Eurathlon 2013

Scenario Application Paper (SAP) – Review Sheet

Team/Robot European Logistics Partners (ELP)
Scenario Reconnaissance and disposal of bombs and explosive devices

For each of the following aspects, especially concerning the team's approach to scenario-specific challenges, please give a short comment whether they are covered adequately in the SAP.

Keep in mind that this evaluation, albeit anonymized, will be published online; private comments to the organizers should be sent separately.

Robot Hardware

The robot hardware seems robust enough and prepared for the bomb disposal scenario (IP67 rated, ruggerized, etc.). Also, the system is prepared to cross rough terrain and be able to reach the area of interest in non-flat terrains with obstacles.

Processing

The robot counts with a Linux PC with an interesting computational capacity. Although it is not commented explicitly in the SAP dopcument, it is assumed that the operation of the robot is mainly tele-operated, then it is assumed that only basic processing of the on-board sensors and communication tasks are integrated in the processing unit.

Communication

The system can implement 2,4GHz wireless IP-based communicaiton. Also, it has the option to implement 4,9GHz in case 2,4GHz cannot be used. The communicaiton range of 1,2Km seems a little bit optimistic. However, for the Bomb Disposal scenario, the presented communication solution seems rasonable. Finally, this system shows an advantage with respect to others which is that it can also be operated with a fiber optical cable. This fact extends the applicaitons where this system can be used.

Localization

The robot uses GPS as its main global localization system. It also uses inertial sensors to know the attitude of the robot as a help for the operator. In my opinion, the localization sensors are suitable for the Bomb Disposal scenario.

Sensing

The robot has different options for the on-board sensors (cameras, RADAR, LIDAR, etc.) However it is not clear from the SAP which one will be used for the Bomb Disposal scenario. The standard sensors of the robots are 4 cameras with illumination are aready for low illumination environment. This standard sensor package seems reasonable for the scenario. However it could be great to know how this team plans to apply other types of sensors to this scenario.

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Vehicle Control

There is no information about this section in the SAP. I assume that the robot will be mainly tele-operated. However, it could be good that the team explains how the vehicle control works and it they plan to implement any assistance or high autonomy mode.

System Readiness

The systems has been used in operation and it is alredy industrialized. Then, the technology system readiness is high.

Overall Adequacy to Scenario-Specific Challenges

The presented solution offers a technological solution for the main challenges of the Bomb Disposal scenario. However, there is a lack of detail about the specific solutions that the team will apply. Specifically, information about the exact sensor suite and control modes that they plan to use in this scenario.

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Team ELP

Scenario Application Paper

Reconnaissance and disposal of bombs and explosive devices

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Vehicle:

The PackBot 510 EOD is a field-proven, commercially available platform that is deployed throughout the world. It is a modular, ruggedized, lightweight (approx. weight: 30 kg depending on configuration) and highly maneuverable platform capable of carrying numerous different payloads.

The vehicle is IP-67-rated and can be submerged in 1.2m depth for over 1 hour. PackBot can climb hills in excess of 50° depending on surface conditions and is capable of climbing various different kinds of stairs.
Two Flippers mounted in the front of the robot assist in climbing stairs and overcoming obstacles.

Available payloads include manipulator- and camera-arms and communications- as well as sensory and computational payloads. By utilizing standardized hardware-Interfaces (Power, USB, Ethernet, Video) and a powerful, embedded Linux platform, it is very easy to add additional sensors and extend the system with further capabilities.

The operational runtime with 4 Li-Ion Batteries averages 15 hrs., depending on driving activity and power consumption of external sensors.

Processing:

On-board Pentium 4 ETX-Computer with integrated flash memory. The System is based upon the “Common OS” Linux-Platform and the iRobot Aware 2 Software Framework.
The software is field-proven, with thousands of units deployed across the world.

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Communication:

The system supports any IP-based communications medium. The chassis features a built-in 2.4 GHz Wireless LAN radio (802.11g). Optionally, a 4.9 GHz (802.11a-derivative) radio-module can be mounted for improved performance in environments where the 2.4 GHz-Band cannot be used. Typical effective communication ranges go up to 1.2km line of sight and beyond, depending on conditions.

The system is capable of extending its operational range by use of MESH-networking.

An optional Fiber optical spooler system carrying up to 250m of optical cable.

If necessary, communication may also be established using UMTS or LTE cellular Networks, as well as satellite links.

Localization:

The PackBot features a built-in digital compass and pitch/roll sensors. Furthermore, 3-axis accelerometers are utilized to detect hard impacts that might damage the robot.

The User Assistance Payload (UAP) features built-in position-sensors and accelerometers as well as a high-precision GPS.

Positional data acquired by the Robot is displayed on the Operator Control Unit (OCU) and is displayed as an overlay of a digital map or Aerial Photo. The route traveled by the robot is also displayed, along with any locations identified as “Points of Interest”.

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Sensing:

PackBot carries built-in absolute and relative sensors to monitor the positions and movements of its joints. The system maintains a 3D-model of itself for purposes of collision avoidance.

Furthermore, all motor voltages, currents and temperatures are constantly monitored as part of a built-in health-monitoring, failure recognition and diagnostics system.

In addition, the robot carries 2-way audio and 4 Video-Cameras with both visible and non-visible (IR) LED-illumination.

The system features interfaces for additional sensors, such as RADAR, LIDAR, Hazardous material and Radiation detectors, temperature and humidity monitors, as well as additional cameras (Thermal or wide-angle)

System Readiness

PackBot 510 EOD is a matured, field-proven, fully functional and ruggedized platform.

TRL: 9 for both hardware and software. (some additional sensors may however be a lower TRL)

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Reconnaissance and disposal of bombs and explosive devices:

PackBot 510 is very capable of traversing both smooth and rough terrain due to its tracked chassis, strong drive motors and low center of gravity. The flippers help the robot climb stairs, cross branches, roots and stones. Furthermore, should the robot fall over due to instability on terrain, it will self-right and be able to continue the mission.

The manipulator arm enables the operator to manipulate valves and levers depending on their type and the shape of their handles. The manipulator arm can be used to inspect objects to heights of above 2 meters. The gripper is however restricted in height, given its mounting position on the second elbow of the arm.

PackBot has proven its ability to traverse even rough terrain at high speed numerous times due to its tracked base and low center of gravity.

The robot, as well its sensors are designed to withstand rough conditions. Smoke, Dust and Mud do not cause damage to the system or its sensors.

The operator will be able to view the imagery of the built-in cameras as well as hear audio from the location of the robot. The OCU will also display a 3D-model of the robot indicating its roll and inclination, as well as the position of all joints. The path traversed by the robot, as well as any points of interest and the direction the robot is facing are overlaid on a map or aerial photo of the area.

Telemetry from additional sensors, such as Hazardous Materials or radiation can be displayed on the OCU in real-time.

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