NEEDS AND CONSTRAINTS FOR CIVIL PROTECTION ROBOTIC SOLUTIONS

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Abstract

For many years, French research programs have been developing a Land robotic system focusing on civil protections use, under direct requirements of end users.

Bouches-du-Rhone fire department is the initiator and the operational leader of these programs. A 'top-down' analysis and scenarios implementation allowed the definition of robotic concept and its evaluation.
Different issues were explored:

- The weight of the UGVs, introducing the concept of a range of tools;
- The abilities of movement and capacities;
- The loading possibilities;
- The polyvalence and the ability to connect with a wide range of sensors;
- The Atex qualification;
- The thermal protection;
- The human / machine interface;
- The tactical place during missions;
- The management and discrimination of the data flow.

After six years studies and development, This UGV ongoing project and its prototypes give now significant benefits to emergency services facing to unusual missions, giving really a good support.
This new tool is now in duty in some specialised squads, giving new data to human Cbrn missions, and sometimes increasing the safety of first responders.

1. INTRODUCTION

The current evolution of threats and emergence of new, mainly chemical, bacteriological and nuclear risks, have led to new requirements [1], which must be studied and taken into account in order to define the operational resources available to today's emergency teams.

In this context, the various experimentations and lessons learned have shown that robotic systems can offer particularly interesting means of intervention, in particular in complex environments (rubble, nuclear or chemical incident zones, etc.) [2]. In addition to decrease the human danger level during missions and the difficulty of certain tasks, the use of UGVs can also increase the global efficiency of interventions and contribute to a more efficient deployment of operational human resources.

However, the robots available on the market just a decade ago were incapable of handling a relatively wide range of interventions and measurements in multiple and complex environments [3]. In

addition, as they were developed for military applications or mine clearing, they were not fully adapted to the needs of civil protection first responders [4,6].

A pluriannual project was therefore set up in the aim of providing a response to current requirements. This program brought together various partners with complementary operational and technological skills:

- A designer and manufacturer, with extensive expertise in robotics and system integration,
- Two firms (SMEs) in charge of developing accessories (e.g. sensors integration),
- Two national research institutes with expertise in radiological and chemical-related technologies and hazard management,
- An ergonomics firm,
- The French Fire Academy for, Rescue and Civil Protection Officers, and the Bouches-du–Rhône Fire department (Sdis 13), possessing user experience and operational expertise.

2. BACKGROUND

In the 1990's, robots were developed for mine clearing missions.

In 2002, and after various missions, the French national firefighter's congress first evoked the "accessibility of robots to the techniques employed in the context of technological and terrorist risks..." [3, 6].

In 2003 and 2004, in the framework of a bilateral industrial partnership, the Bouches-du–Rhône fire department assisted a robotics firm in drawing up a state of the art of firefighter requirements. This analysis enabled the identification of tasks likely to be suitable for robotization [5]. Seven basic functionalities were identified:

- Mobility.
- Ruggedness.
- Transmission.
- Measurements.
- Imaging.
- Operationality.
- Reconditioning.

Lastly, a series of assessment scenarios were drawn up; this was obviously a first step towards defining the intervention modes and working concept.

In 2006, a first industrial consortium, assisted by the national research agency (ANR), spent 4 years researching, developing and assessing the first prototype.

The demonstrator was approved and certified as responding to operational requirements. It was subsequently marketed worldwide [7, 8, 9].

In 2011, a new consortium was set up and financial aid was received from the French innovation fund to expand the robot's capabilities.

3. THE OPERATIONAL CONCEPT

The use of robots has never been intended to replace human intervention; the idea is to support emergency teams in three major areas.

3.1 Inspection and reconnaissance

On arrival at the event scene, a team of firefighters explores the hazard zone in order to:

- Immediately implement initial safety measures,
- Appreciate the extent of the event,
- Determine points of attack and the routes to reach them.

The robot comes into play right from the outset, including while the emergency teams are dressing; this time can be valuable for collecting the first measurements and images.

3.2 Detection and measurement

This action is implemented after initial reconnaissance. It is a tactical decision, designed to seek a product or radioactive element, or to perform a measurement.

3.3 Neutralization

This is a postponed action referring to a (possibly tactical) decision. The aim of this mission is to interact with the source or event in order to neutralize it, at least partially.

3.4 Chronological simulation

Once on site, the various robotic systems can be deployed in according with the following time line.

≈ 3' Forward detection and reconnaissance
Performed prior to all human intervention, e.g. while the teams are wearing PPE
Audio-visual site reconnaissance
Quick and easy deployment

≈ 5' Exploration
Takes place upstream of, or in conjunction with, the human teams
Site appraisal
Initial measurements, plus confirmation or performance of initial detection actions

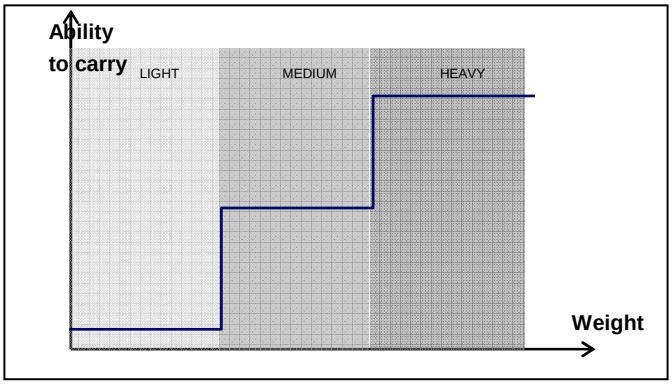
> 15' Long intervention (further to tactical decision)
Sample collection (Gas, liquid, powder)
Networked measurements (Chemical, radiation, temperature)
Liquid danger area marking
Tool deployment
Radio relay positioning
Neutralization (interaction with sources)

3.5 Working towards a range of robots

The variety of tasks identified, their technical specificity and the underlying technical and economic constraints, have demonstrated the impossibility of producing a single robot capable of satisfying all requirements. The notion of a range of robotized products therefore emerged fairly rapidly, along with the identification of three classes of robots.

Lightweight, around 1 kg, for inspection and reconnaissance operations. This is an easy-to-use, remote-operated rapid reconnaissance system. Designed to perform audio-visual site reconnaissance prior to all human intervention, it may also be equipped with an alert function. More than the other types of robot, this robot should be considered as a consumable that may be lost.

Medium weight, several tens of kilos, suitable for specialist interventions (detection/measurement and neutralization) as well as inspection and reconnaissance missions. Must allow for the deployment of special measurement and neutralization modules.



Heavyweight, a semi-automatic platform which can be used autonomously to follow one member of the intervention team. Weighing 100 kilos or more, it incorporates all of the described intervention capabilities. This type of robot is also suitable for carrying loads or tools.

At first, after comparing loading capacity, mobility and finally their versatility, research partners deliberately choose **Medium weight** class mobile base, to develop and improve. This range of UGV covers a very wide spectrum of operational needs, and was picked out by the consortium and users to match with a number, as wide a possible, of mission contexts.

3.6 CURRENT EVOLUTIONS

The main objective of ongoing project is now to further enhance this strategic tool through research and development, by clustering French firms possessing the necessary expertise to guarantee the robot's competitiveness regarding to its niche market.
The number of potential missions, as well as its user-friendliness has to be improved in order to increase this robot versatility.

The following aspects are currently under development:

- Increased heat resistance,
- Improvement of the human-machine interface,
- Optimized interoperability,
- Neutralization of gaz cylinders,
- The thermal protection,
- The tactical place during missions,
- The management and discrimination of the data flow.

A milestone report on these different skills will be done during conference's presentation.

4. CONCLUSIONS

Although it remains to be perfected, the remote-operated mission aid system developed on the basis of needs expressed by users has proved to be satisfactory. This device has shown itself to possess a high functional potential, and is capable of improving numerous aspects of the missions of emergency teams. In particular, it has proved its ability to provide multiple feedback data relative to incident scene, giving strategic information prior to all human intervention. Moreover, the various trials and initial interventions have confirmed the need to define and approve operational processes to integrate this tool in incident first responder's teams.

The robot is now in duty and operational service since March 2012, integrated in Cbrne and usual emergency teams operations with enlarged spectrum, exceeding CBRNe risks.

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