**CpE 412 Mobile Robotics**

**Fall 2019 Final Project Pre-Proposal**

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**Technical Discussion**

**Introduction and objective**

The overall project will be developing a fully autonomous robot that explores an area without colliding with obstacles or other robots that will perform simultaneously. The performance will be held in AER 222 with many obstacles and will be competing with other robots and determine the most efficient robot when it comes to avoid obstacles and explore the area.

This project will enhance one’s knowledge and skills obtained from class by applying it into the practical robotics problem. It will also develop one to write technical documents and gain experiences to adapt in group environment.

**Literature review of relevant articles**

*Obstacle Avoidance for Autonomous Mobile Based on Position Prediction Using Fuzzy Inference* presents methods of using potential membership function(PMF), taking into consideration of the velocity of the obstacle relative to the robot. The proposed PMF for an obstacle and PMF for a goal are unified by fuzzy inference. The article gives specific experiment of this method and another case without using PMF and prove using this method enhances the ability of avoiding the moving obstacle [1].

*Control Strategies for Mobile Robot with Obstacle Avoidance* uses path planning method by vector field histogram. It first generates2D histogram around the robot that represents the obstacles and is keep updated from the sensors. Then the 2D histogram is converted into 1D histogram which calculates steering angle and velocity in that direction. It also notes that the calculation may be accurate, but this method consumes more resources like memory, processor, and power compared to other methods [2].

*Real-Time Obstacle Avoidance for Fast Mobile Robots* by Johann Borenstein and Yorem Koren approached avoiding collision using virtual force field (VFF) method which follows certainty grid for representation of sensory data about obstacles. A field of virtual attractive and repulsive forces determines the direction and speed of the robot and These two decides whether robot to respond to obstacles or ignore it [3].

Research article by Tesfaye Wakessa Gussu and Chyi-Yeu Lin developed geometry-based approach to obstacle avoidance of tri-omnidirectional wheeled mobile robot. This method polls sensor values from ultrasonic sensor. Motions triggering signal were obtained by this sensor and autonomously avoid obstacles. The advantage of this method is its cost by eliminating the need for taking multiple sensor [4].

*Obstacle Avoidance Method for a Mobile Robot* presents a computer-based solution methodology of path planning problems involving obstacles. This communicates with the barrier and the robot and designs new path by interacting with them. The software that was developed by the author was based on the vector field histogram by Borestein. The overall disadvantage of this method was accuracy and approximation to speed, so it is not suitable for high severity-oriented situation due to collision but is suitable for applying minor adjustments [5].

*A study on Artificial Potential Fields* by Kadir Firat Uyanik explains artificial potential fields. Artificial potential fields method is fining a function that represents the energy of the system and generating force on the robot minimizing the energy of the system and reach the minimum v alue at the goal position. Moving to the goal position is transition from a high-value state to low-value state following the downhill path. The article organizes the mathematical background of potential functions and experimental results [6].

*Global Path Planning Using Artificial Potential Fields* describes a path planning technique using artificial potential fields with decreasing the possibility of robot being trapped. It is accomplished by establishing a trial path and modifying the entire path under the influence of the potential fields. The advantage of using this method is relatively fast speed and effective solution [7].

*Obstacle Avoidance for mobile Robot using Artificial Potential Field* approach with Simulated Annealing pins out artificial potential field method is simple and effective, however, can trap robot in its position before reaching the goal. This paper discusses about escaping local minima by integrating simulated annealing and artificial potential field approach to mobile robot. It suggests modifying the original algorithm by letting the temperature decrease to zero with the term simulated annealing and obtain new solution every step and choose it as the current solution [8].

*Moving Obstacle Detection From a Navigating Robot* estimates the relative motion of the object with respect to the robot in order to detects unexpected moving obstacles. Using vision-based algorithm that uses the vanishing points of the segments provides accurate estimate of the robot orientation to maintain the motion of the robot along with the path. Relative motion information of the obstacle can be computed by obstacle and robot from the radial component of the optical flow to reduce uncertainties [9].

*An Omnidirectional Vision-Based Moving Obstacle Detection* in Mobile Robot presents new moving obstacle detection method using an optical flow in mobile robot with omnidirectional camera, which both calculate omnidirectional image and invests panoramic images. Authors used focus of expansion and focus of contraction vectors defined from the estimated flow as a reference vectors to detect moving objects. The paper describes FOE, and FOC vectors extracted from linear velocities of the robot can be calculated from the motor encoder [10].

**Proposed technical approach**

The robot will poll data from sensor to look for obstacles and map according to its data. When there are more than 3 objects less than a meter distance, it will pause and obtain the sensor data after certain amount of time to check if the object is cleared.

The primary preference for the robot movement will be east, north, south and west in order. Having a vector that stores if the robot already traveled the spot so it can avoid the loop that it keeps travel the same position. If the robot has already traveled the spot, it will add 1 to the vector it created and add 100 when it detects obstacles. The robot will check east, north, south, and west in order to seek for empty space in this case, however, if the vector is already filled it will pause and check the directions again to poll the sensor and move to the position which is not filled or have the least amount of number. This will prevent traveling the same routes and identify the moving and stationery object as well with the frequent polling.

**Related past experience**

I have done the maze solving mouse with the similar method described as above. The station was fixed so it had a fixed map vector and whenever the mouse encountered wall the vector value was updated to a big number to represent wall. It also filled the vector space where it traveled and only traveled to the vector that had the least amount of number to avoid getting into infinite loop.

**References**

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