Autonomous Methods in the Application of Simple Swarm Capabilities

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Autonomous Methods in the Application of Simple Swarm Capabilities

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**Introduction**

Swarm technology is a relatively new aspect to the drone industry. It involves multiple drones being able to communicate with each other and relay this back to the user. From this standpoint one operator can control all of them at once while only giving directions to one or more. This involves the use of different autonomous algorithms, similar to autopilot where programs fly the plane, that relay to one another on what adjustments to make or where to go. This idea is very useful in the idea of search and rescue operations where it might be too dangerous to insert a human. Also in operations that might involve the gathering of data from standpoints where we are less efficient than the robots.

**Objective**

The objective of this research is to find and implement two types of autonomous programs run in multiple Arduino controlled r/c cars. The first being a GPS inputted navigation system with collision avoidance (ColA). The GPS navigation is a system where the user inputs a set of coordinates into the program, the program runs, then the bot follows in the shortest path to that set of coordinates. The collision avoidance system is an algorithm that goes in place when an object is detected a certain distance from the car. Once detected the car will stop for a few seconds to see if the object moves. If the object doesn’t move it will reverse its direction at a certain angle then proceed forward until there is no object blocking the path. The second bot being a follow behind the user function with ColA. The follow behind function is one bot that keeps a certain distance from the leader and maintains that distance throughout the entirety of the program.

**Method**

When trying to decide the method of transmitting and receiving data there were three options that stood out: Wi-Fi, hobby RC, and Bluetooth. With each they had their positives and negatives, but overall the best signal for the swarm was Wi-Fi. The biggest reason being the ability to control multiple devices, the range, and the server. From this all of the drones will have Wi-Fi units and connect through a server that will have the ability to control each and every drone through one server on the computer.

**Concept**

The idea has changed over time but the final concept is to have the control server with Wi-Fi linked drones. It starts by the server sending the drone leader a control signal (blue) with a GPS coordinated route. From there the drone goes through the route sending back sensor data (black) and also the coordinates of its location with obstacles (red). Once the data goes to the server it then bounces out the signal (red dash) to all of the other drones with different translations to follow the drone leader to cover more ground. Those drones then bounce back data from the different sensors being used and also the coordinates of the obstacles in the area (black).

In this figure it shows how the ground drones will go through an environment. As the drone leader at the top goes through the area it will be sending signals back to the server. Then the server will send out the leader’s path with the coordinates translated five meters in any direction depending on the drone receiving it. This way the drones can cover the most area possible.

**Design Process**

Given the complexity of aerial drones, the decision was made to use ground drones in the initial phase of the swarm. This process began by gutting out the circuitry in three remote control vehicles, leaving the motors, battery, and chassis. From there an Arduino Uno was placed inside each vehicle along with an Adafruit CC3000 Wi-Fi module, Arduino Ultrasonic Sensor, Parallax V1.2 Motor Shield, and battery pack to control the vehicle. Once the vehicle was completed then the process of building the server began. This stage has been the most complex part of the research and has not been completed yet.

**Future Work**

There is a great amount of work to be done in the future. This includes finishing up the server to make it user friendly and the coding for the drones. Then using the techniques found in the autonomous r/c cars and applying it to drones, which are much harder to control as opposed to ground vehicles, we will implement a similar type of swarm with multiple aerial vehicles in the future. Using this pack formation will be the precursor to swarm operations in data collection or search and rescue, also the possibility of aerial drone to ground drone swarm capabilities in the mapping of an area.

Other work might include:
- Implementation of cameras for image processing
- Robotic control arms for sampling of an area
- Defensive algorithms
- Aquatic drones

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**Outcomes**

Due to the small timeframe in which the grant was received and the symposium was held, only a small amount of this large research project was completed. The ground drones were completely wired together and the initial testing of the Wi-Fi server has been completed in addition to the obstacle avoidance system being implemented. The process of having the drone communicate with the Wi-Fi is underway and the swarm is slowly coming together through the construction of the server. Once completed the drones should be able to be accessed through a secure web browser and can be controlled by the user or autonomously. The leader drone will have the ability to be taken out of commission and the rest of the swarm will be able to make it to the destination with limited input from the user.