A Centralized Associative Behavioral Robotic System

Rolando Panez rpanez@mil.ufl.edu
Max Makeev max@mil.ufl.edu
A. Antonio Arroyo arroyo@mil.ufl.edu
Eric Schwartz ems@mil.ufl.edu

Machine Intelligence Laboratory
University of Florida

Abstract

The implementation of swarm robotics is still in early stages. However, through associative behavior a simple form of swarm behavior can be implemented and used to accomplish certain tasks in a team effort. This paper discusses the idea of associative behavior, in terms of simplified swarm intelligence, between robots using the master/slave concept. This paper will give a brief history on swarm intelligence and how it correlates to centralized associative behavior. It will then describe the necessary system components to achieve this behavior.

1 Introduction

Associative behavior incorporates the idea of a master-slave system and swarm intelligence. The master/slave concept can be described as a system in which there is a centralized intelligence controlling all subsystems. Master/slave systems are useful to help distribute a workload. The system introduced in this paper focuses mainly on implementing this concept with robots.

The concept of swarm intelligence is best summarized as follows: Any attempt to design algorithms or distributed problem-solving devices inspired by the collective behavior of social insect colonies and other animal societies.[Bonabeau, Dorigo, and Theraulaz, 1999][3]. Current efforts in swarm robotics focus minimal robots that collaborate into a larger and more able robot. An example of this is the Swarm-Bot[1]. The Swarm-Bot is composed of many smaller robots called s-bots. The research of Swarm-Bot displays results of the s-bots moving together in formations to accomplish various tasks. The system discussed in this paper will use this idea of swarm robotics to organize the slave robots as they follow the master robot. However, unlike swarm robotics, the smaller robots will not required direct communication with the other small robots.

2 System Description

A centralized associative behavioral robotic system will use the ideas of swarm intelligence combined with master/slave concept. This system consists of a single master robot and multiple slave robots. This configuration is best described as in figure 1. The slave robots incorporate a swarm behavior to stay within a relatively close proximity of the master robot. The only communication necessary will be between the master robot and each individual slave robot.

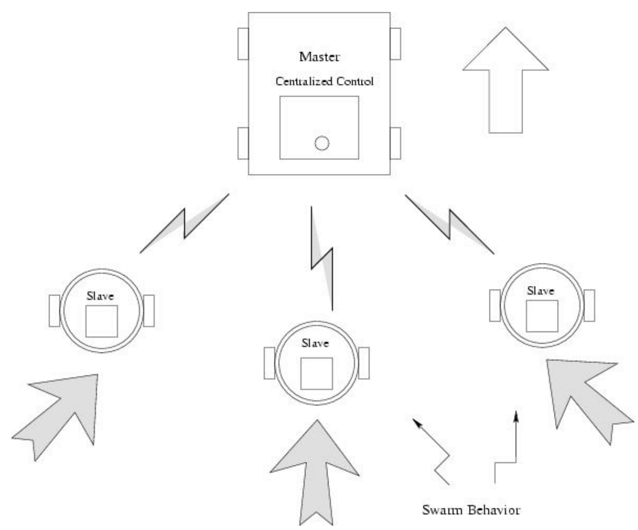

Figure 1: System Overview

2.1 Master Robotic Unit

The master unit must be designed to control the entire system. This component of the system should communicate with the other components, mainly the slave units, to help identify their location relative to the master robot. This unit is the only unit which must be programmed with the desired task. The slave robotic units will depend on the master unit to avoid "getting lost".

2.2 Slave Robotic Unit

The slave units work in a cooperative effort to accomplish a particular task. Each of the slave units are completely unaware of the global environment and are only concerned with localized objectives. The slave units have no control over any other part of the system; they merely work under the control of the Master unit. In respect to swarm behavior, the slave will follow the master in a flock. However, further research will have the slaves adjust in patterns depending on the task. For this, communication between slave robots may be necessary.

3 Application theory

This system is most efficient in applications where the goal is to maximize the coverage area; some possible applications for this system are lawn mowing and mine sweeping.

Lawn mowing can be accomplished as follows: the master unit will lead the pack of slave units. The master unit will be equipped with vision in order to differentiate between cut and uncut grass; also if the master unit sees an ant hill it can tell a slave unit to dump ant killer on top of the ant hill. The slave units will follow the master unit trimming a path as they go.

A mine hunting swarm can cover a large field with great precision. If a slave unit finds a mine, he will relay the information back to the master unit. The master unit will process the information and tell the slave unit to mark the territory of detonate the mine.

4 Current Work

Based on the description above, different ideas have been considered. The task of each slave robot realizing its location relative to the master robot is the most difficult. To achieve this, the use of sonar sensors paired with RF communication will be used. The RF communication will allow for real time synchronization of the system clock amongst all components. Based on this synchronized clock, the time of flight of sonar can be measured from the master robot the slave robots.

5 Conclusion

The system presented in this paper can prove to be useful in certain applications as described above. Once a base system is in place, slave robots can be added to increase efficiency. The goal of this system is to create an inexpensive form of swarm robotics. The advantage of swarm robotics is having multiple low cost robots that can accomplish a given task.

6 References

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