NIP1 TASK 2: DISASTER RELIEF ROBOT

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

### Disaster recovery environment

The bubble rob recovery environment is meant to emulate a living room setting within a domestic home after an earthquake.

### Obstacles added to the environment

Obstacles added to the environment for BubbleRob to interact with were an overstuffed chair, a coffee table, a plant, a cabinet, a person named Bill, and the 4 walls of the room.

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

BubbleRob (the robot) will improve disaster recovery in the environment with two or more additional objects because as the number of objects grows the more dangerous it is for humans to go in to assess the environment. BubbleRob is small and equipped with three sensors and a camera.

BubbleRob’s goal is to find any people who are in the environment. He will continue to look until he is stopped by the human controlling him. So, once he finds Bill he will continue on searching for more people until stopped. The camera will send visual data of the environment to the humans outside of the environment.

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

BubbleRob is equipped with two additional sensors that act as “arms” or “whiskers” that detect objects to the left and right of his body. This helps BubbleRob from getting stuck in an area that he will not fit and allows for a more efficient way to search for people since he can detect people from either side of him as well.

## 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 implementation in the prototype

#### Reasoning

The act of reasoning in AI includes inference, planning, and learning. BubbleRob can reason with his sensors by responding to the obstacles in his surroundings. BubbleRob uses planning by use of the sensors. Once a person is found he plans to continue looking for more humans until he is stopped. BubbleRob learns by use of his sensors as well because he keeps track of how many humans he has found and their locations.

#### Knowledge Representation

BubbleRob uses knowledge representation in the form of alerting the humans outside the environment of the humans trapped inside the environment with reports from the sensors and the visuals from the camera.

#### Uncertainty

BubbleRob is uncertain of the position of the obstacles in his environment, whether people are trapped inside or not, and of the size of the environment.

#### Intelligence

BubbleRob is intelligent because he mimics a human rescuer in an emergency. He assesses the environment with his sensors, searching for obstacles, assessing the obstacles, and reporting his findings. He thinks like a human rescuer because he continues to look for survivors within the environment until he is told to stop.

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

### Advantages

### Limitations

BubbleRob has three active range finder sensors that use UAV light to measure the distance to nearby objects and reroute his course around them. Multiple active sensors can pose a threat to the stability of BubbleRob because they can consume too much energy and cause BubbleRob to fail. BubbleRob is also limited in by the inability to sense anything above him. This could cause him to run into an object, like a coffee table, that is too short for him to fit underneath and he would just stay stuck there until a human intervened. BubbleRob is not meant to sense aftershocks of a quake or falling objects with a force sensor. BubbleRob also may get stuck in a loop on legs of chairs or tables in certain situations and will need to be rerouted by a human. Another limitation BubbleRob has is that he cannot remove debris from survivors.

### Assessing the Success of the Prototype in Solving the Problem

BubbleRob’s prototype was assessed for success in solving the problem by running the prototype to see if he had the ability to find Bill. Depending on his start point, BubbleRob found Bill. It was found that if BubbleRob was monitored by a human and rerouted when stuck on an object in the environment he was able to find Bill every time. This is because BubbleRob does not stop looking for survivors until he is instructed to do so.

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

### Testing

1. Set BubbleRob into a controlled environment
2. Run BubbleRob’s program
3. Document information
   1. Time it takes to reach the objective; Find a human survivor
   2. When he gets stuck
   3. Where he gets stuck
   4. What works to reroute BubbleRob
4. Review documented issues and adjust the program
5. Test the adjusted program
6. Repeat this test cycle until the BubbleRob prototype is up to expectations

### Implementation

1. Gather the Program
   1. Download the zip folder ‘bubbleRob’ from the attached files
   2. Extract the folder to the appropriate location
2. Open the program in CoppelliaSim
   1. Open CopelliaSim
   2. Go to File -> Open Scene
   3. Navigate to the BubbleRob folder
   4. Open the bubbleRob.ttt file
3. Run the simulation
   1. Make sure the bubbleRob scene tab is selected
   2. Press the play button near the top center of the window

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

### Further Improvements

BubbleRob could be improved in many ways:

* Add a sensor that detects for aftershocks and falling objects
* Add a voice that can communicate to survivors where the exit is
* Add a microphone so the survivors can talk to human emergency personnel on the outside of the environment
* Add popup windows that the human emergency responders can view with the location of the survivors
* Add code to the program that allows BubbleRob to reroute himself when stuck on an object in the environment
* Add an arm to the robot to help move heavy debris from survivors

#### How Reinforced Learning can optimize the prototype’s performance

“Reinforcement learning is the training of machine learning models to make a sequence of decisions.” (Błażej Osiński, 2018) BubbleRob can be optimized by reinforcement learning by minimizing his uncertainty. With reinforcement learning algorithms implemented into BubbleRob’s code he could be programmed to be rewarded for tasks such as finding a human survivor, rerouting when he is stuck, removing debris from the human without causing more damage, avoiding areas that are too small for him to fit into, detecting falling objects or aftershocks. The goal would be to maximize his total reward and minimize penalties when he fails to do a task up to standards. In order to maximize the reward the reinforcement learning model needs to be set up with random paths through the environment and no hints about the environment before being placed into the environment.

## Submit the robot code.

See project submission.

## I. Provide a Panopto video recording that describes the robot and demonstrates its functionalities to stakeholders that are non-practitioners, including 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

• an explanation of the benefits of using the robot in disaster recovery

Note: For instructions on how to access and use Panopto, use the "Panopto How-To Videos" web link provided below. To access Panopto's website, navigate to the web link titled "Panopto Access", and then choose to log in using the “WGU” option. If prompted, log in using your WGU student portal credentials, and then it will forward you to Panopto’s website.

To submit your recording, upload it to the Panopto drop box titled “INTRODUCTION TO ARTIFICIAL INTELLIGENCE – NIP1 Task 2 | C951.” Once the recording has been uploaded and processed in Panopto's system, retrieve the URL of the recording from Panopto and copy and paste it into the Links option. Upload the remaining task requirements using the Attachments option.

## J.  Acknowledge sources, using in-text citations and references, for content that is quoted, paraphrased, or summarized.

# Works Cited

Błażej Osiński, K. B. (2018, July 5). *What is reinforcement learning? The complete guide*. Retrieved from deepsense.ai: https://deepsense.ai/what-is-reinforcement-learning-the-complete-guide/