Multi-Agent Disaster Response Scenario Outlining the Benefits of Inter-Agent Model Exchanges

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1 Introduction

The location I have found to be the most suitable for a rescue mission is Bucharest's Old Town, where most of the buildings have a high seismic risk. An earthquake with a magnitude greater than 7.0 on the Richter scale would destroy most of the buildings located in the Old Town.

2 Further Details About the Proposed Disaster

For the purposes of this scenario, let's assume that an earthquake with the same characteristics as the one from 1977 hit Bucharest. It had a magnitude of M = 7.2 and a depth of about 90 km. As for the time of occurrence, let's assume it happened at 17:00 on a Friday, since the amount of traffic in the location is moderate.
After the earthquake, upwards of 75% percent of the buildings in the Old Town will have collapsed. Survivors will be trapped beneath several layers of debris, since the buildings are about 3 or more stories high.

3 Mission Type

After an earthquake of this magnitude in a location known for its high seismic risk, and perhaps more important, with close to 2 million visitors per year (as of 2019), the top priority should be a search and rescue mission.

4 Employed Tools

UAVs (Unmanned Aerial Vehicles) are key to a successful mission, as they can offer a more bird's eye view of everything that is happening on the ground, thus

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being able to guide UGVs and human agents towards the survivors. They can also assess the damage, and provide real-time updates to the other agents.
UGVs (Unmanned Ground Vehicles) can be used in order to traverse rough terrain and locate survivors in hard-to-reach locations.
Snakes (or Serpentine Robots) are flexible and agile robots can maneuver through tight spaces and obstacles, making them ideal for search and rescue operations in collapsed structures. They can reach areas that are inaccessible to human rescuers and provide visual feedback and sensor data to guide the response teams.
Rescue dogs can be used to locate survivors thanks to their keen sense of smell. Their handlers can benefit from the data provided by the aforementioned agents.
Communication and Localization Tools can be employed in order to facilitate coordination among agents and improve the efficiency of search and rescue efforts. This includes radio communication systems, GPS tracking devices, and RFID (Radio Frequency Identification) tags for monitoring the locations of responders and survivors, perhaps even by triangulating the survivors' cell phones signals.

5 Detailed Description of Model Exchange

The agents can transfer several AI models between themselves, including models for object detection and recognition, mapping and navigation, anomaly detection, thermal imaging analysis, and victim recognition, among others. These models are used to classify and locate survivors, distinguish between humans and debris, create detailed maps of the environment, plan optimal paths for search and rescue operations, identify signs of life, detect human shapes under rubble, recognise distress signals, and analyze and interpret the behaviors and reactions of rescue dogs.
For example, the AI models for object detection and recognition can be integrated into the drone's camera systems to help them identify survivors and distinguish between humans and debris. This is useful for locating areas of interest more accurately and enabling drones to share insights about collapsed structures, potential survivor locations, or hazardous conditions. Similarly, UGVs can be equipped with AI models for mapping and navigation, allowing them to autonomously explore the disaster area, create detailed maps of the environment, and plan optimal paths for search and rescue operations. Agents can also exchange AI models for anomaly detection or victim recognition, allowing UGVs to identify signs of life, detect human shapes under rubble, or recognize distress signals. By sharing these models, the agents can collectively improve the UGVs' ability to locate survivors and prioritize rescue efforts.
Another example is the integration of AI models into snake robots to enhance their perception capabilities. For instance, models for object detection or thermal imaging analysis can help identify survivors or detect temperature variations indicating potential locations of trapped individuals. Agents can also exchange AI models that improve the snake robots' locomotion and path planning algorithms. By sharing these models, the agents can collectively enhance the robots'

ability to navigate complex terrains and tight spaces, ensuring efficient search and rescue operations.

6 UAV and UGV Model Exchange

Agents, Models, Situation
Agent A1: Unmanned Aerial Vehicle (UAV) equipped with Model X (AI model for object detection and recognition in aerial imagery), Model Y (AI model for mapping and navigation in UGVs), and Model Z (AI model for anomaly detection in UGVs).
Agent A2: Unmanned Ground Vehicle (UGV) equipped with Model W (AI model for victim recognition) alongside other undisclosed models.
Model X: AI model for object detection and recognition in aerial imagery.
Model Y: AI model for mapping and navigation.
Model Z: AI model for anomaly detection.
Model W: AI model for victim recognition.
Situation S: A collapsed structure with survivors trapped in a hazardous area inaccessible to human rescuers.

Agent A1, the UAV with Models X, Y, and Z, is conducting aerial reconnaissance in Bucharest's Old Town after an earthquake. Its primary functionality is to provide real-time updates, create detailed maps of the environment, and detect anomalies. However, A1 encounters a collapsed structure in a hazardous area where human rescuers and UGVs cannot enter.
A1 realizes that its existing AI models, X, Y, and Z, are insufficient to accurately locate and identify survivors in this specific situation, since they are trained for mapping and overall awareness. While Model X can detect objects, it does not specialize in victim recognition under rubble or in distress. Models Y and Z primarily assist in mapping, navigation, and anomaly detection in UAVs but lack the specific capabilities for victim recognition.
Agent A2, the UGV with Model W (AI model for victim recognition), possesses the necessary AI model to address the challenges presented by situation S. Model W excels in identifying signs of life, detecting human shapes under rubble, and recognizing distress signals accurately.
Agent A1, realizing the need for Model W to enhance its capabilities, communicates with Agent A2 and requests the transfer of Model W. Recognizing the urgency and importance of the situation, Agent A2 willingly transfers Model W to Agent A1.
With the newly acquired Model W, A1 can now accurately identify signs of life, detect human shapes under rubble, and recognize distress signals from its aerial perspective. This improved functionality significantly enhances A1's ability to contribute to the search and rescue mission in Bucharest's Old Town, thus being able to locate survivors under the collapsed structure. By facilitating the transfer of Model W from A2 to A1, the agents demonstrate the practical

implementation of AI model sharing in disaster response scenarios. Their collaboration ensures that the specialized models and expertise of one agent can be utilized by another, ultimately increasing the overall effectiveness and efficiency of the rescue team in saving lives.

7 UGV and Snake Robot Model Exchange

Agents, Models, Situation
Agent A1: Unmanned Ground Vehicle (UGV) equipped with Model X (AI model for mapping and navigation).
Agent A2: Snake Robot equipped with Model W (AI model for obstacle detection and maneuvering).
Model X: AI model for mapping and navigation.
Model W: AI model for maneuvering through tight spaces(estimating and analyzing the gap between two obstacles and comparing it to the agent's shape).
Situation S: A collapsed building with survivors trapped in tight spaces and obstacles.

Agent A1, the Unmanned Ground Vehicle (UGV) with Model X, is deployed to a disaster site where a building has collapsed, trapping survivors in tight spaces and obstructed areas. Its primary functionality is mapping and navigation. However, A1 encounters the complexity of the collapsed building scenario by unexpectedly entering one, where traditional mapping approaches alone are insufficient to overcome the various obstacles.
A1 realizes that its existing AI model, Model X, lacks the specialized capability required to effectively address the situation. Model X excels in mapping and navigation but does not possess the expertise needed for navigating through tight spaces.
Agent A2, the Snake Robot with Model W, possesses an AI model specifically designed for obstacle detection and maneuvering. Model W enables the snake robot to navigate through tight spaces, identify obstacles, and adapt its locomotion to overcome various terrain challenges.
Recognizing the limitations of its own capabilities, Agent A1 communicates with Agent A2 and requests the exchange of Model W. Agent A2 transfers Model W to Agent A1.
With the integration of Model W, A1 gains enhanced obstacle detection and maneuvering capabilities. It can now detect obstacles in its path, plan alternative routes, and navigate through tight spaces more effectively. This approach allows A1 to safely navigate out of the collapsed structure which it entered by accident.

8 Conclusions

AI model sharing between agents could have increased the efficiency of the rescue team, which is critical to the survival rate in the case of an earthquake of this magnitude, especially in such a vulnerable area. This solution thus proves to be better since it allows for a more efficient use of perhaps the most important resource in a search and rescue mission, time.