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Final Project Proposal

This project proposal for Acme Robotics will consist of an R&D project in the field of swarm robotics. The aim of the project will be to develop a module that will allow multiple robots to ‘chase’ another object moving in an unknown and unpredictable manner. Each robot in the swarm should have a unique role, and their collective actions should take advantage of the nature of chasing as a group. A path planning algorithm will be implemented in order to allow the robots to track down and surround the object. This project has many potential applications. An automated fleet of police cars could more effectively chase down a fleeing criminal. Video games that involve dealing with swarms such as Pacman or Call of Duty: Black Ops could make use of the project for path-planning of the ‘enemy’ characters. The planned prototype for this project will be a simulation in which the user controls an object through an obstacle course while a swarm of robots implementing the designed algorithm will attempt to chase the object down. The planned visuals for this simulation should mimic the proposed ‘police chase’ implementation. This simulation should demonstrate the performance of the algorithm to the users as they attempt to flee from the swarm.

The team for this R&D project will consist of Sanchit Kedia, Tanmay Haldankar, and Qamar Syed. This team will implement the Agile methodology for development and test-driven development. Agile development for this project will consist of three week-long sprints. At the beginning of each of these sprints, an iteration meeting will be held in order to determine tasks, assign responsibilities, and estimate needed time for the iteration. During the iteration, daily work is expected along with daily commits and builds. In terms of roles for this project, each task will consist of two pair programmers and a design keeper. The pair programmers will employ the typical driver and navigator roles, while the design keeper will also monitor and ensure that the development is following the outlined design and diagrams. Development will be test-driven, meaning that tests for classes and functions will be developed first, and the classes and functions will be made to pass these tests.

The project will make extensive use of ROS and ROS2. A bridge will be used to allow nodes from either to connect with each other. The output will be a ROS package with a launch file to run the entire simulation. The simulations themselves will use Gazebo, a ROS simulation tool. The swarm robots will communicate with each other as ROS nodes as well. The project will be coded in C++ and primarily make use of the standard library and Boost for data structures and potentially multi-threading. The project will be hosted on GitHub and implement continuous integration. The build system will be done by Colcon which makes use of Cmake. This project will use the MIT license for open source projects.

The design for this project will initially be done using UML diagrams, both for classes and program flow. Although subject to change, the planned algorithm will work as follows. One node will continuously output the current location of the target object. The other nodes, the individual robots in the swarm, will take this value to plan their path. Each robot will attempt to reach a certain distance offset from the target at a certain angle. A heuristic will be employed to discourage robots from following similar paths as well. After reaching within a certain distance from the target, the robot will attempt to directly approach the target. The specific path planning algorithm is required to act in real-time; typically variations of the RRT algorithm are used to fulfill this requirement.

The main unknowns for this project are the implementation of both ROS and ROS 2 in one project and effectively implementing multiple real-time path planning algorithms with limited computational power as there will be at least 20 robots at one time. The codename for this project will be ‘Pacman’. Below is a basic diagram of the initially planned class structure for this project.