Disaster Recovery Bot

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

The disaster recovery environment represents a flood happening within a building, and the flood is preventing people from evacuating. The obstacles added were blue cylinders that represent the water, and white cylinders that represent the walls of the building. The cylinders will be detected by the robot as obstacles that it cannot run into. If the robot detects a cylinder, it will back up, turn a few degrees to the right, and try moving forward again. In the simulation, the robot is not able to leave the building or enter the water. The only goal is to find the person, which is represented by a green cube. Once the robot detects the person, it sends a message saying that it's goal has been reached.

B. Explain how the robot will improve disaster recovery in the environment with two or more additional obstacles.

The robot can aid in disaster recovery primarily by doing things that humans either can't do or have a hard time doing. Two things that come to mind would be: withstanding excessive cold/heat that may harm a human in some way (death, loss of consciousness, etc.), and sending a video feed to the rescue team. The video would show the team the layout of the building, which would potentially help them reach the person much faster. People are capable of sending a video feed, but again, the cold or heat (cold in the case of a flood) would likely make it very difficult for a person to provide a reliable feed. The robot would also be able to tell the rescue team exactly where NOT to go through this video feed.

C. Justify the modifications you made to BubbleRob's architecture, explaining how additional sensors will aid the disaster recovery effort.

The two additional proximity sensors in the front of the robot help the robot avoid obstacles much more easily. A single sensor runs a much higher risk of the robot missing an obstacle, causing the robot to hit it, which could not only damage the robot, but possibly damage the building. Any extra damage to the building should be avoided at all costs, or you run the risk of creating more obstacles, if not killing someone or collapsing the building entirely. The four disk sensors were added as a way to detect the robot's goal. There is one sensor in each of the cardinal directions, spanning 90 degrees each. This forms a full circle around the robot, and when a sensor detects a person, it tells you which sensor is picking them up. This can aid in finding the exact location of a person, especially if the front of the robot were to miss them. It's entirely possible that the robot could back into someone, or the person might just barely be out of reach of the sides of the front sensor. If the person is able to move, they could also go near the robot in any direction and they will be picked up.

D. Explain how optimization principles are implemented in the prototype and how these optimization principles include the concepts of reasoning, knowledge representation, uncertainty, and intelligence.

Optimization principles are shown through the addition of extra sensors. There was also a change to the movement of the robot, where the time that it is backing up after detecting an obstacle was reduced to an eighth of the original time. The amount of time that the BubbleRob tutorial had for it by default was arguably too much, and was more likely to lead to the robot getting stuck in a loop. Reducing it further would allow it to more accurately search an

area, but it could also take more time, which is a risky thing to try and balance in disaster recovery. The sensors include the concepts of reasoning, knowledge representation, and uncertainty because: the robot will be able to reason whether or not it should move forward or back up and turn, it gains temporary knowledge each time it runs into an obstacle by knowing that an object is in the way, and the uncertainty aspect comes in that the robot never knows what is ahead of it until the sensor picks it up. The intelligence concept comes in when the robot is able to tell the difference between objects. The different types of sensors allow this intelligence, with the cones detecting obstacles, and the disks detecting people and sending alerts.

E. Explain the advantages and limitations of the robot as well as the criteria for assessing the success of the prototype in solving the problem.

There are many advantages to the robot, but there are definitely many limitations as well. The robot is able to successfully do its task, which is done by avoiding obstacles, finding the trapped people, and avoiding damaging anything. The rest of the process is left to the rescue teams. The camera allows rescue teams to view the building's layout, see what's safe and what isn't, and this allows them to more safely and efficiently save the trapped person. The main advantage of the robot is saving human lives, whether it is the person that is trapped or the people trying to rescue them. Unfortunately there are plenty of limitations to the robot, although many could be fixed with further improvements. The robot does not have any way of knowing if there are any people in the environment that it's searching until it actually senses one near it. There is no cone sensor currently on the rear of the robot, so it may back into objects. There is currently no way for the robot to know where it has been, so it has the potential to search the same place multiple times. Nothing currently detects bumps, cliffs, etc. so the robot may damage itself. In a real life situation, the robot would not have a high chance of success. It would probably fail to find everyone, and it would most likely damage itself, a person, or the building. On the plus side, it would at least be able to avoid obstacles pretty well.

F. Outline a plan for the testing and implementation of the robot.

The testing and implementation plan would include making sure that the robot does the following:

- Finds every person
- Avoids every obstacle
- Does not damage anyone or anything
- Correctly determines when a person is in range of the sensors
- Correctly sends a video feed

Like with most software, plenty of optimizations and improvements would need to be made throughout the testing phase. Repeatedly running a wide variety of simulations that follow this testing criteria would be a good way to determine whether or not the software is ready. The robot would need to be implemented with reinforced learning behavior. Without this, it would never be able to meet the testing criteria outside of simulations. Real-life simulations would be a good way to decide how exactly the implementation should be done.

G. Explain how the prototype could be further improved, including how reinforced learning can optimize the prototype's performance.

The robot, in its current state, is very simple and cannot do very much outside of the most basic of simulations. There are several improvements that could be made to the prototype, such as adding additional proximity sensors,

adding a heat/cold sensor, increasing the range that it can scan for people, allowing the robot to turn in a variety of directions, and increasing the robot's speed. The primary thing that would benefit this prototype, however, would be machine learning. Unsupervised and reinforcement learning techniques would all be extremely beneficial to this type of bot. Supervised techniques are not a realistic way to handle this sort of situation. In real life, there are too many unknowns to account for, which means that the robot knows basically nothing going into a disaster recovery event. A rewards system would be a great improvement for the robot. The robot could be given a reward any time it does something correctly, which would act as a feedback loop. This feedback loop would help the robot learn what to do and when, which would lead to the robot avoiding obstacles, avoiding searching the same place multiple times, avoiding causing damage, and finding people more efficiently.

Sources

No sources were directly quoted or paraphrased. The following book assisted both in understanding the AI and responding to the prompts.

Russell, S. J. & Norvig, P. (2010). *Artificial intelligence: A modern approach* (3rd ed.). Retrieved December 8, 2020, from https://wgu.ucertify.com/?func=ebook&chapter_no=1#top