Development of an Experimental Multi-robot CBRNE Reconnaissance Demonstrator
System Description and Technical Validation

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Abstract. This paper presents a prototype of a multi-robot reconnaissance system for detection of chemical, biological, radiological, nuclear and explosive (CBRNE) threats. Our system consists of different robot platforms which are able to carry highly modularized payload platforms: either a multi-purpose CBRNE sensor suite or a mobile manipulator for semi-autonomous sample collection. A variety of sensors is available for detection and identification of chemical and radiological hazards as well as for collecting potentially dangerous airborne biological particles. A manipulator can be used to gather chemical and biological samples directly from surfaces in the environment. A detailed description illustrates the robot platforms, the CBRNE sensor suite and relevant parts of the user interface. For a technical validation preliminary real world experiments are presented.

Keywords: multi-robot, CBRNE, hazard detection, emergency response.

1 Introduction

Chemical, biological, radiological, nuclear and explosive (CBRNE) incident response becomes increasingly important in our days. On one hand, threats by terrorist groups can cause great damage with relatively small effort. On the other hand, disasters in industrial areas may release dangerous and not easily detectable chemicals. If such an emergency occurs, information about what has happened and how the situation develops is crucial for an effective response. However, it is difficult to explore these scenarios without mortal danger for the involved action force, be it fire fighters, army or police. Unmanned systems help reducing the number of human beings which are required within the danger zone. Robots can support response planning and situational awareness. They can help removing responders from dangerous situations or even allow for immediate site feedback prior to human entry. A robot can be sent ahead, assess the situation at hand and return information and sensor data back to the controller. In [1] Humphrey and Adams classified eight fields of robotic applications in the domain of CBRNE emergency response. Using Cognitive Task Analysis (CTA) and

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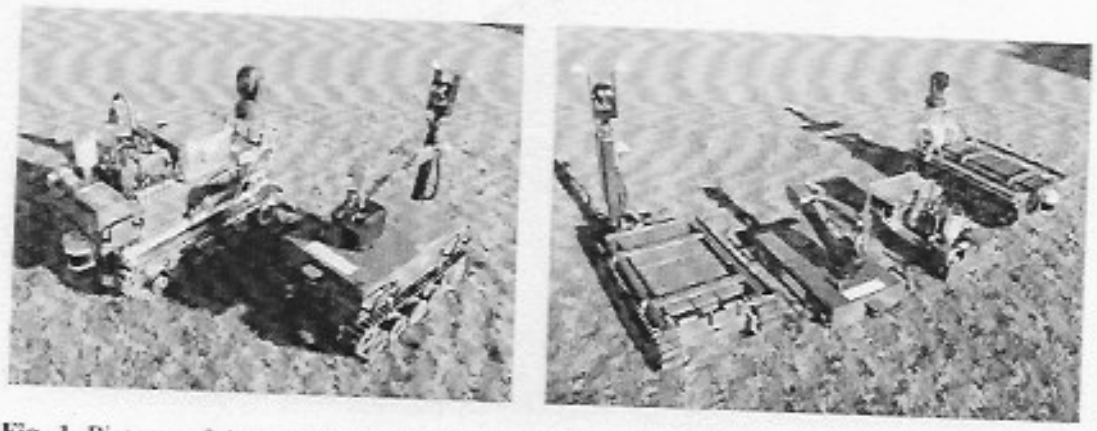


Fig. 1. Pictures of the two tracked CBRNE vehicles, the QinetiQ Longcross with the CBRNE sensor platfrom and the tEODor carrying the manipulator platform (*left*). Both platforms can be easily dismounted and exchanged (*right*).

Information Flow Analysis (IFA) they proved the feasibility of these tasks and also stated requirements for the acceptance of robots in the human-centric field of CBRNE response activities.

A mobile manipulator greatly enhances the vehicle's utility beyond pure sensor capabilities. On the one hand, its mobility could be increased because the manipulator and the attached gripper can be used to open doors and gates or to push obstacles away. On the other hand, a manipulator-equipped vehicle has the capability to gather images and video from a wider variety of perspectives or to open packages of interest. In addition, the manipulator can be used to collect samples of the hazardous material or from potentially contaminated surfaces for later analysis. So far, for biological and some chemical threats there exists no classification equipment suitable for mobile employment. Thus, samples have to be taken to be analysed in adequate laboratories.

Moreover, the use of more than a single vehicle offers further advantages. When a large area has to be inspected and monitored more robots can simply divide the work spatially. If the area of interest is too far away for reliable communication, robots can act as relay points for data transmission. Or there could be direct cooperation between differently equipped robots. Since general purpose robots usually result in very heavy and complex systems, often a variety of smaller and specialized systems is preferred. Thus, for example, a robot with a manipulator could be used to take a specific sensor from another vehicle carrying a variety of sensor devices. With the help of a mobile arm the operator could then try to have a closer look at the hazardous material and, afterwards, re-attach the sensor to the reconnaissance robot.

Important disaster response requirements, which have to be met by any robot system in this domain, include the ability to

- operate in areas with high radiation or danger of explosives,
- take samples and manipulate,
- do long-time surveying in contaminated areas,
- probe in problematic environments and conditions,
- monitor the movements of a threat, and
- provide real-time data from multiple mobile sensor sources.