Tracking, Mating Wheeled Mobile Robots

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July 8, 2003

Table of Contents

Abstract

Executive Summary

Introduction

Integrated System

There are many examples of multi-agent autonomous robots. Among those are the wheeled mobile robots. This project consists of two wheeled mobile robots for tracking and mating of which there is one inspecting robot and one that needs to be maintained. The visionary plan for this system can be applied to a robot that requires regular maintenance checks. The service robot finds and pulls up to the other robot and makes a link through a hard-line serial port connection. The examining robot then uploads or downloads necessary information and then leaves or goes to inspect another robot.

After a brief look at the make up of the similarities, there are two major discussions involved in the detailed description of these two robots. The first will solely incorporate the robot to be analyzed and probed. Following this outline will be a comprehensive framework of the seeking robot.

Mobile Platform

The mobile platform is constructed mostly from 1/8" aluminum. The box that holds the LetATwork II development board and most of the electronics is constructed from lexan, a nonconductive material. The top of the vehicle is also made from lexan and holds the LEDs for position feedback and IR sensors for obstacle avoidance. The steering mechanism was taken from a Motor Works die-cast replica of baja racer.

Actuation

There are two motors for each robot. One motor is used to controlling the velocity of the robot. The differential gear box is made from a set of spur gears. This gear box is actuated with a DC motor from Pololu which can be seen in figure 1.

Figure 1. Pololu DC motor and Gearbox (item number 70093)

Because Ackerman steering is being used, a second motor is used to for directional control with an 81-MG Hitec servo motor from Servo City as seen in figure 2. This servo motor was chosen because of its small size and rather high torque.

Figure 2. Hitec servo motor (HS 81MG) used for steering

The wheels are also taken from the die-cast model and are JB welded to nuts and screwed to the axis.

Sensors

The main sensing unit in the system is the position feedback from the camera system developed by Phasespace.

Figure 3. Front view of the four cameras from Phasespace


Figure 4. The camera system setup in the SAMM lab

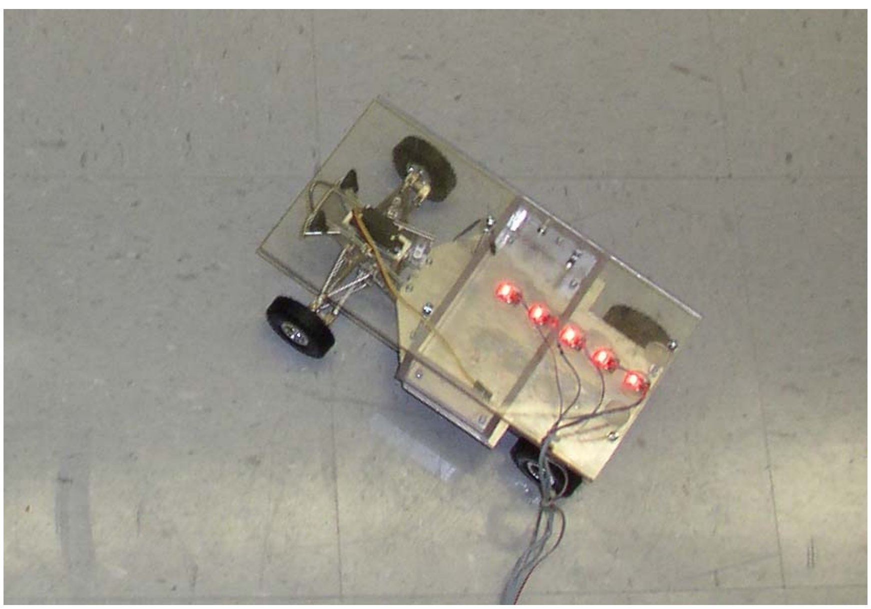


Figure 5. LEDs mounted on vehicle

Power

The power for the robots is provided by a 7.2 volts battery pack of NiMH.

Specified Differences

As discussed before, there are a few key differences in the manufacturing of these robots. One robot functions to find and mate with the second robot. Therefore, the first robot extends the connection while the second has incorporated a task of receiving the probe.

Stationary Robot to be Probed

The inspected robot is the member of multi-agent team that needs to be frequently examined. A port was designed for the serial connection with another robot. More importantly is the reception mechanism for the link.

For the simplest demonstration this robot does not need any actuators for driving or steering only for the reception device. In the most basic example there is a limit switch that lets this robot know that the first robot has docked.

Inspecting Robot

The assessing robot is given the task of trajectory planning through the feedback information from the Phasespace vision system. Since the feedback information is given in x, y, z coordinates some manipulation needs to be made to the data. By allowing the vehicle to react to the error signal, it pulls up to the rear of the stationary robot and slows to a stop. When distance between the robots is correct, it extends a mechanism used for the docking.

Behaviors

Command Reception

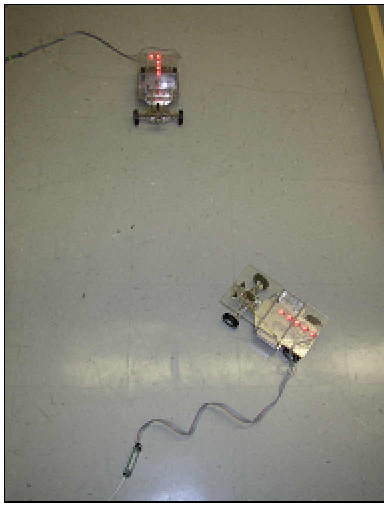
LCD display of communication

Obstacle Avoidance

Docking

Experimental Layout and Results

The first test was determine whether or not the positioning system was feeding back relatively acuate data. Figure 6 illustrates the results of this test. A tape measure was used to measure the distance between the robots and then compared with the data given by the positioning system. All of these units are in millimeters. The tape was only accurate to about a centimeter. As one can tell, the results are very accurate. This test was successful.



Sensor	Measured
206	210
478	480
772	770
1022	1020

Figure 6. Distance test for the positioning system

The second test was to check the quadrants to determine relative position between the robots. This second test proved successful as shown in figure 7. In quadrant one, X and Y are both positive. On the right side of the Y-axis the Xs are positive and negative on the other side. Above the X-axis the Ys are positive and negative below.

X = -350.5 Y = 280.3	X = 392.1 Y = 275.1
X = -331.8 Y = -271.6	X = 368.7 Y = -376.3

Figure 7. Relative position test for the positioning system

The third test was to check the relation between the robots. This task was difficult but proved very successful. The follower robot was positioned facing above and below the leader robot as seen in figure 8. The left picture of the follower robot facing down gives a positive angle. Facing the robot to the other side gives a negative reading.

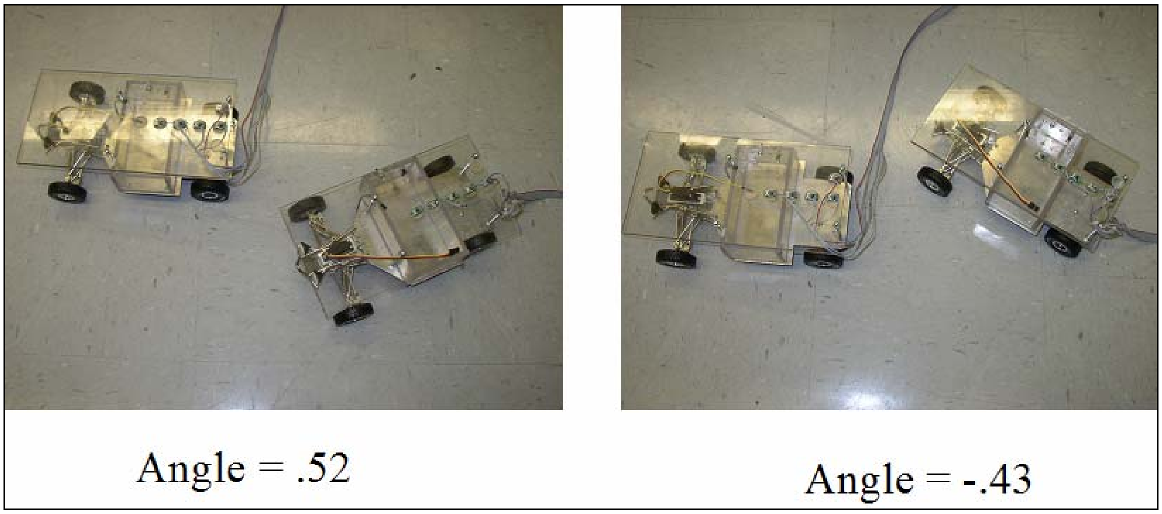


Figure 8. Relative orientation test for the positioning system.

Conclusions

Documentation

i. Lists and summary of relevant websites
ii. Datasheets

Appendices

i. Program Code for Robot 1
ii. Program Code for Robot 2