ESMERA EMERGENCY RESPONSE CHALLENGES

Emergency responses cover personal assistance, traffic accidents, fires and environmental risks. This is one of the key areas of the civil domain.

Here are some examples of civilian applications of robotic technology:

- Security monitoring of strategically important sites (airports, power plants, nuclear power plants, pipelines, railways, industrial sites, etc.)
- Crop and forest monitoring, and firefighting and other natural events;
- Relief in areas characterized by population flows
- Surveillance and response in affected areas (areas destroyed, for example following earthquakes, collapsed or partially collapsed buildings or sites dangerous to humans);
- Assistance in the operation or training of personnel working in the civilian sector (e. g. emergency responses, hazardous environment operations, etc.)

As explained in the Robotics 2020 Multi-Annual Roadmap, the barriers to commercialization are technical and not technical. For AUVs and UAVs, in some areas of application in the civil field, non-technical barriers are important. For these challenges, it is also necessary to work on both the technical challenge and compliance with legislation or ongoing legislative developments.

ESMERA has identified several industrial challenges and classified the needs for further technical advances in 3 main challenges. Under each Emergency response challenge, ESMERA propose two options of industrial challenges that can be solved, option a) ESMERA proposed challenge and option b) Open challenge.

Emergency response 1: Communication Systems for Fire Robots

The communication system must transmit the data (video, temperature sensor...) to the operator and transmit the commands (left, right, turn on the water flow, etc.) However, due to the complex environment and extreme conditions of the fire area (underground parking, metal structure, etc.), there could be communication problems which makes the usage of robots difficult. Reliable communication with robots is essential to maintain control while using a robotic platform in firefighting.

It is expecting from the solution to fulfill the following metrics:

- **Remote control:** The main idea is to keep the firefighter outside the burning building, but to keep the ability to control the robot, which will be engaged inside. He will enter the building, progress to the fire, use his fire hose to extinguish the fire.
- **Capability to work in extreme conditions:** Since it is expected from the system/robot to work in the fire area, the system must be capable to work in extreme conditions (high temperature, water steam, smoky environment etc.).

Under the above challenge, ESMERA project proposes two options. The proposer must address at least one of these challenges although addressing more than one or highlighting where elements of the proposed system could be used for the benefit of more than one system would be beneficial.

A) ESMERA proposed challenges: this challenge is extracted from *one* industrial use case which is:

EMERGENCY RESPONSE CHALLENGE 1.A (ER1.A)) **A Communication system for extreme conditions:** The proposed technologies must take into account the following elements:

- The robot/system operates in a fire environment in which the temperature may be high at the upper level, but it is colder near the ground (90-120°C). In addition, due to the use of water, the robot will be exposed to steam.
- Ability to maintain sufficient communication in a complex structure such as an underground car park or tunnel. The solution could be based on the use of regularly placed tags.
- The solution must be simple and could be quickly deployed without any configuration during the operation.
- It should represent significant progress compared to current technology (currently, Wi-Fi technology with max. range 40m or Ethernet cable with length 20m is used). From the solutions, it is expected a coverage up to 2.4km, with a minimum of 500m.
- A target cost for the whole system should be under 10 k€.
- The system must be adaptable to the frequency rules applied in each country; frequency technology should be preferred overpower transmission.
- The test and demonstration could be carried out on the experimental robot of the Paris fire brigade in an underground car park or tunnel in Ile-de-France. The frequency rules must be adapted to the French rules unless a demonstration in another robot or country is proposed.

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This challenge is provided by Paris fire brigade.

Figure 1. REX: Operational Robot

Figure 2. Experimental Robot

B) Open challenge (EMERGENCY RESPONSE CHALLENGE 1.B (ER1.B))

Any other proposal for similar technologies is eligible for funding, provided that a thorough explanation of the industrial needs is presented. The proposals will also have to clearly identify the state of the art in commercially available solutions and highlight the differences/advances over it. More specific each proposal in order to be in line with the ESMERA requirements has to provide:

- Clear indication of the company, institution or other that are in need of the proposed solution (no funding is allocated to challenge providers)
- Description of the problem that the company or companies need to be solved.
- Proof that currently there is no comparable solution (concept or approach, performance, cost…) in the market.

Emergency response 2: Autonomous UAVs for inspection and reconnaissance:

Nowadays, UAVs are used for occasional inspection or reconnaissance missions in which it is required to control them remotely.

It is expecting from the solution to fulfill the following metrics:

- **Autonomous Operation:** Current UAV systems do not perform many advanced operations autonomously required in inspection or reconnaissance such as taking-off, going around the building, opening/closing windows, etc. without a command of an operator.
- **Decisional autonomy:** Under this topic, it is expected from the system to guide the people in unexpected situations such as to broadcast to people to stay at home, to close doors in case of fire or to broadcast to people not to use any electrical system to prevent explosions in case of gas leak, etc.
- **Navigation Capabilities.** It is expected from the proposed systems to be capable to get information from mapping services and to deal with the environments without GNSS signals.

Under the above challenge, ESMERA project proposes two options. The proposer must address at least one of these challenges although addressing more than one or highlighting where elements of the proposed system could be used for the benefit of more than one system would be beneficial.

A) ESMERA proposed challenges: this challenge is extracted from *one* industrial use case which is:

EMERGENCY RESPONSE CHALLENGE 2.A (ER2.A))
Inspection and Reconnaissance of the environment for unexpected situations. In this challenge, we are expecting from proposers to find a solution to inspection or reconnaissance problem with addressing the following capabilities:

- Evolution in an urban environment. Mapping services (Google map or Open street map) could be the main input for the navigation
- To deal with environments even with degraded or no GNSS signals.
- The system has to be autonomous: mission configuration, taking-off, going around the building, locating windows, executing basic task, and landing.
- The system should manage collision detection and avoidance management
- The flight endurance should be more than 20 min
- The range should be 300m
- The setup of the system should be simple, with no or few set up operation during the intervention. It has to be fully automated.
- The operational safety must be proven a risk analysis should be provided
- The target cost should be under 40 k€ per UAVs
- Development should be done in close collaboration with the regulation authorities EASA (European Union Aviation Safety

Figure 3. An example of a fire area and its surroundings

Agency), in order to be able to use the final system.

Demonstration have to focus to alert mission. The objective is to have a system that can alert people while the first responders are focused on rescuing

- Fire alert to tell people to stay at home, to close doors.
- Gas leak, to tell people not to use any electrical system to prevent explosions.

The system should demonstrate configuration, taking-off, going around the building, locate windows, deliver recorded message, and landing. A link with the DGAC (Direction Générale de l'Aviation Civile) can be established thanks to the Paris fire brigade, to authorize the demonstration and help to take into account all the requirements of the operational safety rules.

This challenge is provided by Paris fire brigade.

B) Open challenge (EMERGENCY RESPONSE CHALLENGE 2.B (ER2.B))

Any other proposal for similar technologies is eligible for funding, provided that a thorough explanation of the industrial needs is presented. The proposals will also have to clearly identify the state of the art in commercially available solutions and highlight the differences/advances over it. More specific each proposal in order to be in line with the ESMERA requirements has to provide:

- Clear indication of the company, institution or other that are in need of the proposed solution (no funding is allocated to challenge providers)
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Emergency response 3: Swarm Robots for Extreme Environments

Emergency responses also work in extreme conditions such as in an NBCR (Nuclear, biological, chemical, radiological) crisis. For such cases, it is not only important that a system is able to work in extreme conditions but also it has a real-time mapping of the contamination. Based on the data from the real-time mapping, areas under risks can be expanded or shrank.

It is expecting from the solution to fulfill the following metrics:

- **Ability to work in extreme conditions.** NBCR conditions are extreme conditions in which human beings cannot enter without special equipment or the usage of many systems might be dangerous. It is expected from the developed system to work in such an environment without any risks.
- **Decisional autonomy.** Based on the received data, it is expected from the system to decide for the further steps. It is expected from the system to analyze the data and to decide the next steps in real-time.
- **Online Navigation Capability:** The system should use map services to find its way and also allow people to track it.

Under the above challenge ESMERA project proposes two options. The proposer must address at least one of these challenges although addressing more than one or highlighting where elements of the proposed system could be used for the benefit of more than one system would be beneficial.

A) ESMERA proposed challenges: this challenge is extracted from *one* industrial use case which is:

EMERGENCY RESPONSE CHALLENGE 3.A (ER3.A))

Swarm Robots for NBCR Area Fence. In an NBCR (Nuclear, biological, chemical, radiological) crisis, the fencing of the zone is critical to ensure the protection of first responders and civilians. Winds or other factors change the distribution of the contaminating cloud. It is important to have a real-time map of the contamination and to adapt the area's fence to the real-time map. The expectation is to have a swarm of heterogeneous robots which are able to physically mark no-entry zones, according to the real-time contaminant pollution. In this challenge, we are looking for a system capable of doing the following items:

- The system should fence the area depending on thresholds and dynamically mark the area.
- The area covered by the system is expected to be up to 1km.
- The system should measure the contaminant (sensors not to be developed) and climatic condition such as wind
- The system must be able to adapt the fences dynamically and autonomously according to the contaminant and weather conditions at a speed of up to 4 m/s.
- The system should be autonomous and could navigate thank to sensors and Google/ Open Street map of the area
- The target cost should be under 150 k€ for a complete system
- The development should be done in agreement with the legislation in order to be able to use the final system

The demonstration should focus on:

- Contamination monitoring (follow winds….)
- Performing a secure area around a building based on the input of contamination and wind sensors with a consistency

This challenge is provided by Paris fire brigade.

B) Open challenge (EMERGENCY RESPONSE CHALLENGE 3.B (ER3.B))

Any other proposal for similar technologies is eligible for funding, provided that a thorough explanation of the industrial needs is presented. The proposals will also have to clearly identify the state of the art in commercially available solutions and highlight the differences/advances over it. More specific each proposal in order to be in line with the ESMERA requirements has to provide:

- Clear indication of the company, institution or other that are in need of the proposed solution (no funding is allocated to challenge providers)
- Description of the problem that the company or companies need to be solved.
- Proof that currently there is no comparable solution (concept or approach, performance, cost…) in the market.

Glossary Terms:

AUV: Autonomous Underwater Vehicle

UAV: Unmanned Aerial Vehicle