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EU FP6 Project RESCUER: the development of a dexterous robot and intelligent information technologies for EOD/IEDD/rescue missions

1 Abstract

The RESCUER project of the European Commission's 6th Framework Programme for Research, Technology Innovation and Demonstration focuses on the development of an intelligent Information and Communication Technology and mechatronic Emergency Risk Management tool for the improvement of Explosive Ordnance Disposal, Improvised Explosive Device Disposal, and Civil Protection Rescue Mission scenarios. The tool will be tested in five selected tasks. The project output will include guidance for management of risk, which extends the range of interventions possible beyond those, which are currently considered. The extended range of interventions will include tasks which are too risky at present to commit human involvement, tasks where access might not be possible without ICT and mechatronic support, tasks where such support would significantly enhance the speed, accuracy or range of tasks/sensors especially in EOD, IEDD, significant toxic/radiation/flammable/explosive contamination, mechanical failure and other relevant hazardous situations or combinations of hazards. The paper reviews the technical concepts formulated during the first eight months of the project.

Keywords: Civil protection, Emergency management, Robotics, Secure wireless communication, Multi-sensory technology, Explosives technology, Military technology, Knowledge-based systems, Safety technology

2 Introduction

Today numerous companies from around the world manufacture robots for use in military, bomb disposal (Figure 1), and surveillance applications. The sizes of these robots can vary from as small as a shoebox to as large as a teleoperated tank. Control and traction methods vary considerably. Some are controlled by radio frequency while others use fibre optic or coax cable. Traction methods vary from multiple-track tank-like treads to multi-wheel combinations.

Currently the bomb disposal robots are focused mostly on the possibility to grasp simple-shape rigid objects and to transport them to a disposal place, or to disrupt the threat on-site. They all have single manipulator arm with a two jaw gripper, a vision system limited to mo-

Figure 1 Examples of bomb disposal robots

notype view of the target area and joystick control of the robots motion and handling. The rescue robots are generally of observation type. Only a few commercial rescue robots are equipped with manipulators, which are similar to the bomb disposal robots.

Half of the IEOD/EOD and rescue missions fail due to the improper technical capabilities of the applied mechatronic systems. These systems are not equipped to cope with the complexity, dynamics and uncertainty inherent in disaster response cases and cannot be considered as dextrous and robust. In other words – they are targeted on specific tasks and cannot be considered as intelligent.

To respond the challenge illustrated in Figure 2below RESCUER develops a solution along the following objectives:

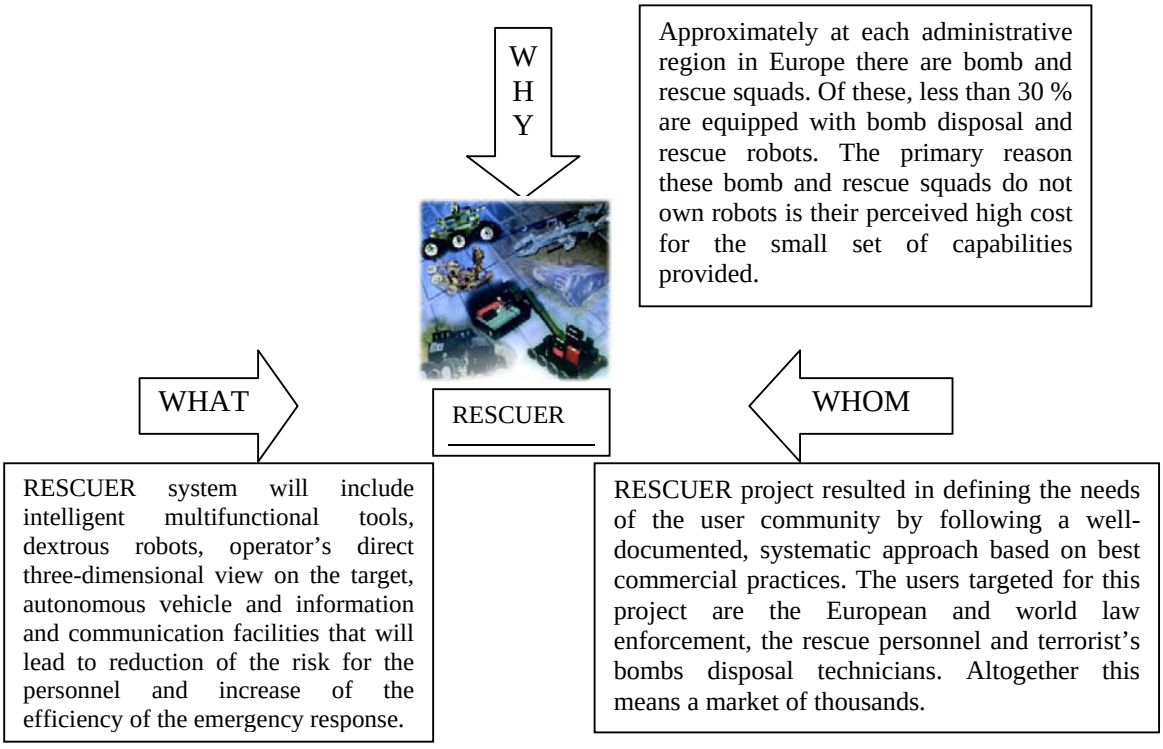

Figure 2 The objectives of RESCUER

3 The user and technical requirements

The user and technical requirements were specified along the categories shown in Figure 3. The detailed specification was defined in agreement with the literature data, the relevant standards, and guidelines, based on the end user partner of the project: the State Agency for Civil Protection, Bulgaria. The detailed report is accessible in a public deliverable of the project from the project WEB page: http://www.rescuer-ist.net

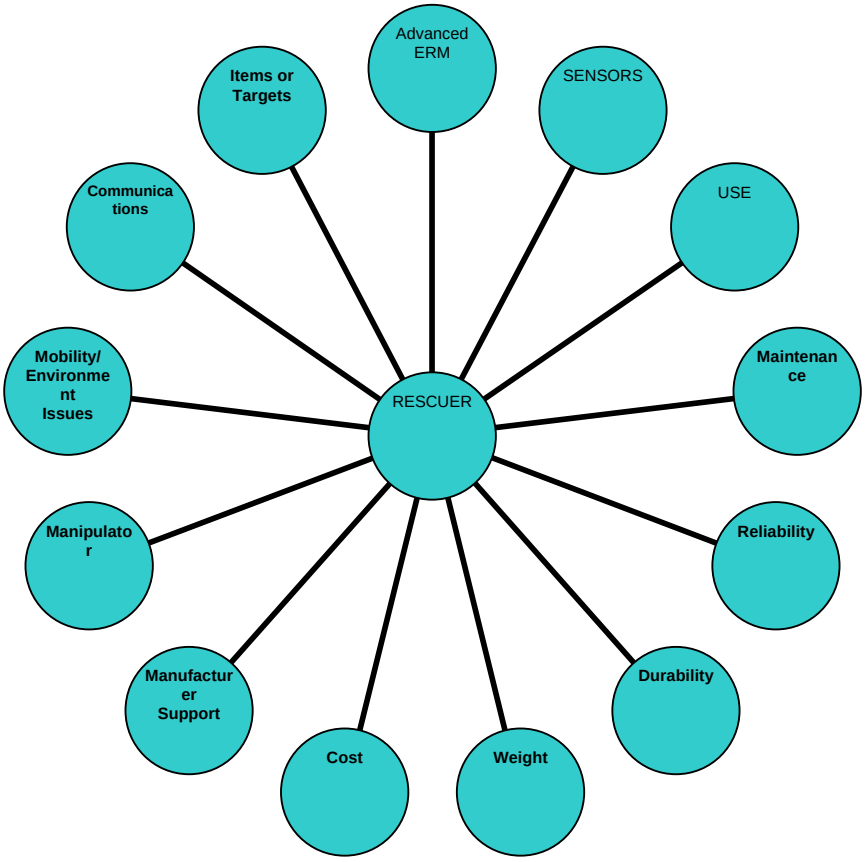

Figure 3 The categories of the user and technical requirements

4 The RESCUER concept

A dextrous mechatronic system like RESCUER is capable of achieving given goals under conditions of uncertainty. In contrast to current remotely controlled bomb disposal and rescue systems, which are, by definition, designed to deliver given behaviour and are therefore predictable, RESCUER may arrive at specified goals in a non-deterministic manner. RESCUER is endowed with flexibility and dexterity, which means, it is capable of responding to frequent changes in the environment without being re-configured. This qualitative difference in RESCUER behaviour is a result of the separation of the domain knowledge from the mechanism for problem solving. The operating personnel will be supported by a knowledge-based system for the management of the emergency risk situations, as well as for the direct operation of the mechatronic device. In addition to the embedded

knowledge based system, the most cost-effective and powerful means of support implementation is through the use of distributed artificial intelligence, where a community of intelligent software agents decides on the optimal or near-optimal action for risk identification and management in manmade or natural disasters and bomb disposal.

RESCUER aims to replace totally the rescue worker in operations potentially dangerous for his/her life and health. The rescue worker will distantly lead and monitor the risk operation with RESCUER; meanwhile all data from the rescue operation (videos, pictures, sensors' measurements, ERMMAS' decisions, coordinates) will be transferred to and stored in the civil protection monitoring and information centre through secure WEB based communications. The new mechatronics assisted IEDD/EOD and rescue technologies (Figure 4) increase the safety of the rescue workers by reducing the level of risk from extreme to low. Currently, in half of the IEDD/EOD and rescue cases when a robotic device is used, a human specialist must complete the task because the robotic device fails to do so. The RESCUER method for IEDD/EOD and rescue operations removes totally the need of direct human interaction at the dangerous area. The RESCUER system will significantly reduce the time in search for survivors (from at least 48 to 12 hours, reaching a searching speed of 250 m^2 per hour) by ignoring the advance observation procedures right after the emergency starts when the human rescuers must be extremely cautious but also extremely fast. If a victim is located in a partially collapsed building RESCUER helps by providing the rescue team a map with its location. This will result in a cut of the rescue operation time, lowering the risk for the operators and enhancing the likelihood that the victims will be extracted properly.

RESCUER system will include multifunctional tools, two simultaneously working robot arms with dextrous grippers, smart sensors for ordnance, for human detection and for the assessment of the environment, autonomous vehicle and advanced information and communication facilities that will lead to improvement of the emergency risk management. Components of the RESCUER mobile mechatronic unit (Figure 5) will be:

1. The mobile platform
2. The manipulators arms
3. The three finger gripper
4. The two finger gripper
5. The stereo vision head
6. The CCD cameras
7. Sensor for gas analysis
8. Sensor for detection of explosive materials
9. Sensor for detection and measurement of nuclear radiation
10. Device to locate trapped personnel
11. Sensor for detection electronic components
12. Searchlights
13. Load box
14. The on board controller PC

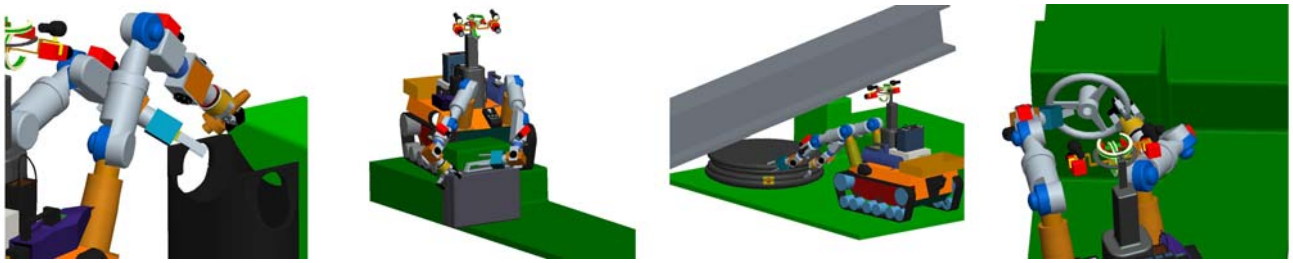

Figure 4 RESCUER's technology for selected EOD/IEDD/rescue missions

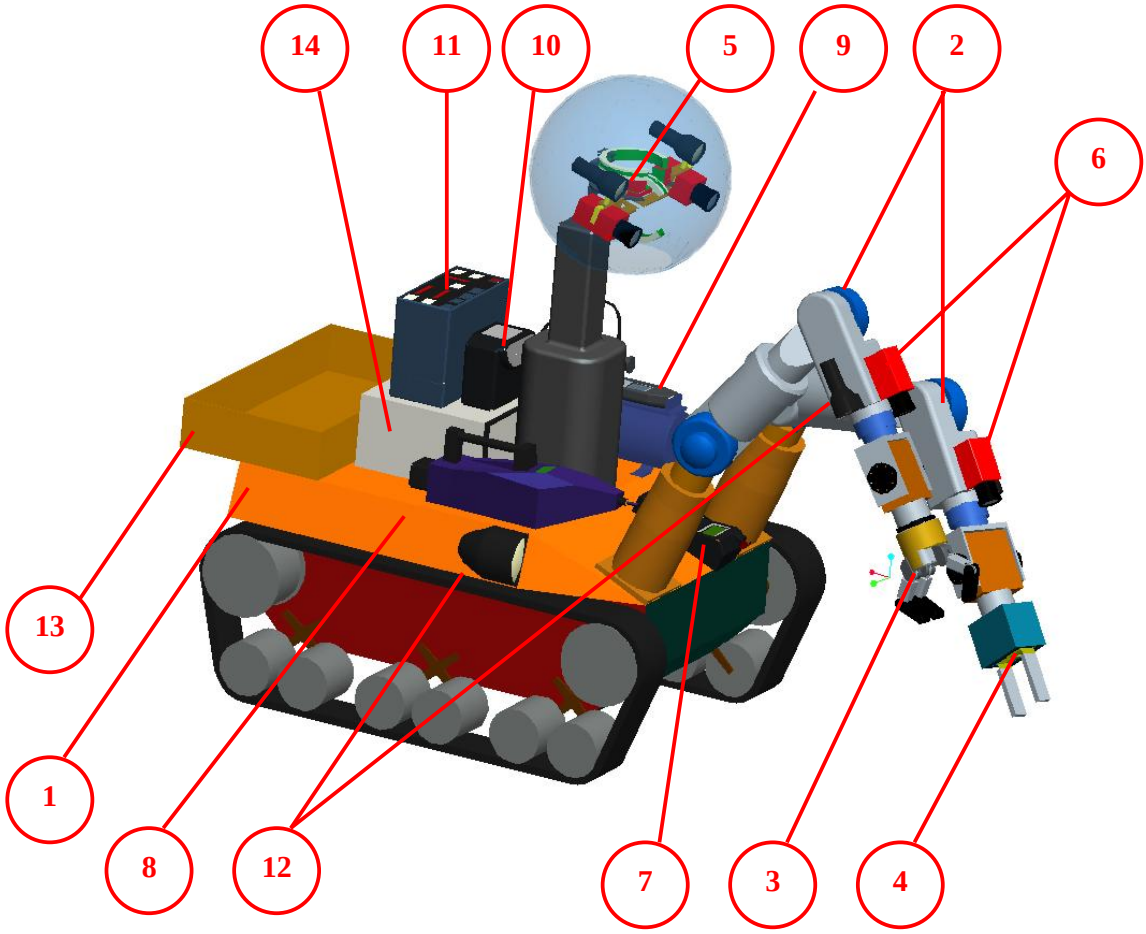

Figure 5 Conceptual CAD model of the mobile mechatronic unit

In this initial phase of the design process we have already attempted to simulate how the mobile mechatronic unit will work in selected scenarios. According to the workplan of the project the RESCUER system will be live tested in five basic EOD/IEDD and rescue missions: 1. opening a plastic bag and taking out an object from it, 2. turning a suit case of 5 kg upside down and opening the key lock or numeric lock, 3. Lifting of collapsed structures with air presser pillows, 4. closing of an industrial valve, 5. pick up and place bombs with two arms up to 5 kg of weight. Figure 4 visualizes how the RESCUER mobile mechatronic unit completes the missions 1-4.

5 Conclusion

The RESCUER system will combine two separate streams of law enforcement support systems – bomb disposal robots and rescue robots in one more powerful, more practical, more functional, more intelligent and more dextrous machine.

Acknowledgements

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