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C951 Introduction to Artificial Intelligence, Task 2.

Introduction.

As of August 18th, 2023, Western Governors University presents the introduction to a performance assessment as the following:

“Real-time search-and-rescue robots are increasingly used to supplement the efforts of the first responders in areas affected by natural disasters. They are used to spot-check the situational awareness of people in distress, survey the extent of flood or tornado damage, evaluate the number of people that had not been evacuated from their neighborhoods, clean debris, and create passable routes.

For this task, you will use the Coppelia Robotics virtual robot and its environment to demonstrate how such robots may be used in disaster recovery. Your first step is to familiarize yourself with this technology by reviewing the information in the “Coppelia Robotics Resources Page” and “CoppeliaSim User Manual” provided in the Web Links section.

For the next step, you will thoroughly describe a disaster situation similar to the ones mentioned above. Next, you will create a virtual prototype of an autonomous robotic recovery system that demonstrates goal-seeking behaviors in navigating through a predefined area. The robotic recovery system will solve a disaster recovery problem of your choice by using the Coppelia Robotics BubbleRob and its environment as the starting point of your prototyping. You will also add sensors to the robot. These sensors will collect vital information to aid in the disaster recovery effort for the scenario you described.” (WGU, *NIP2 — NIP2 TASK 2: DISASTER RELIEF ROBOT*).

A. Disaster Environment.

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

The environment consists of an area, trapped inside of a fire. Walls of fire in the simulation are seen by the red, orange, and yellow cylinders representing a fire. The fire surrounds an individual that needs rescuing [1]. Separate from this fire, a separated fire is within the environment. This fire is next to a tree yet to catch aflame [2].

1 – Obstacle in the environment, a fire needing navigation.

2 – Obstacle in the environment, limiting navigation to rescue.

B. Improved Disaster Recovery.

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, ‘BubbleRob’, is designed with three navigation sensors to make pinpoint adjustments should the robot come close to the fire. As BubbleRob navigates a fire without coming in contact with the fire, the adjustments described will lead the robot to any potential humans with a different infrared radiation than the fire it is avoiding; The robot, by use of a vision sensor, will compare color values from fire to human to detect if a human is nearby, currently unreachable yet locatable. Should a human color scheme (infrared) be discovered in the fire, the robot will then be designed after proper consulting to notify the team that deployed BubbleRob. Professional action from the deployment team would then occur post-notification from the robot. The robot improves disaster recovery by providing an understanding of the risks of the fire not yet navigated. Then should the robot become destroyed performing a full search, it is better for a robot’s life to be lost knowing no human life is at risk than the opposite.

C. Architecture.

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.

'BubbleRob', a CoppeliaSim robot, comes with one sensor with clearance detection. The changes made to the robot in the simulation makes use of two more additional sensors. A sensor approximately 45 degrees left [1] and a sensor approximately 45 degrees right. The two sensors help the robot make finer adjustments to avoid the fire or other obstacles it may detect [2]. The original sensor is set in the middle of the robot, with a vision camera. The vision camera is now modified to stop simulation should the sensor detect a mix of RGB key values that are abstract to the RBG key values of the fire which it avoids [3].

1 – Additional sensor assisting robot path navigation, for obstacles in the left direction.

2 – Additional sensor assisting robot path navigation, for obstacles in the right direction.

3 – No longer a base vision sensor, sensor used for abstract color detection. (Infrared intent).

D. Internal Representation of the Environment.

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

The robot consists of three sensors, the two additional and the main sensor on BubbleRob. A vision sensor on the original sensor of the robot, continuously scans the environment while the three sensors make path adjustments to navigate through a fire. While the continuous vision scan occurs, a ‘human’ obstacle has been set to a different color value than the fire surrounding them. This be supported with the idea that human infrared can be detected separate from a fire’s infrared as seen with thermal imaging cameras (TIC) in modern fire combat efforts. Through the continuous vision scan, when a human obstacle is detected the robot, rather the simulation as of now, halts with a message via CoppeliaSim’s output window stating human infrared has been detected.

E. Reasoning, Knowledge Representation, Uncertainty, and Intelligence.

Explain how the robot implements reasoning, knowledge representation, uncertainty, and intelligence to achieve its goal.

Reasoning:

BubbleRob navigates an environment until it detects a ‘human’ infrared. The robot continuously navigates the fire with its sensors, adjusting by backing away from what the sensors detect as not a ‘human infrared.’ The robot’s reasoning stems solely from its one vision sensor and its three proximity sensors, that, if it has not detected what the logic looks for, then move forward and if it may not move forward, turn and attempt movement again; Conversely, if BubbleRob is moving forward or turning to move forward, it has not found what it seeks from its logic.

Knowledge Representation:

BubbleRob’s sensors collect what it “knows” and acts accordingly. The three proximity sensors detect all relevant (nearby) objects within their environment as it navigates the environment. The vision sensor collects the color values as knowledge and stops the simulation if what it knows compares to what calls for a stoppage, I.E., the values for ‘human’ object infrared detection.

Uncertainty:

BubbleRob only knows to continue until instructed not to. The robot navigates the environment, uncertain of what the environment consists of, as no two are identical. Once the vision sensor detects the ‘human’ object with the appropriate RGB value BubbleRob stops. BubbleRob, via the proximity sensors, will make navigation adjustments until meeting the criteria, stopping upon ‘human’ detection; BubbleRob navigates the uncertain environment and acts appropriately with its architecture.

Intelligence:

BubbleRob’s ability to make proper adjustments to navigate an environment while refusing to stop navigation until “instructed” otherwise makes the robot simple yet intelligent. The proximity sensors will direct the robot to conduct appropriately sized movements while keeping the robot safe. While doing so, the robot will compare values continuously and intelligently to stop navigating when appropriate.

F. Further Improvements.

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

Overall, BubbleRob could be improved by additional fire combat methods and by proper notification that a 'human' object infrared upon detection by SMS, GPS notification, etcetera. The improvements could involve mechanical improvements, sensor placement such as three-hundred-and-sixty-degree sensing, or the general shape of the robot.

Reinforced Learning:

Reinforced learning presents a means of training the robot based on success or failure and rewarding or punishing the robot based on the outcome. Reinforced learning then be used to reward the robot for detecting human infrared, going unpunished if no human infrared exists and no human is present. The robot's outcomes are then limited due to the limited design of the robot. A human infrared is present and detected, or no human infrared is present such that no human is present, or no human infrared is present with a human present. BubbleRob and its simplicity would benefit from the former of the three, and rewarding that detection would reinforce the method the robot used to repeat its action(s) for another successful location should a human be present within an environment. Only the latter is punished by mapping the "failure" and reinforcing the use of the previously rewarded action.

Advanced Search Algorithms:

Search-and-rescue robots are useful with advanced search algorithms. BubbleRob would improve with an advanced search algorithm as it scans the environment, making the most of its search by thoroughly searching the environment for all human presence regardless of the position of the human then BubbleRob becomes more efficient in its search.

G. Robot Code.

Submit the code you created.

The simulation is in the submission as:

- ‘C195 Anthony Coots Task 2.ttt’.

H. Panopto Recording.

Provide a Panopto video recording that describes the robot and demonstrates its functionalities to stakeholders who are nonpractitioners.

Please see the following:

https://wgu.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=7d7b7fd0-aaf6-4c91-9a68-b06301399e9c

I. Sources.

Western Governors University. (n.d.). *NIP2 — NIP2 TASK 2: DISASTER RELIEF ROBOT*. WGU Performance Assessment. https://tasks.wgu.edu/student/010958511/course/24060007/task/2894/overview

J. Professional Communication.

Thank you for your time. All questions/comments/concerns are best posted through the evaluation, otherwise:

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