TERRIFFIC: TOOLS FOR THE INITIAL 30 MINUTES AFTER A CBRNE INCIDENT

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Abstract

The TERRIFFIC project brings together 10 European organisations, which work together to deliver an important step change in the effectiveness of first responders during the initial hours of a Radiological, Nuclear, explosive (RNe) incident. This will lead to reduced response times, less health and safety risks for the response teams, and less human intervention in the operation due to a higher number of automated processes and extended mobile detection capabilities.

1. INTRODUCTION

The time needed to assess the situation after a CBRNe (Chemical, Biological, Radiological, Nuclear, explosives) incident is critical to minimize the exposure of the public as well as first responders. This trade-off between speed, effectiveness and the safety of first responders during the first hours continues to be a major challenge today, after many years of operational and technological innovation. To complicate things even more for first responders, the situation is often highly dynamic due to many factors - especially if the incident involves terrorism: the presence of perpetrators in the crime scene and combination of the Radiological and/or Nuclear (RN) attack with a conventional attack; changing meteorological conditions; fragility of buildings damaged by explosions; the presence of a secondary Improvised Explosive Devices (IEDs) timed to explode after the arrival of first responders; the presence, and state, of victims; the reaction of the civil population etc. Hence the situational awareness must be dynamically updated, in particular swiftly taking into account the evolution of the radiation plume and determining the extent and severity of the contamination and the dimensions of the control zone. The aim must be to collect and to update information quickly whilst in parallel the responders prepare for intervention or are already intervening. This allows to greatly reduce the damage, suffering and costs caused by CBRNe incidents. Within the European TERRIFFIC project trials are ongoing to optimize the assessment process. The paper presents newest developments within the TERRIFFIC project to get optimal information to first responders in the initial 30 minutes after an incident. The concept involves radiation monitoring with unmanned vehicles (drones and robots). A comprehensive system of complementary, interconnected and modular software and hardware components will be presented. Advanced mixed reality technology will be leveraged to provide first responders with ad-hoc available and continuously updated information during operations.

2. ENABLING CONTINUOUS, FAST AND AUTOMATIC COMMAND INTERVENTION

The overall concept of the TERRIFFIC project is given in the chevron diagram presented in FIG. 1. and in the overview concept diagram in FIG. 2. Similar to many existing systems TERRIFFIC utilizes state of the art sensors developed by CEA and ARKTIS to gather initial information. These systems are incorporated on industry standard unmanned ground (Nexter) and airborne drone systems (Aeracces). These systems are designed to operator in CBRN environments and carry MESH based communications systems to transmit the sensor telemetry out of the affected area. This information is then passed to the analysis and estimation systems - which take live sensor data and continuously calculate the current estimated location, characterisation (type of material) and source term of the incident. This information is then passed to the Bruhn NewTech frontline CBRN reporting module where the data is displayed and annotated before this is then finally transmitted to specialist in field augmented reality systems to display the result.

In essence, the gathering of sensor data through to the display of the radiation areas, risks for advising first responders is done rapidly, continuously and with a high degree of automation. Both the ability to estimate source term positions and locations automatically and the display of these invisible hazards in augmented reality are two of the most unique elements of this system.

FIG. 1. *Chevron diagram showing the different steps involved in the TERRIFFIC system*

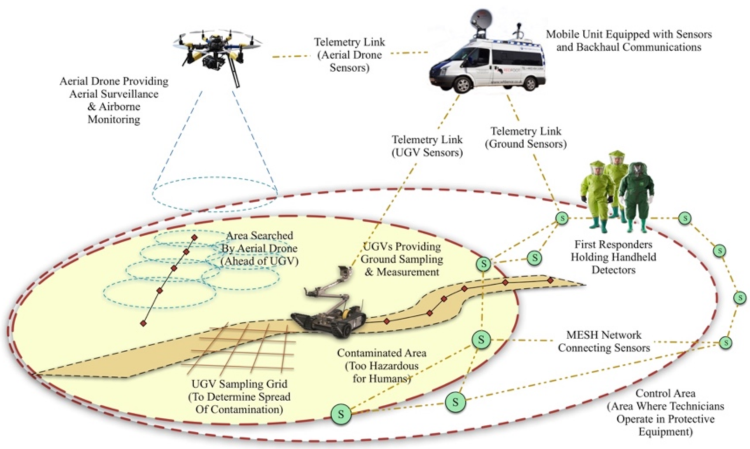

FIG. 2. Concept of operation diagram of the TERRIFFIC system

3. THE TERRIFFIC BUILDING BRICKS

In this section the building bricks of the TERIFFIC system are described. The four main layers of the system anticipated in the previous section will be described in more details. The aim of the description is to give an overview of the purpose of the single components. Section 3.1 describes the Radiation Detection Sensors, Section 3.2 will give a brief overview of the unmanned platforms, Section 3.3 details some of the specific features of the information processing algorithm and Section 3.4 introduces the managing and decision making tools.

3.1. Radiation Detection Sensors

The detectors representing the core components of the system are listed below:

(a) One of the systems deployed by CEA LIST for contamination monitoring is illustrated in FIG. 3. The detector is autonomous, working on battery and able to discriminate beta contribution from gamma background using a specific detector and associated pulse shape processing. This specific feature is of high interest for end-user, especially for intervention after a radiological event.
(b) A detector with reduced in weight and size so that it can be mounted on UAVs and UGVs to detect gamma radiation.
(c) Nanopix, a very compact gamma camera allows the remote localization and visualization of radioactive hot spots by superimposing a gamma image onto a visible image of the scene. With a weight of 268g and a size of 8x5x5 cm3,Nanopix is currently the smallest coded aperture camera ever developed.
(d) A portable neutron detector that can be integrated into the above listed mobile van. This core component will be based on the Arktis Radiation Detectors' M1000 large-area neutron detector

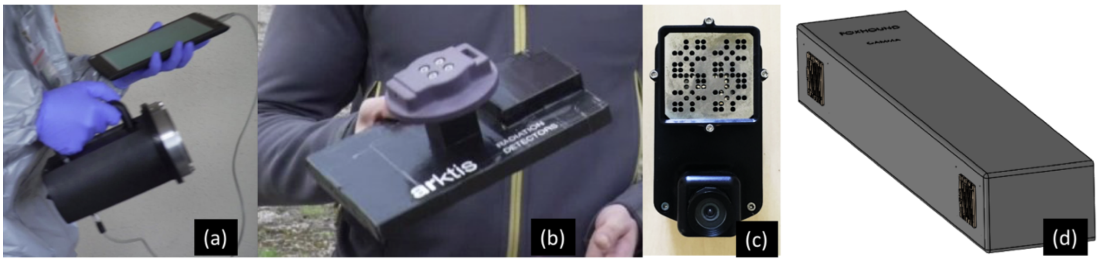

FIG. 3. (a) Beta radiation contamination monitor. (b) SiPR plastic scintillator detector. (c) Miniaturized gamma camera (d) Mobile detection Kit.

3.2. Unmanned platforms (UAV and UGV)

An unmanned aerial vehicle, including autopilot function and mission automation, allowing for integration of miniaturised payloads to detect radiation outdoors, while being compatible with common decontamination techniques. This core component will be based on the TERRIFFIC partner Aeraccess' Unmanned Aerial Vehicles (UAV) Q800X, but with further developments with respect to the coordinated use of UGV and UAV for a common operation mode.

An unmanned ground vehicle, allowing for integration of various detectors, piloted automated exploration and manipulation tasks. This core component will be based on the TERRIFFIC partner Nexter Robotics' Nerva-X robot.

FIG. 4. Unmanned vehicle platforms

3.3. The information Processing algorithm

One of the aspects unique about the TERRIFFIC system is the development of an inverse plume modelling system. This system developed by the Ecole Centrale de Lyon (ECL) is able to take sensor readings from a scene and by using a unique algorithm, then calculate the location and source term for an event.

Currently the system (Called ReWind) is only able to valuate the value for solid sources, but it is believed that this is extendable to plume based releases where material transport has occurred.

This is very different from existing approaches, whereby a Hazmats expert has to use their judgement and based on the scene and detector values, guess what the source term is and its location. Often repeated modelling iterations are required manually by the operator before the plume fits the measurements. This is time consuming and is more of an art than a science. In addition as more readings come in, this may require iterating the process again as these did not fit well with the expert's estimation.

The ReWind algorithm as part fo the TERRIFFIC system is transformational as this is one of the key elements that provides a very rapid

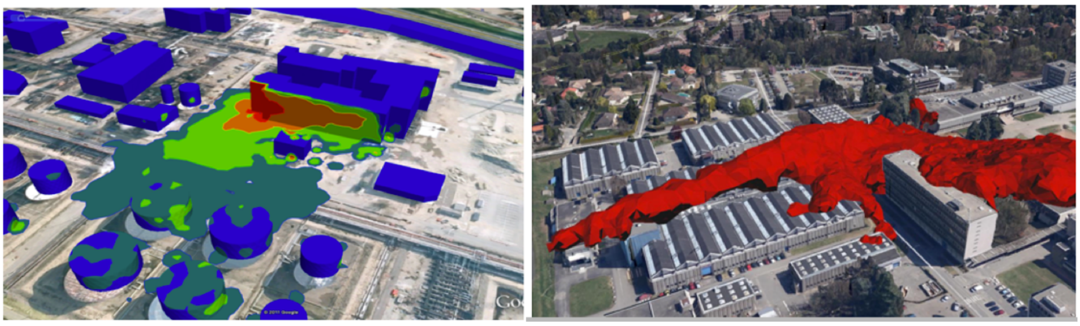

FIG. 5. *Example of 3D plume modelling based on the algorithm being developed within the TERRIFFIC project.*

3.4. Management and decision making tools

The data generated by the system are displayed in two distinct decision making tools:

(a) The Command and Control software system to visualize the current situation and reporting the detector data, health status and the exclusion zone. FIG. 6

(b) The Command and Control software system to visualize the current situation and reporting the detector data, health status and the exclusion zone. FIG. 7
The Augmented Reality On Scene System was developed by the Luxembourg Institute of Science and Technology to allow first responder to visualise in context the locations of invisible hazards, such as radiation or chemical contamination. It is linked via 4G or WIFI communications to the TERRIFFIC external modelling applications to allow information about safety zones, hazards and drone operations to be seamless passed to field teams seamlessly. It has also been designed to be compatible with the Bruhn Newtech Frontline application, used in the monitoring and management of CBRN events.

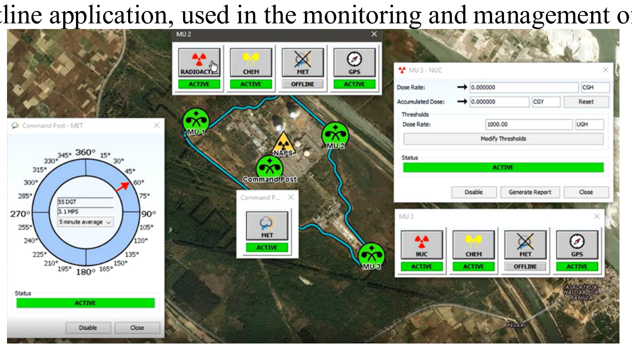

FIG. 6. Command and Control CBRNE Frontline application (Bruhn Newtech).

FIG. 7. Screen shot of the Augmented Reality On Scene System developed by the Luxembourg Institute of Science and Technology for First Responder.

4. OUTLOOK

The components described above will be integrated into end-user testable system and undergo field trials. These field trials will provide useful feedback on the applicability of the system and its practical fit into the actual operations of RNe first response.

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