picture of vehicle		
Name of vehicle	telemax	

Basic data

Height (max):	260 cm (Total height from ground to top, including antennas etc.)
Height (min)	75 cm
Width:	40 cm
Length:	160 cm(flipper horizontally extended)
Weight:	80 kg
Turning diameter:	
Ground clearance:	10 cm
Average noise level:	
Climbing performance:	45 degree
Wheel or track driven:	4 tracks
Propulsion:	Battery
Endurance:	4 hrs
Max. speed:	10 km/h
Payload:	10 kg

Communication equipment

Device 1	Data communication link 1
Type:	Radio
Frequency	434 MHz
Possible frequency range:	From 433 to 435 MHz
Power:	Up to 1000mW
Modulation:	
Number of channels	80

Device 1	Data communication link 2(optional)
Type:	Radio
Frequency	2353 MHz
Possible frequency range:	From 2353 to 2381 MHz
Power:	5000mW
Modulation:	
Number of channels	5

Sensor equipment

Vision	1xcolour camera with 10xoptical zoom, auto focus and integrated LED illumination
GPS	Garmin 16-HVS, Average accuracy 15m
Radiation	Thermo Electron RadEye-PRD or other
Gas	Dräger Xam7000 or other
CWA, TIC	N.N.

Computing equipment on vehicle

Number of computers	1
Number of CPUs	
Type of CPU	
Operating system(s)	VxWorks

Basic data about control station

Pictures of control station:

Number of operators(mandatory/optional)	1/3
Number of computers	3
Number of CPUs	
Type of CPU	
Operating system	Windows
Space needed for control station(LxWxH)	Size of Sprinter: 7500x2500x3200 cm
Weight of control station	5000 kg
Power source needed	Optional 230V with 1600W
Additional Information	

ARTOR

Team Information

Team name:	ARTOR	
Team leader:	Philipp Krüsi	
Team leader's email:	Phillip.kruesi@mavt.ethz.ch	
Nationality	Switzerland	
Website	http://artor.ethz.ch	
Location:	Switzerland	
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Competition

Competition	Autonomous navigation using GPS, GLONASS and GALILEO

Team Description

Team ARTOR is a collaboration between the Autonomous Systems Lab (ASL) at ETH Zürich, RUAG Defence and armasuisse W+T. The team is composed of Researchers and technical staff at ASL and RUAG Defence, under the leadership of Philipp Krüsi (PhD student, ETH/ASL) and Dr. Thomas Nussbaumer (Head of the armasuisse research program UGV, RUAG Defence). The focus of our research lies in fully autonomous navigation in rough and three-dimensional outdoor terrain. This includes localization and terrain mapping based on laser range measurements and stereo vision, as well as system-compliant motion planning. Our robot ARTOR (Autonomous Rough Terrain Outdoor Robot) is a 6-wheeled, skid-steered electric vehicle. An array of onboard sensors is used for monitoring the robot's state and gathering information about the environment for online mapping, localization and obstacle avoidance. The equipment includes a rotating 3D laser scanner, two 2D laser scanners, a stereo camera, a GPS receiver and an inertial measurement unit. Furthermore, a pan-tilt-zoom unit containing both a visual and a thermal camera is installed. All data processing for autonomous navigation, including mapping, localization, path planning, obstacle avoidance and motion control, is performed on the onboard computer, using the robot operating system ROS.

Vehicle

Picture of vehicle		
Name of vehicle	ARTOR	

Basic data

Height (max):	125 cm
Height (min)	125 cm
Width:	75 cm
Length:	140 cm
Weight:	330 kg
Turning diameter:	
Ground clearance:	14 cm
Average noise level:	60 dB(A)
Climbing performance:	30 degree
Wheel or track driven:	Wheels
Propulsion:	Batteries
Endurance:	2 hrs
Max. speed:	9 km/h
Payload:	50 kg

Communication equipment

Device 1

Type:	WLAN 802.11 b/g/n
Frequency	2400 MHz
Possible frequency range:	From 2400 to 2500 MHz
Power:	100 mW
Modulation:	OFDM
Number of channels	16

Device 2

Type:	COFDM Video/data sender
Frequency	1150 MHz
Possible frequency range:	From 1150 to 1300 MHz
Power:	Adjustable, max. 1000 mW
Modulation:	COFDM: QPSK/16QAM
Number of channels	10

Device 3

Type:	Telemetry sender
Frequency	916 MHz
Possible frequency range:	From 916 to 921 MHz
Power:	Adjustable, max. 2000 mW
Modulation:	FSK
Number of channels	3

Device 4

Type:	Emergency stop sender
Frequency	434 MHz
Possible frequency range:	434 MHz
Power:	< 10 mW
Modulation:	FM – narrow bandwith
Number of channels	

Device 5

Type:	Quad Band GSM modem
Frequency	850/900/1800/1900 MHz
Possible frequency range:	
Power:	
Modulation:	
Number of channels	

Sensor equipment

Laser	1 x Velodyne HDL-32E 2 x Sick LMS 151
Vision:	1 x Point Grey Bumblebee2(stereo, front) 1 x AVT Stingray(mono, back) 2 x color camera(1 front, 1 back) 1 x pan-tilt-zoom unit with thermal and visual camera
GPS:	Trimble Pathfinder ProXH
Inertial measurement unit:	Xsens MTi

Computing equipment on vehicle

Number of computers	1
Number of CPUs	4
Type of CPU	Intel Core i7 2.6 GHz
Operating system(s)	Linux

Basic data about control station

Pictures of control station:	
Number of operators(mandatory/optional)	½
Number of computers	2
Number of CPUs	4/1
Type of CPU	Intel Core i7 1,7 GHz
Operating system	Linux/Windows
Space needed for control station(LxWxH)	100x200x100 cm
Weight of control station	10 kg
Power source needed	230V with 500W

RIS

Team Information

Team name:	RIS	
Team leader:	Simon Lacroix	
Team leader's email:	simon.lacroix@laas.fr	
Nationality	France	
Website	http://www.laas.fr	
Location:	France	
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Competition

Competition	Reconnaissance and surveillance in urban structures
	Search and rescue in s smoke filled underground structure
	Autonomous navigation using GPS, GLONASS and GALILEO

Team Description

Autonomous mobile robotics has been a research topic studied at LAAS/CNRS since the late 70's. We have always favored a constructive and integrative wayof thinking robotics, aiming at defining robotics as a wholesome scientific discipline. A wide variety of problems are studied: environment perception and modeling, path planning, task planning, task execution control, motion control, decisional architecture, heterogeneous multirobots systems, learning, human robot interaction... In field robotics, our focus is currently on aero-terrestrial multi-robot systems. Our vehicles are the rovers *Mana* and *Minnie*, two SegWay RMP400 that have been equipped at LAAS with a stereovision bench, a Velodyne Lidar, a solid-state inertial measurement unit and a fiber-optic gyro. The main robotics functionalities we aim at demonstrating cover the wide range of classical functions related to autonomous navigation: robot localization, terrain mapping, motion generation... and multi-robot cooperation.

Vehicles

Name of vehicle	Mana	
	Minnie	

Basic data

Height (max):	120 cm (total height from ground to top, including antennas etc.)
Height (min)	90 cm (Total height from ground to top of the vehicle)
Width:	80 cm
Length:	115 cm
Weight:	130 kg
Turning diameter:	
Ground clearance:	10 cm
Average noise level:	??? dB(A)
Climbing performance:	30 degree
Wheel or track driven:	Wheels
Propulsion:	Batteries
Endurance:	2 hrs
Max. speed:	30 km/h
Payload:	90 kg

Communication equipment

Device 1	
Type:	WLAN 802.11a
Frequency	5.2 GHz
Possible frequency range:	From 5.15 to 5.35 GHz
Power:	600 mWatts
Modulation:	64 QAM
Number of channels	13

Emergency Stop	
Type:	FM
Frequency	433,92 MHz
Possible frequency range:	433.90 / 434.10
Power:	10 mW
Modulation:	FM
Number of channels	2

GPS corrections transmission	
Type:	Serial Modem
Frequency	868
Possible frequency range:	869.40 / 869.65
Power:	250 mW
Modulation:	SF FSK
Number of channels	1

Sensor equipment

Laser	1 Velodyne HDL-64E Lidar
Vision	2xMarlin F131-B FireWire cameras mounted on a Directed Perception Pan&Tilt unit
GPS	Novatel OEM4 RTK-DGPS. Average accuracy 2.0cm (at best)
Gyro	1 KVH E-Core 5000 Fiber-optic gyrometer

Computing equipment on vehicle

Number of computers	2
Number of CPUs	2
Type of CPU	Intel i7 and Core 2 Duo
Operating system(s)	Linux

Basic data about control station

Pictures of control station:	
Number of operators(mandatory/optional)	1/3
Number of computers	1
Number of CPUs	1
Type of CPU	Intel i7
Operating system	Linux
Space needed for control station(LxWxH)	300x400x250(LxWxH)
Weight of control station	A few kg
Power source needed	230V with 500Watts
Additional Information	

ENSTA Bretagne

Team Information

Team name:	ENSTA Bretagne	
Team leader:	Adrien Bellaiche	
Team leader's email:	adrien.bellaiche@gmail.com	
Nationality	France	
Website	http://www.ensta-bretagne.fr	
Location:	France	
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Tel.:		
Fax:	+33 298348750	

Competition

Competition	Search and rescue in s smoke filled underground structure

Team Description

A little team of students and researchers in the fields of robotics from the graduate and post-graduate institute ENSTA Bretagne.

Vehicle 1

Picture of vehicle		
Name of vehicle	Tracker	

Basic data

Height (max):	30 cm (Total height from ground to top, including antennas etc.)
Height (min)	
Width:	40 cm
Length:	80 cm
Weight:	20 kg
Turning diameter:	
Ground clearance:	6 cm
Average noise level:	40 dB(A)
Climbing performance:	30 degree
Wheel or track driven:	Wheel
Propulsion:	Batteries
Endurance:	1 to 2 hrs
Max. speed:	
Payload:	None

Communication equipment

Device 1	
Type:	WIFI b/g/n
Frequency	2,4 GHz
Possible frequency range:	2,4 GHz
Power:	
Modulation:	Digital
Number of channels	2

Sensor equipment

Vision	Acoustic Camera based on ultrasonic sensors and Arduino
GPS	Arduino compatible GPS

Computing equipment on vehicle

Number of computers	1 on each
Number of CPUs	1
Type of CPU	Raspberry Pi
Operating system(s)	Linux

Basic data about control station

Pictures of control station:	
Number of operators(mandatory/optional)	1 mandatory
Number of computers	1
Number of CPUs	4
Type of CPU	Intel i5
Operating system	Linux
Space needed for control station(LxWxH)	60cm x 40cm x 30cm
Weight of control station	5 kg
Power source needed	On battery for 2 hours, then electric
Additional Information	

Vehicle 2

Picture of vehicle		
Name of vehicle	Buggy	

Basic data

Height (max):	20 cm (Total height from ground to top, including antennas etc.)
Height (min)	
Width:	15 cm
Length:	40 cm
Weight:	5 kg
Turning diameter:	
Ground clearance:	6 cm
Average noise level:	40 dB(A)
Climbing performance:	30 degree
Wheel or track driven:	Wheel
Propulsion:	Batteries
Endurance:	1 to 2 hrs
Max. speed:	15 km/h
Payload:	None

Communication equipment

Device 1	
Type:	WIFI b/g/n
Frequency	2,4 GHz
Possible frequency range:	2,4 GHz
Power:	
Modulation:	Digital
Number of channels	2

Sensor equipment

GPS	Arduino compatible GPS

Computing equipment on vehicle

Number of computers	1 on each
Number of CPUs	1
Type of CPU	Raspberry Pi
Operating system(s)	Linux

Basic data about control station

Pictures of control station:	
Number of operators(mandatory/optional)	None
Number of computers	0
Number of CPUs	0
Type of CPU	
Operating system	
Space needed for control station(LxWxH)	None
Weight of control station	0
Power source needed	0
Additional Information	We’ll use 4 or 5 buggies. They are completely autonomous, and adequate their position to make a wireless bridge between the control station of the tracker and the tracker itself

MuCAR

Team Information

Team name:	MuCAR	
Team leader:	Prof. Dr.-Ing. Hans "Joe" Wünsche	
Team leader's email:	Joe.wuensche@unibw.de	
Nationality	Germany	
Website	http://www.unibw.de/tas	
Location:	Munich	
Institution/Company:	University of the Bundeswehr Munich	
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Fax:	+49 896004-3074	

Competition

Competition	Autonomous navigation using GPS, GLONASS and GALILEO

Team Description

Team MuCAR develops and operates MuCAR-3, and is headed by Prof. Dr.-Ing. H.-J. Wuensche, chair for "Autonomous Systems Technology" and head of the identically named institute. Our vehicle is named "MuCAR-3", the third generation of our Munich Cognitive, Autonomous Robot Cars. The first two vehicle generations drove on German Autobahns under the leadership of Prof. Dickmanns as far back as 1987; both vehicles have retired to museums. MuCAR-3 is based on a stock VW Touareg with a V6 TDI engine, modified to allow computer control of steering, brake, throttle and automatic gearbox. Full body skid plates allow testing in rough terrain. 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 degree Laser Scanner mounted on the roof of the vehicle. It is advantageous in special applications such as off-road driving, until our vision systems can fully cope with those scenarios as well. The main vision sensors are 3 forward looking cameras placed on a two-axis platform inside the vehicle. The arrangement resembles the human vision system, with a tele-camera as "fovea" and 2 slightly outward pointed 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, while the view of the tele-camera with its narrow field of view is inertially stabilized. Our robust and fast 4D-approach to perception has been augmented by an innovative fusion of vision and lidar data and excels in offroad environments featuring poor GPS conditions. Team MuCAR participated at the ELROB 2007, 2008, 2009, 2010, 2012 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.

Vehicle

Picture of Vehicle		
Name of Vehicle	MuCAR-3	

Basic data

Height (max):	205 cm (Total height from ground to top, including antennas etc.)
Height (min)	
Width:	193 cm
Length:	480 cm
Weight:	2800 kg
Turning diameter:	
Ground clearance:	30 cm
Average noise level:	81 dB(A)
Climbing performance:	45 degree
Wheel or track driven:	Wheel
Propulsion:	Fuel(Diesel), Volkswagen 3.0 ltr V6 TDI
Endurance:	8 hrs
Max. speed:	205 km/h
Payload:	> 250 kg

Communication equipment

Device 1	
Type:	Wireless Radio Modem; optional, for use with a local D-GPS base station only
Frequency	
Possible frequency range:	
Power:	
Modulation:	
Number of channels	

Device 2	
Type:	Wireless LAN; optional, for communication between multiple vehicles only
Frequency	
Possible frequency range:	
Power:	
Modulation:	
Number of channels	

Sensor equipment

Vision	3 RGB cameras with wide-angle & tele-lens, mounted on custom build 2 axis platform inside the vehicle 1 IR-camera mounted on top of vehicle 1 color night vision camera mounted inside the vehicle
Lidar	Velodyne HDL64E-S2 3D LIDAR System
INS	OxTS RT3003: Full 6 DOF IMU system with integrated D-GPS system
MEMS Gyros:	1 for internal camera pitch axis stabilisation

Computing equipment on vehicle

Vehicle control:	dSpace Autobox
Camera platform	dSpace MicroAutobox
Central Vehicle Computer	Double Hexa Core Intel Xeon System used for: - Vision analysis, feature extraction and object detection - Situation analysis and behavior decision - Path planning - Attention Selection
Operating system(s)	Linux

Basic data about control station

Pictures of control station:	
Number of operators(mandatory/optional)	
Number of computers	
Number of CPUs	
Type of CPU	
Operating system	
Space needed for control station(LxWxH)	
Weight of control station	
Power source needed	
Additional Information	Control station is mounted inside the vehicle. No external control station

SpaceApps

Team Information

Team name:	SPACEAPPS	
Team leader:	Jeremi Gancet	
Team leader's email:	jeremi.gancet@spaceapplications.com	
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Website	http://www.spaceapplications.com	
Location:	Zaventem	
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Competition

Competition	Reconnaissance and surveillance in urban structures
	Mobile manipulation for handling hazardous material
	Search and rescue in s smoke filled underground structure
	EOR/EOD/IEDD/CIED (for professionals only)

Team Description

Group of 6 Company staffs (robotic systems team and more)

Vehicle

Picture of vehicle		
Name of vehicle	MILOU	

Basic data

Height (max):	150 cm (Total height from ground to top, including antennas etc.)
Height (min)	39 cm (Total height from ground to top of the vehicle without mast)
Width:	67 cm
Length:	99 cm
Weight:	67 kg
Turning diameter:	
Ground clearance:	13 cm
Average noise level:	70 dB(A)
Climbing performance:	45 degree
Wheel or track driven:	Wheel
Propulsion:	Batteries(24V 20Ah Sealed Lead Acid)
Endurance:	1 hrs
Max. speed:	3.6 km/h
Payload:	10.6 kg

Communication equipment

Device 1

Type:	WLAN (IEEE802.11b/g/n), 2 TPLink TL-ANT2405 (AntennaWireless Radio Modem; optional, for use with a local D-GPS base station only
Frequency	2.4 GHz
Possible frequency range:	Unknown
Power:	2x5 dBi antenna, integrated wifi module with unkown power
Modulation:	Unknown
Number of channels	Unknown

Sensor equipment

Laser	Hokuyo LRF URG-04LX
Vision	Point Grey BumbleBee XB3 BBX3 12S2C-38
GPS	XSens MTi-G / Septentrio AsteRx2i HDC
Inertial measurement unit	XSens MTi-G / XSens MTi

Computing equipment on vehicle

Number of computers	1 Mini ITX
Number of CPUs	1
Type of CPU	Dual Core AMD 1.6 GHz
Operating system(s)	Linux

Basic data about control station

Pictures of control station:	
Number of operators(mandatory/optional)	1 or more
Number of computers	1 or 2(Laptops/PCs)
Number of CPUs	1 each
Type of CPU	Intel CORE i5 or Core i7
Operating system	Linux / Windows XP / Windows 7
Space needed for control station(LxWxH)	100cm x 200cm x 250cm (LxWxH)
Weight of control station	25 kg(with table)
Power source needed	220-240V
Additional Information	

Fraunhofer FKIE

Team Information

Team name:	Team FKIE	
Team leader:	Dirk Schulz	
Team leader's email:	elrob@fkie.fraunhofer.de	
Nationality	Germany	
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Location:	Wachtberg	
Institution/Company:	Fraunhofer Institute for Communication, Information Processing and Ergonomics FKIE	
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Tel.:	+49 2289435-483	
Fax:	+49 2289435-210	

Competition

Competition	Reconnaissance and surveillance in urban structures
	Mobile manipulation for handling hazardous material
	Autonomous navigation using GPS, GLONASS and GALILEO

Team Description

The FKIE employs currently 300 staff members, who perform studies in computer science and ergonomics with application to diverse research area of command & control, communications, intelligence, surveillance, and reconnaissance (C3ISR). A distinctive aspect of the FKIE methodology is the fact that we are as accomplished in technology as we are in the so called “human factor”. As experts in ergonomics we know how to equip technologies with user interfaces that are easy to operate and control. Also unique to us is the fact that we handle the entire data processing chain from acquisition to display allowing us to work in highly specialized units or interdisciplinary teams according to the project’s requirements.

- Analysis, modelling and evaluation of military data formats and processes
- Distributed data processing in heterogeneous systems (interoperability)
- Information and knowledge management
- Communication in heterogeneous networks
- Analysis and evaluation of sensor data sets
- Protection of data networks against interference or cyber attacks
- Ergonomic user interfaces for intelligent support of users.

The research group Unmanned Systems of the Fraunhofer-Institut 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. Our key skill is the development of innovative tools for human-robot interaction and cooperation. For this purpose new developments are constantly integrated in experimental systems and evaluated in co-operation with security authorities and organizations as well as the German army.

The Unmanned Systems department:

The Research Group Unmanned Systems as part of the FKIE develops innovative techniques for the efficient guidance of human-multi robot systems within military applications. Remote-controlled unmanned mobile systems have high demands on the operator’s concentration and cognitive abilities, especially if the control is to be maintained over long time periods. In order to increase the efficiency and the available deployment options, the research group develops assistance functions which enable the operator to guide the mobile systems on a high level of abstraction, while the robots execute the required low-level commands autonomously. Additionally, the research group serves as consultant and evaluator for the German army. The booth presents an overview of the current activities of the FKIE regarding Unmanned Systems, in particular

- The experimental CBRNE Reconnaissance Platform
- NEC techniques for multi robot systems
- Mobile 3D world model generation
- Autonomous outdoor navigation

European Land-Robot Trials (ELROB)

Vehicle 1

Picture of vehicle		
Name of vehicle	GARM	

Basic data

Height (max):	141 cm (Total height from ground to top, including antennas etc.)
Height (min)	141 cm (Total height from ground to top of the vehicle without mast)
Width:	74 cm
Length:	178 cm
Weight:	400 kg
Turning diameter:	
Ground clearance:	10 cm
Average noise level:	60 dB(A)
Climbing performance:	40 degree
Wheel or track driven:	Track
Propulsion:	Batteries
Endurance:	4 hrs
Max. speed:	13 km/h
Payload:	250 kg

Communication equipment

Device 1	Debug Interface
Type:	WLAN 802.11b
Frequency	2400 MHz
Possible frequency range:	2400 to 2500 MHz
Power:	0.1W
Modulation:	GMSK/8PSK/QPSK/16QAM
Number of channels	13

Device 2	Wide Range Data Connection
Type:	Wideband Radio Modem
Frequency	160 MHz
Possible frequency range:	157 to 160 MHz
Power:	25W
Modulation:	2GMSK
Number of channels	128

Device 3	Video Data Link
Type:	COFDM video transmitter
Frequency	370 MHz
Possible frequency range:	250 to 390 MHz
Power:	1W
Modulation:	QPSK
Number of channels	15

Device 4	Emergency Halt
Type:	Radiosafe Link
Frequency	433 MHz
Possible frequency range:	433 to 435 MHz
Power:	0.01
Modulation:	FM
Number of channels	64

Sensor equipment

Laser	2xSick LMS 511, 1xVelodyne HDL-64E
Vision	Self-manufactured 360°-Cam with dual ACTi 4xMPEG4 video grabbers
GPS	OxTS RT3002
Inertial measurement unit	OxTS RT3002

Computing equipment on vehicle

Number of computers	1
Number of CPUs	4
Type of CPU	Intel Core 2 Duo QX9600
Operating system(s)	Linux

Basic data about control station

Pictures of control station:

Number of operators(mandatory/optional)	1
Number of computers	1
Number of CPUs	2
Type of CPU	Intel Core Duo
Operating system	Linux
Space needed for control station(LxWxH)	200x200x200
Weight of control station	10 kg
Power source needed	None, 230V optional
Additional Information	

Vehicle 2

Picture of vehicle		
Name of vehicle	Telemx	

Basic data

Height (max):	85 cm (Total height from ground to top, including antennas etc.)
Height (min)	76 cm (Total height from ground to top of the vehicle without mast)
Width:	80 cm
Length:	160 cm
Weight:	100 kg
Turning diameter:	
Ground clearance:	51 cm
Average noise level:	30 dB(A)
Climbing performance:	45 degree
Wheel or track driven:	Both
Propulsion:	Batteries 24V
Endurance:	0.66 hrs
Max. speed:	4 km/h
Payload:	40 kg

Communication equipment

Device 1	Video & Data downlink
Type:	COFDM Transmitter
Frequency	
Possible frequency range:	
Power:	
Modulation:	
Number of channels	

Device 2	Data uplink
Type:	
Frequency	
Possible frequency range:	
Power:	1W
Modulation:	
Number of channels	

Sensor equipment

Laser	3xHokuyo UTM-30LX
Vision	2x Telemax cameras, 1XCVBS Cam
GPS	Topcon Legacy E+
Inertial measurement unit	XSens MTi

Computing equipment on vehicle

Number of computers	1
Number of CPUs	2
Type of CPU	Intel Core 2 Duo QX9600
Operating system(s)	Linux

Basic data about control station

Pictures of control station:	
Number of operators(mandatory/optional)	1
Number of computers	1
Number of CPUs	2
Type of CPU	
Operating system	Linux
Space needed for control station(LxWxH)	
Weight of control station	
Power source needed	
Additional Information	

Vehicle 3

Picture of vehicle		
Name of vehicle	TeodorPrime	

Basic data

Height (max):	155 cm (Total height from ground to top, including antennas etc.)
Height (min)	155 cm (Total height from ground to top of the vehicle without mast)
Width:	72 cm
Length:	130 cm
Weight:	300 kg
Turning diameter:	
Ground clearance:	10 cm
Average noise level:	40 dB(A)
Climbing performance:	50 degree
Wheel or track driven:	Track
Propulsion:	Batteries
Endurance:	0.66 hrs
Max. speed:	3,6 km/h
Payload:	100 kg

Communication equipment

Device 1	Data Link
Type:	WLAN 802.11b
Frequency	2400 MHz
Possible frequency range:	2400 to 2500 MHz
Power:	0.1W
Modulation:	GMSK/8PSK/QPSK/16QAM
Number of channels	13

Device 2	Emergency Halt
Type:	Emergency Halt
Frequency	434.1 MHz
Possible frequency range:	422 to 435 MHz
Power:	0.01W
Modulation:	FM
Number of channels	64

Sensor equipment

Laser	43xHokuyo UTM-30LX, 1xSick LMS 511
Vision	2xTelemax Manipulator Cam, 1x USB cam
GPS	XSens MTi-G
Inertial measurement unit	XSens Mit-G

Computing equipment on vehicle

Number of computers	1
Number of CPUs	2
Type of CPU	Intel Core 2 Duo QX9600
Operating system(s)	Linux

Basic data about control station

Pictures of control station:	
Number of operators(mandatory/optional)	1
Number of computers	1
Number of CPUs	2
Type of CPU	
Operating system	Linux
Space needed for control station(LxWxH)	
Weight of control station	
Power source needed	
Additional Information	

SCentRo

Team Information

Team name:	SCentRo	
Team leader:	Jacques Penders	
Team leader's email:	j.penders@shu.ac.uk	
Nationality	United Kingdom	
Website	http://www.scentro.ac.uk	
Location:	Sheffield	
Institution/Company:	Sheffield Centre for Robotics (University of Sheffield and Sheffield Hallam University)	
Adress:	SHU, Howard Street, S11WB Sheffield	
Tel.:	+44 1142253738	
Fax:		

Competition

Competition	*Reconnaissance and surveillance in urban structures*
	Mobile manipulation for handling hazardous material
	Search and rescue in s smoke filled underground structure

Team Description

Around 6 PhD students from Sheffield Hallam University and the University of Sheffield

Vehicle

Picture of vehicle		
Name of vehicle	PIONEER P3 AT	

Basic data

Height (max):	100 cm (Total height from ground to top, including antennas etc.)
Height (min)	27.7 cm (Total height from ground to top of the vehicle
Width:	50 cm
Length:	62 cm
Weight:	12 kg
Turning diameter:	
Ground clearance:	11 cm
Average noise level:	
Climbing performance:	20 degree
Wheel or track driven:	Wheel
Propulsion:	Batteries
Endurance:	2.4 hrs
Max. speed:	0.7 km/h
Payload:	12 kg max.

Communication equipment

Device 1	
Type:	Video, Zigbee, RS232 and RS485 Radio
Frequency	5.8 MHz, 900 MHz, 868 MHz
Possible frequency range:	750 MHz to 1 GHz
Power:	1W
Modulation:	--
Number of channels	4 Channels

Sensor equipment

Laser	HOKUYO URG
Vision	IR Camera
Radar	Microwave Doppler Radar
Inertial measurement unit	Meters
	Odometry Sensors
	8 Sonars Variable Typ

Computing equipment on vehicle

Number of computers	2
Number of CPUs	2
Type of CPU	Intel Dual Core 2.56 GHz
Operating system(s)	Linux/Windows 7

Basic data about control station

Pictures of control station:	
Number of operators(mandatory/optional)	4
Number of computers	4
Number of CPUs	4
Type of CPU	Intel 2.56 GHz Dual Core X 2, Intel 3.3 GHz Quad Core X 2
Operating system	Linux/Windows 7
Space needed for control station(LxWxH)	1000 x 1000 x 1000 cm(LxWxH)
Weight of control station	
Power source needed	Plugs (as many as possible)