+10 Swarming Robot of Doom, a Working Title

Alex Weinert
Swarm Bot
EEL 5666
2008 Jan 31
Dr. Schwartz
Dr. Arroyo
Adam Barnett
Mike Pridgen
Sara Keen

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Abstract

Executive Summary

Introduction

Integrated System

The robot as designed is to be a cheap robust robotic platform. It is designed around 2 PCBs, a microcontroller board and a sensor board. The general design is box shaped with a track drive powered by 2 servos. The bottom of the robot houses the servos and batteries. The mid level contains the PCB with the microcontroller, and servo drivers, and power regulation. The top of the robot houses the sensor board with the magnetic field sensor (compass), a CdS cell, and IR range finders. There is also a solar panel on top that can recharge the batteries.

This design is intended to be cheap and easy to build, with the final robot having wires to only the batteries, servos, solar panel, CdS cell, and between the PCBs.

The software will be used to keep the robot following 2 basic behaviors: keeping withing a certain distance of nearby robots, and orienting itself to nearby robots.

Mobile Platform

The platform is designed to be as simple as possible. Each robot is designed to be as small and as light as is practical, so the platform doesn't have to withstand much force. The intended environment is indoors or clean concrete. The prototype platform will be made with wood cut with the T-Tech, however it would be nice if the final design was made using the rapid prototyper.

Actuation

The only actuation on the robot will be 2 servos driving a tracked drive. This system is designed to be simple and cheap. The 2 rear wheels will be be attached directly to the servos' axles. The two front wheel will spin freely, attached by and axle though the body of the robot. The front and rear wheels will be attached using some sort of “tank track”. Due to the small size of the robot and the terrain which it will travel on, all that this needs to be is something like a thick rubber band.

Also thanks to the small size, it can be driven by smaller servos. The servos will be controlled directly from the microcontroller board I am designing. A separate power regulator will be used to provide the power to the servos to keep the power demands of the servo separate from the logic circuitry.

Sensors

The robot is using four types of sensors: IR range finding, bump, CdS, and magnetic field. All the sensors are integrated on a single PCB. It will also use a wireless serial chip to transmit orientation information.

To keep costs of each robot down, the IR range finders are a 40Khz clock signal from a 555 or crystal, output to an IR led, and read by a hacked sharp IR receiver. This produces an analog signal which the microcontroller reads and converts to a distance.

The bump sensor is simple and is on the front of the robot to detect a collision with another object and shut down/reverse the motors in case the IR range finders miss the object or the behavioral algorithm decides to do haywire.

A CdS cell is simple, and will go through a logarithmic op-amp to increase the dynamic range.

The magnetic sensor is used to find the orientation of the robot relative to the local magnetic field. The sensor I will most likely use outputs a digital signal and gives the x and y component of the magenetic field. The microcontroller will convert this signal to radial units where North is 0. Inside, it is very likely that the magnetic field will not correspond to true magnetic North. However, as long as the field direction is relatively constant [+/- 15 degrees] over scales of about a meter it should be fine. The biggest worry will be interference from the servo.

The orientation will be broadcast over the wireless serial transmitter over a range of 1-3 feet. The robot will receive any orientations over the wireless receiver, and will orient itself based on a running average over a certain time period.

Behaviors

Each robot will have three primary behaviors. The first two are keeping avoiding any robots within a certain distance, and try to keep other robots within a certain distance, I.e., to keep nearby robots within a certain range. This is accomplished using 5 IR range finders.

The third behavior will be to orient itself to nearby robots by using the orientations received from nearby robots. This is accomplished using a running average of orientations received from nearby robots.

There are some secondary behaviors, mostly obstacle avoidance. For the most part the robot will stay away from all objects the IR sensors can "see". However, if the robot is boxed into a corner or hits something the IR doesn't detect, then the robot must change be able to get out of this situation.

The CdS cell will be used to modify the behavior of the robot. When a bright enough spot is found, the robot will change the parameters of it primary behavior.

Emergent Behaviors

The idea behind the robot is that multiple simple robots will interact and produce emergent behaviors. By adjusting the parameters of the primary behaviors, groups of robots will demonstrate behaviors such as swarming and flocking. If extra sensors are added, then goals such as resource finding and transport can be accomplished [like ants].

The specific emergent behavior these robots should demonstrate is flocking until a bright enough area is found. When this are is found they will swarm there. During these behaviors, the robots should be able to avoid predators and obstacles alike.

Conclusion

Documentation

Appendices