LESSONS FROM RECENT DISASTER EVENTS AND NEW TECHNOLOGIES FOR FUTURE USAR MISSIONS – INTREPID* (EU H2020)

Harris Georgiou[1], Alexios Vlachopoulos[2] , Aspasia Tzeletopoulou[3], Anastasia Andriopoulou[4]
[1,2,3,4] *Hellenic Rescue Team of Attica (HRTA), Greece.*
(E-mails: harris@xgeorgio.info, nosailor01@gmail.com, atzelet@gmail.com, aandriop2@gmail.com)

ABSTRACT
On October 17th-21th, 2022, Hellenic Rescue Team of Attica (HRTA) participated in the 2nd Pilot in Marseille (France), in the context of the INTREPID project (EU H2020). The purpose was to test new technologies developed in the INTREPID project, especially the individual improvements and modules integration during the last 12 months of that period. INTREPID aims to make the first hours of emergency and natural disaster for First Responders safer and more efficient by developing technologies that accelerate operational risk assessment capability by creating a unique platform. This paper presents a brief overview of these activities, under the scope of recent USAR mission deployments of our team that highlighted the importance and operational need for such technologies.

Keywords: Rescue, field tests, crisis management, security and safety, first responders.

1. INTRODUCTION

Every USAR mission is different, as it depends on various external and internal factors. Weather, location, access, local infrastructure, travel time, are only some of these external factors, while team's readiness level, organization, skill level and experience, toolkits available, are a few of the most important internal factors. On the other side, every USAR mission is an effort against time, beginning as a speed race and gradually becoming a marathon run. First Responders (FR) must be physically and mentally capable of adapting to this changing working environment, keeping track of hazards while at the same time maximizing the probabilities of survival for the trapped victims.

In such a pressing, dynamic and dangerous environment, every asset the FRs have at their disposal is invaluable in terms of enhancing any of the three main components of the deployment:

- **The FR team:** Personnel (safety, situational awareness, efficiency, endurance, cooperation, etc) and team assets (drones, cameras, sensors, communication devices, etc).
- **The victims:** Detection (sensing), triage (informed decisions), extrication (safety, speed).
- **The operations:** Situational awareness (top-level), worksite triage (prioritization), asset dispatching (e.g. UxVs, medical teams), communications (horizontal/HQ, vertical/teams), logistics, infrastructure (camp), medium/long-term mission planning, etc.

Each of the components above require special design, pre-mission planning, deployment management and contingencies. Moreover, if the USAR mission is planned for a typical 7-10 days cycle, significant work has to be conducted prior and during the deployment, sometimes 50% of the total team effort, for the supply chain and the logistics support of the field team. This work becomes even harder when there

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is lack of reliable information regarding obstacles they might be facing, like access routes and worksite hazards, which increase uncertainty and risk level.

The purpose of the INTREPID project [1, 2] is to greatly enhance these team-level success factors and at the same time mitigate the uncertainties and risks during the deployment. It introduces novel technologies that augment and improve all three components of the deployments, i.e., FR team, victim management (detection) and operations [3]. By developing modular and portable devices, it enables safer and more efficient work environment for the FR teams inside the "hotzone", accelerating the exploration and assessment of potentially hazardous sites. Moreover INTREPID introduces an innovative platform that enhances the mission planning in disaster zones at the wide-area level, i.e., focusing on operational rather than team-level prioritization. From its beginning, the project follows a user-centric approach according to which tools are validated frequently by end-users [2]. The project started on October 2020 and concludes on September 2023.

The following sections present a brief description of the second round of large-scale piloting activities of the INTREPID, conducted at the end of the second year of the project. Additionally, some reflection is added in the scope of the large-scale earthquake in Turkey-Syria (February 2023) [4] and a devastating train crash in Greece (March 2023) [5], discussing the lessons learnt and the operational/technological gaps that are very relevant with the context of this project.

2. METHODOLOGY – DESCRIPTION OF THE FIELD TRIALS

As part of the practical assessment during their development, these new technologies are to be extensively tested and evaluated in the field by FRs. The second such large-scale piloting activity took place at the technical training center C.E.T.I.S. of the Bataillon de marins-pompiers de Marseille (BMPM). This is the elite unit of firefighters of the French navy, i.e. they are additional divers, CBRN experts and specialists in search and rescue at sea.

Figure 1. BMPM training center during the main scenario of the piloting activities, with a simulated car fire outside after an explosion and HRTA field team entering the adjacent building for extricating an already detected victim.

In this piloting event, the complete INTREPID toolkit was deployed and tested at the BMPM's training center, with the main purpose of evaluating the efficiency of individual modules and functionalities, as well as assessing the integration level between them. Some of the technologies ranged from dynamic 3D

mapping inside buildings (visual tracking, LIDAR) and an integrated C&C platform in the operations center, to "hybrid" human/AI decision-making missions and wearables for proximity/distance sensing between team members operating in conditions of zero visibility.

According to the scenarios, the HRTA team participated in one of the pilot's scenarios involving the extrication of a victim from a building (Figure 1). During the scenario, the HRTA team used sensors (wearables for proximity/distance sensing) to collect data for a series of activities, as well as to test and evaluate the C&C platform and the mobile phone application (INMOS).

Some of the modules/services that are worth-noting for their innovation and “breakthrough” functionalities they bring in the FR team capacity are the following:

- Intelligence Amplification Module (IAM), combining information fusion from multiple sensors and platforms together with AI-based decision support for the operations.
- Path Planning Module (PPM), analyzing access routes towards a search location or a detected victim, as well as safely away from identified hazards, dynamically as the environment changes.
- Extended Reality Module (AR COP), introducing “embedded” information in the immediate area where the FR team operates, as well as information to and from the C&C.
- Environment Assessment Module (EAM), featuring “smart” and quick automation of the area assessment, even before the FR team is ready to enter the “hotzone”.
- Environment Mapping Module (EMM), featuring a detailed, dynamic and information-rich presentation of the “hotzone” area to both the FR team and the C&C.

All these features are enabled by multiple sensing platforms, including UGVs and UAVs deployed at the moment the FR team arrives on location and begins preparations to move, as well as modules that the FR team members themselves carry as part of their gear and continue to monitor, map and analyze the environment as they move.

3. DISCUSSION

Even at the very early stages of the INTREPID project, specific design priorities were identified by FRs and prioritized by the development partners. Based on the three main components of focus, i.e., the FR teams, the victims and the operations, special attention was given on addressing the current gaps in terms of operations and available solutions.

For the FR teams, three main priorities are of outmost importance: (a) safety, (b) speed, (c) sensing. For (a) safety, FRs need to ensure individual and team-level risk mitigation regarding possible hazards in an unknown and highly dynamic environment. This means enhancing their situational awareness via sensing modalities and properly designed interfaces, in order to have prompt but non-intrusive information flow between them. In terms of INTREPID, this includes AR, reliable communications, position tracking, location “probing” via UGV, etc. Regarding (b) speed, it is important to have clear and detailed understanding of the “hotzone”, especially during the wide-area assessment stage when FR team deployment needs to be prioritized and planned. Usually, this implies the use of UAVs for mapping, but in INTREPID this includes several other modules (PPM, EAM, EMM, etc) which enable mission-centric information fusion, assessment and AI-based decision making in the C&C. All these features enable fast and reliable scanning for victims, as well as assistance to triage. Finally, for (c) sensing it is important to put distance between the FR team and the immediate area of investigation within the “hotzone”; this is the best way to mitigate exposure to risks and hazards. Moreover, sensors

can provide detection capabilities other than the human or K9 senses (look, hear, smell for victims and hazards), typically via special modalities that enhance or supplement these (NV, IR/thermal, CO and other dangerous chemicals, etc).

One of the most crucial aspects that was confirmed again during our team's deployment inside the disaster areas in Turkey after the earthquake was the need for reliable communications inside the "hotzone", as well as in terms of logistics, reporting and support from the remote C&C (long-range). Equally important is the notion of being prepared for any contingencies and being highly adaptive in an unknown, dynamic and dangerous environment, all the time, for several days. This is why it is extremely important to keep the FR team out of harm's way as much as possible, minimizing exposure time (i.e., fast speed) and maximizing distance (i.e., remote multi-sensing) from the hazardous zones. In USAR missions such as the one in Turkey, all these have to be achieved consistently and reliably for several days (typically 7-10), which means planning the logistics and support for all these technical assets for long-term operations.

In contrast, a localized disaster zone like the one created after a devastating train crash has completely different operational aspects and priorities. Smaller scale means faster wide-area assessment, but in the recent event in Greece it was with huge fires (heavy smoke) and during night time, which translates to a very challenging environment for mapping UAVs and severely degraded remote sensing capabilities. At the same time, high number of victims and only limited assets on location means that quick and accurate triage, based on actionable information from inside the "hotzone", is of vital importance for maximizing the impact of SAR operations during the first few moments or hours (at most) from the event.

4. CONCLUSIONS

The second INTREPID pilot was conducted successfully on October 2022, at the closing of the second year of the project. The partners had the chance to closely collaborate for almost an entire week, a very important and valuable aspect of this event after the difficulties imposed during the covid-19 outbreak. The toolkit was deployed and tested in realistic conditions and under multi-aspect scenarios, assessing the performance of each individual module, as well as the integration level between them. The results of the test provided very valuable feedback to all partners regarding the requirements and constraints of real-world SAR operations. These results were revisited by our team (HRTA) during very recent disaster events in Turkey-Syria (earthquake) and in Greece (train crash), confirming the operational gaps and the need of such new technologies.

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