**A. Describe the disaster recovery environment you chose and the two obstacles you have added to the environment.**

**Environment**
The environment is a maze. It simulates a building with survivors trapped in it.

**Obstacles**
- **Walls:** The walls throughout the environment prevent the robot from traversing a certain direction
- **Lack of information:** The most substantial obstacle is the robot's knowledge of the environment. It does not know where the goal is or what is around it. It must gather information from the environment to overcome this obstacle.

**B. Explain how the robot will improve disaster recovery in the environment from part A after you have added the two obstacles from part A.**

The robot will be able to scan the environment and locate the survivors effectively and quickly. It can traverse small spaces as well as continually search the environment for the objective. This can greatly aid in saving disaster victims.

**C. Justify the modifications you made to CoppeliaSim's robot architecture, including two sensors you chose to add, and explain how these sensors will aid the disaster recovery effort.**

I modified the robot to have a center of gravity for smooth rotations. The robot contains six sensors. Four of the sensors scan adjacent tiles. This allows the robot to traverse more quickly not needing to rotate every time it enters a new space. Additionally, the robot has 2 sensors on the front for locating humans. With these sensors, it can swiftly navigate a random maze and locate the survivors.

**D. Describe how the robot maintains an internal representation of the environment.**

There are several data structures involved in maintaining an internal representation of the environment:
**Stack**
A stack is implemented to keep track of recent movements every time the robot explores a new tile.
**2D Array**
A 2D array is used to keep track of and update a representation of the environment around it. The values of the array correspond with the following:
- 0: Unexplored
- 1: Occupied by robot
- 2: Explored
- 3: Blocked Cell

**HashMap**
A hashmap is utilized to maintain a key-value pair relationship. This hashmap contains the most adjacent tiles at any given point in time. “Up”, “Down”, “Left”, and “Right” are associated with values 0, 2, and 3.

**Standard Array**
A standard array is used to contain the robot's options for movement at any given point in time. “Up”, “Down”, “Left”, and “Right” are the only values that will be in this array.

**E. Explain how the robot implements the following four concepts to achieve its goal:**

- **reasoning**
  It scans the surrounding tiles, only traversing to tiles that are not blocked.

- **knowledge representation**
  The robot uses the data structures mentioned in section D to maintain knowledge about the environment.

- **uncertainty**
  The robot does not know where the goal is or what the environment around it is. It scans the environment updates it’s knowledge and traverses accordingly.

- **intelligence**
  The robot utilizes a depth-first search algorithm. When it reaches a situation with several options, it will first traverse spaces it has not yet explored. After that, it will backtrack until it finds more tiles to explore. It will do this until the goal is reached or the entire environment has been explored.

**F. Explain how the prototype could be further improved, including how reinforced learning and advanced search algorithms can improve the prototype’s performance and learning.**

The robot currently contains a stack of all the movements it took to reach its goal. This knowledge can be used in congruency with a deep-learning neural network. These inputs can be fed into the network and have the weights continually updated. This can be used to gather a more broad intelligence about the environment to traverse it more quickly. It is important to not overfit the model and preprocess the data for quality.

The robot could also use a more advanced search algorithm if the location of the survivors is apparent. It can constantly keep track of the distance from the objective and update that appropriately. This is however situational. If the location is unknown, depth-first or breadth-first are appropriate search algorithms. Depth-first search was implemented in this project.

**G. Submit the robot code that you created.**
The code and the scene file will be included with the submission

**H. Provide a Panopto video recording that describes the robot and demonstrates its functionalities to stakeholders who are nonpractitioners and include each of the following:**

- a statement of the disaster recovery problem
- a summary of the environment and the obstacles
- a summary of the robot's goal and objectives
- a description of the robot and its architecture
- a demonstration of how the robot meets its disaster recovery goals
- an assessment of the robot's capabilities
- an explanation of how to improve the prototype

The video link will be included with the submission. It can also be reached here: https://wgu.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=cb12ac77-706a-42cf-a97a-b16e00eb24a5