Search and Rescue Robot

Our proposal is a search and rescue robot, the robot's job is to explore a known map in an efficient manner returning the victim's positions to human responders, while avoiding unknown obstacles. This idea is interesting and useful because, in wake of disasters, known and mapped areas often become dangerous for humans and new obstacles appear, e.g. rubble. The robot we will use is a Pioneer 3-DX, equipped with a camera, however this may change. The robot will consist of four independent main modules with one group member assigned to each. The four modules are as follows: path planning, obstacle avoidance, victim detection, and localisation. The text below discusses an idea of how each will be implemented.

Path Planning (Patrick):

The path planning module will be given a known map of the search area as an input, i.e. the map boundaries and any known obstacles (we will be assuming a flat terrain). The module will generate a coverage tree, to ensure all areas are visited, and an A* algorithm will define how to reach each area after considering known obstacles. It will output the robot's current waypoint.

Obstacle Avoidance (Junlin):

The obstacle avoidance module will use an artificial potential field (APF) algorithm. It will take the robot's current waypoint and generate an attraction vector, it will then use its sensors to detect nearby obstacles and produce repulsion vectors. These vectors will be combined to produce the robot's new velocity.

Victim Detection (Hana):

When the robot reaches a new predefined area, it will rotate and search for victims using its camera. It will be implemented through colour-based computer vision techniques as the victims will be defined as a static red square in our simulation. It will store the locations of the victims using the robot's current position and rotation and depth calculations.

Localisation (Maureen):

We will implement a Monte Carlo localisation algorithm for localisation. This module will output an estimate of the robot's position that will be passed into the three other modules (for building and testing we will use the robot's actual position).

Existing work:

Our implementation of each module is based on well-established techniques: A*, APF, Monte Carlo localisation, and colour-based computer vision techniques. Our contribution will be to combine these techniques into a real-time system for complete map coverage and victim detection, in our simulated environment.

Hypothesis and Experiments:

We hypothesize that the final robot will efficiently cover the entire map, detect all victims, and navigate around unknown obstacles, so that it may be helpful in search and rescue missions. To test this, we will place our robot in a variety of simulated environments with a variety of obstacles in each environment and then evaluate how successfully the robot traverses these environments and locates the victims.