Swarm Intelligence, Distributed Control and Game Theory with Multiple Autonomous Robots

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This research project uses methods of multiple autonomous vehicle control with the lack of a centralize control structure. Dependencies on a master controller in master/slave system can cause major problems if that master device fails. Consequently the slave devices would be rendered useless. If we move away from a master/slave method we can create robots that for the most part only rely on themselves and not a centralize control device. This should allow for a robot to fail and the others to complete the overall task. Knowing that we wanted to use a non-centralized control, the next step was for us to find a task for multiple robots to accomplish. It was decided to use the robots to search a room and map out the obstacles. The mobility of the robot and the infrared sensors are all we need to complete this task.

Using the Evolution Robotics' ER1 robot, we are designing algorithms to work together to map out the obstacles in an area. As a group these robots will need work together to find every obstacle in an area. The algorithms will need to equally distribute the robots so that they may work as fast as they can to map an area. Optimization equations created with game theory will help create better more cost efficient robots.

Research into swarm intelligence and distributed control was done to derive a artificial intelligent method to complete the non-centralized control. Swarm Intelligence is a system with collective behaviors of naive agents that can interact with each other and their environment, causing coherent patterns to emerge. Using these patterns we can create the robots to mimic these patterns. Distributed control is a method of control in which the sub-tasks are scheduled into a robot and then robots will do more of a cost analysis approach to bid for the task they wish to complete.

Implementation of the distributed control was chosen because of its communication and ability to expand the robots. Game Theory would then be applied to help with the path generation of each robot. Cooperative Game Theory, similar to what John Nash developed and what is the basis for modern day economics, is what would need to optimize these robots. Richman's Cost Function for the Richman Game will allow us to "bid" for the movements and reward the robot with the best plan. The idea will be to only allow the least costly robots to make their moves so that the other robots will not interfere or collide with eachother.

The ultimate goal is to build social beings out of the robots. They will be able to interact with out a master device telling them what to do; similar to how humans or some insects work. This social interaction would be beneficial in many applications such automated automobiles, search and recovery, home environmental variables such as lighting and temperature. The benefits to creating socialized beings are endless.