**C951 Task 2: Disaster Relief Robot**

**Sochandaling Teng #010309126**

1. **Disaster Environment**

The disaster environment is a building floor that is on fire. During the fire, there are obstacles for rescuers to stop the fire and rescue people trapped inside the area. In the layout of the environment, there are four cuboids representing the walls of the building’s structure which prevent the robot from exiting the enclosed space. The mission of the robot is to maneuver the area to detect and distinguish between humans to rescue and hazards to avoid. The cylinder represents the human trapped inside the building. The robot is equipped with a special sensor to detect the human and notify the rescuers through the console window when the sensor is tripped. The two cones represent the hazards to avoid including flame and electric spark. To detect those hazards, the robot is equipped with additional sensors to send an alert of the obstacle it is facing to the console window and to make a turn when the path is blocked by those obstacles.

1. **Improved Disaster Recovery**

The disaster environment is very unpredictable and dangerous for the survivors and the rescue teams. By deploying the robot in disaster recovery, it can assess the situation in real time and aid in search-and-rescue operations without putting first responders at risk. The robot is equipped with advanced sensors to navigate through complex danger zones to locate humans trapped in the fire and detect any obstacles. The robot can provide real-time data to assess the extent of the damage and map the surroundings to let the rescue teams know about any potential risks or danger zones to avoid. Moreover, the robot can search for survivors and communicate with the rescue teams through its camera and sensors, so the rescue teams can plan accordingly and rescue the survivors in time. The robot also mitigates risks for the rescue teams to ensure their safety by assisting in dangerous tasks such as detecting flame and electric spark which might be too dangerous for the rescue teams to operate. Deploying the robot in disaster recovery provides more effective recovery efforts and more support to the first responders in saving lives and responding to dynamic environments.

1. **Architecture**

To be applicable to the disaster recovery environment, the bubbleRob tutorial model was used and expanded beyond its existing tool. Additional two sensors were added on top of its built-in sensor to detect humans and hazards (flame and electric spark). The built-in sensor is to help the robot avoid any object by making a turn to keep itself safe. The blue sensor acts as a human detector and changes its color to green with the presence of a human (blue cylinder), and the red sensor acts as a hazard detector and changes its color to green with the presence of a hazard (red cone). These sensors will help the robot in detecting humans or hazards and improve the robot’s capability to navigate the environment. By expanding its tool, the robot can perform better which makes disaster recovery more effective and efficient.

1. **Internal Representation of the Environment**

The robot maintains its internal representation of the environment through information collected by its sensors. The sensors collect data about the environment which navigates the robot to make decisions and adjust to the surroundings. The robot moves forward in a straight path until it encounters an obstacle in its way, then it backs up and makes a turn until the path is clear to continue. The add-on sensors allow the robot to gain knowledge of whether it detects humans or hazards by changing the color of the sensors and relaying the message through the console window. The sensors also provide traces of the robot’s movement and distances to objects which allow the robot to navigate more effectively and find a better path for the disaster recovery efforts.

1. **Reasoning, Knowledge Representation, Uncertainty, and Intelligence**

***Reasoning:*** The robot makes decisions by processing information collected whether it detects humans or hazards in the environment. If the robot detects a hazard, the red sensor will change to green and the robot will back up to steer away from the object at a slower pace until the path is clear. If the robot detects a human, the blue sensor will change to green and the robot will relay a message to the console window that a survivor is found.

***Knowledge Representation:*** The robot collects information about the environment through its sensors to detect and distinguish between humans and hazards. The blue sensor detects humans within its proximity while the red sensor detects all obstacles (flame and electric spark) the robot is facing. Plus, its built-in sensor detects all objects in the environment which allows the robot to behave and interact differently with each type of object.

***Uncertainty:*** The robot can adapt to the unknown environment using its sensors to respond to any events and uncertainties. With all of its sensors, the robot will continuously move forward the path until it detects humans or hazards and make a turn until the path is clear. Although the environment is unknown and the information is incomplete, the robot can adjust smoothly to its surroundings with the adaptability of its sensors.

***Intelligence:*** The robot can achieve its goal with its ability to perform tasks and adapt to an unknown environment. The robot can process the information collected to adjust its pathing, either to move forward to search for survivors or back up when encountering obstacles. The sensors will keep the robot safe from danger zones and help the robot distinguish between humans and hazards to relay the message to the console window. With such ability and knowledge, the robot can perform better to achieve more effective and efficient disaster recovery.

1. **Further Improvements**

The prototype of the robot can be further improved to increase its effectiveness in enhancing its performance, learning and capability in the real disaster recovery environment by incorporating the following AI tools.

***Reinforced learning:*** The robot will make decisions by learning its optimal behavior based on its interactions with the environment and its responses to any events (Synopsys, n.d.). Rewarding the robot for detecting humans or penalizing the robot for encountering obstacles will train the robot how to react in certain situations. This will make the robot more adaptive in an unknown environment by learning the consequences of its behaviors to maximize the reward so that the robot can navigate more effectively to complete its mission and achieve its goal.

***Advanced search algorithms:*** The robot will ensure that all humans are saved timely and all hazards are detected in order to increase the effectiveness of the disaster recovery mission. In the scenario, the robot must search for all survivors to rescue them timely. Hence, Dijkstra’s algorithm can be implemented to optimize the robot by finding the shortest path to reach the survivor and continuing until all survivors are detected (Alfariz, 2023). Furthermore, due to the scalability and flexibility of the algorithm, the robot may adapt incrementally and perfectly to an unknown environment such as new obstacles or uncertain situations (Alfariz, 2023). This will increase the effectiveness of the robot to complete its mission in the dynamic disaster recovery environment.

1. **Robot Code**

The robot code (.txt) and the robot scene (.ttt) files are attached and submitted along with this document.

1. **Panopto Recording**

The Panopto video recording link below is uploaded and submitted along with this document. The recording demonstrates the robot and its functionalities including the diaster, the problem, the environment, the obstacles, the robot’s mission and goal, the robot’s design and capabilities, how the robot completes its mission, and how the robot can be improved.

<https://wgu.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=bdd8d67f-1529-4f6f-a593-b0f3006c49f2>

1. **Sources**

Alfariz, M. F. (June 11, 2023). Autonomous Robotics Algorithm Path Planning Dijkstra’s With Python. Retrieved from <https://medium.com/@alfarizmfauzan/autonomous-robotics-algorithm-path-planning-djikstra-with-python-7da8c0f80aee>

Synopsys. (n.d.). What is Reinforcement Learning?. Retrieved from <https://www.synopsys.com/ai/what-is-reinforcement-learning.html#1>