FASTER: FIRST RESPONDER ADVANCED TECHNOLOGIES FOR SAFE AND EFFICIENT EMERGENCY RESPONSE

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ABSTRACT

The FASTER project (EU Horizon 2020) aims to establish a new approach for disaster response in order to improve Europe's overall disaster resilience. This will be accomplished by the targeted employment and synergistic deployment of a set of appropriate and complementary technologies. Immediate response is the second phase of the disaster management cycle and is a very important aspect for dealing effectively with disasters. Consequently, FASTER will improve the disaster response and monitoring capabilities by providing first responders with a suite of core and supplementary tools to augment their situational awareness and, as a result, improve their safety as well as enhance their operational capacity. The focus of disaster response is mitigating the impact of the disaster and ensuring the safety of those in immediate risk. However, as this takes place during the emergency, it also includes the safety of first responders who provide the means and resources for effective disaster mitigation and protection of life. Their in-field effectiveness is critical to mitigation and ensuring a short and smooth recovery phase.

Keywords: search and rescue, crisis management, security.

1. INTRODUCTION

The European Environment Agency (EEA) reports that Europe is experiencing an increasing number of disasters, derived either from natural phenomena, technological accidents or human actions [1]. These disasters affect EU citizens, the EU economy and the environment every year [2]. Over the period 1980-2016, the total reported losses caused by weather and climate-related extremes in the EEA member countries amounted to 436 billion EUR. The economic and societal impact will continue to escalate, as weather-related disasters alone could affect about two-thirds of the EU population annually by the year 2100, according to a recent data-driven forecast study [3]. First responders (FRs) are the people who are among the first to arrive and provide assistance at the disaster scene. They are typically professionals with specialized training, including law enforcement officers, firefighters, emergency medical personnel, rescuers, K9 units, civil protection authorities and other related organizations.

Due to the nature of their work, FRs are often operating in risky and hazardous environments, including collapsed, burning or flooded buildings, darkness, smoke, heat, and broken communications. Furthermore, FRs may experience health incidents (e.g. sudden illness, dizziness or exhaustion strokes) during operations, which can prevent them from completing their mission, and, more importantly, put their own life at risk. FRs may often not notice early signs or choose to ignore them in favour of accomplishing their mission, which can lead to become additional casualties of the disaster [4].

Despite their commitment and proper training, FRs' capabilities are often limited by the chaotic environments they operate in, making it extremely difficult for them to estimate the exact position of the victims, dangerous areas, or other FR teams. Though modern technology has played an important role in aiding FRs, it is often geared towards everyday or commercial use, and difficult to realize its full potential during a crisis. Autonomous vehicles are useful in disaster scenes, according to a member of the Reykjavik Search and Rescue (SAR) Team, who claims that using drones has enabled them to respond faster and more accurately [5], but they lack in operational autonomy. Cameras and other sensors can enhance situational awareness; however, an overwhelming amount of information may achieve the opposite. Multiple displays and devices, though useful on their own, can quickly add clutter and weight to carried equipment. Drones can permit faster and more accurate responses but lack operational autonomy. Communication between FRs and the Command and Control center is often hindered by broken, overloaded or non-existent network infrastructure [6]. Multiple FRs agencies and community volunteers, operating on the same scene need, need proper coordination. Often the problem lies not so much in the lack of resources and willingness to provide help, but in the logistics to efficiently direct and deliver assistance to the right places where and when it is most needed. These problems raise the need to harness the rapidly evolving technology towards protecting FRs from multiple and unexpected dangers, and to provide solutions enabling them to operate in a seamless and efficient way in any environment and in cooperation with the community.

2. IDENTITY AND VISION

FASTER [7] is a research and innovation project, funded by the European Commission, that aims to address the challenges associated with the protection of FRs in hazardous environments, while at the same time enhancing their capabilities in terms of situational awareness and communication.

FASTER is a joint, interdisciplinary endeavour, which started in May 2019 and has a planned duration of 3 years. It is undertaken by a consortium of 23 member organizations coordinated by CERTH, consisting of 8 research institutes, 3 leading industries, 4 SMEs, and 8 First Responder agencies including law enforcement agencies, firefighters, medical emergency services, K9 units, disaster response teams and civil protection organizations. Funded by the European Commission under the Horizon 2020 program, it spans much of the EU (Belgium, Finland, France, Greece, Italy, Malta, the Netherlands, Poland, Portugal, and Spain), as well as Japan.

FASTER acknowledges the development of a diverse range of tools which partially address some of the identified issues that FRs are facing, and intends to improve, extend and adapt them, developing integrated solutions for FRs that will be validated on the field.

3. METHODS

FASTER has a clear vision of going well beyond the state of the art providing cross-discipline tools to assist FRs in all aspects of their work and more importantly to increase their safety while operating. More specifically, FASTER aims at improving FRs' situational awareness by creating a secure IoT network for real-time data collection, including environmental (e.g. ambient temperature) and

biometric measurements, from sensors, wearables and smart textiles, fitted on FRs' gear. Additionally, in FASTER, text analysis techniques will be coupled with deep learning algorithms to eventually implement a classifier for social media posts and an event detection algorithm. Algorithms will be able to recognize emergency situations such as floods, fires, extreme weather events, and damaged infrastructure by simply scrapping the web.

The retrieved data will be then provided to both individual FRs through AR-enabled devices and operation leaders creating a Common Operational Picture with an innovative interface for portable devices. Especially, the AR interface will be developed to handle operations in any environment, seamlessly switching from registered to unregistered modes without misleading the user allowing FRs to digitally annotate the incident scene, and navigate them in complex environments. Similarly, FASTER's Portable Common Operational Picture tool will be carefully designed for enabling FRs to understand critical information at a glance and to acquire an overall and continuously up-to-date situation awareness.

Additionally, multi-functional autonomous vehicles equipped with vision sensors will be employed in order to enhance the operational capabilities of the FRs and at the same time allow them to see beyond obstacles and inspect unreachable or dangerous areas. In detail, each FR will be equipped with a small lightweight UAV ready to be utilised on demand assisting in visually inspecting otherwise inaccessible areas. Drones will be combined with AR technology for eventually offering an X-Ray like view to the FRs. In parallel, hand gesture recognition methods will be developed within FASTER allowing navigation of autonomous vehicles including drones in the disaster scene, mobile mission management (e.g. accepting mission tasks, reporting a problem, etc.), and haptic communication (e.g. by identifying gestures as messages and transmitting them as Morse code vibrations) between the FRs.

FASTER will also provide the technology for enhancing the communication between FRs and K9s. Wearables will be fitted on K9s' collar or body in order to collect data that will be later fed into Deep Learning (DL) algorithms for automatically classify the K9s' behaviour enabling FRs to easily understand the information when the dog is out-of-sight.

UaVs and 5G technologies will be also employed in order to achieve resilient and reliable connection. More explicitly, FASTER will address resilient communications in multiple levels. Firstly, in extending the communication network beyond the last operational point of communication by using a drone or swarm of drones as a relay service. Secondly, in emergency messages broadcasting to both civilians and FRs, considering safety processes and operational commands respectively. Towards that end, FASTER will introduce the Emergency Communication Box for broadcasting the aforementioned messages, where a mobile application will accompany it and will be able to receive and read the transmitted messages. Lastly, in managing and orchestrating of applications for FRs, including technologies related from IoT to AR/VR in a 5G infrastructure. Available tools and techniques for managing network services and properly extending them to meetFRs' needs will be also employed within FASTER and the application of blockchain and smart contract technologies to coordinate transparent interactions between FRs and all other parties involved in the relief effort will be also explored.

Finally, particular emphasis will be put on the engagement and involvement of the FRs in the development of tools ensuring that they will be compliant with their requirements and needs.

4. PILOTS AND VALIDATION

The FASTER solution will be demonstrated in three carefully selected scenarios that cover a diverse range of disaster scenarios. Firstly, FASTER will be piloted in Madrid, in a multi-storey building

collapse case where a structural failure triggers a complete collapse. The second use case concerns a major flood in a high-density urban environment and will be realised in Alessandria area in Italy. The final use case refers to an indoor disaster scenario, where an explosion occurs in a populated building and will be demonstrated in Kajaani, Finland. All FASTER tools will be validated in at least one of the above pilots, giving the researchers, integrators, and FRs the opportunity to examine their usefulness and interoperability in different use cases.

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