TOWARDS THE DEVELOPMENT AND IMPLEMENTATION OF A LIGHT WEIGHT MOBILE AUTONOMOUS ROBOT

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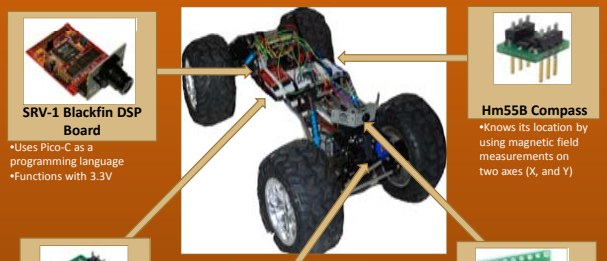
Abstract

The goal of our research project is to develop a lightweight autonomous agent that can be implemented in search and rescue, surveillance, and reconnaissance of hazardous areas. The reason for having a cost effective, light weight autonomous agent is to place multiple small robots (instead of one big one) in a dangerous environment (i.e. chemically hazardous areas) instead of risking human or k9 life. Our objective with these agents is to create a test bed for experiments with behavioral control. We wanted to transform a remote controlled car into an autonomous robot with obstacle avoidance and target seeking behavior. In normal remote control operation, the servos and drive motors receive a pulse width modulated signal from the transmitter that is used to control speed and servo position. These signals were measured and duplicated (removing the remote control reciever) using an autonomous control system implemented by a Blackfin digital signal processor. Using an embedded C interpreter in the DSP, programs were written and loaded into the DSP to implement the autonomous agent. For these agents to have obstacle avoidance, we used a sonar range finder and an algorithm that caused it to slowly move around the obstacle. We used a compass module for target seeking behavior. When initialized, the agent attempts to reach a predefined target. Upon sensing an obstacle, the agent moves around to eliminate the obstacle presence while continuing to move on the target.

Robot Components



SRV-1 Blackfin DSP Board
- Uses Pico-C as a programming language
- Functions with 3.3V

Hm55B Compass
- Knows its location by using magnetic field measurements on two axes (X, and Y)

H48C Tri-Axis Accelerometer
- Measures gravitational (g) force of ±3g on three axes (X, Y, and Z)
- Detects free-fall
- Uses MEMS (Micro Electro-Mechanical System) technology
- Capable to detect Static(Tilt) and Dynamic Acceleration

Servo
- Provides position control
- Converts a small mechanical motion into one requiring much greater power
- Uses pulse width modulation to change positions

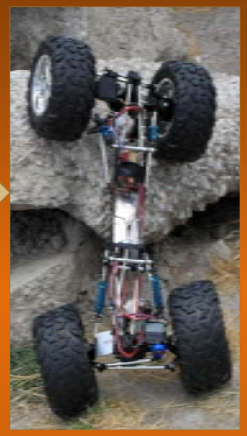
EZ3 Ultrasonic Sensor
- Emits ultrasonic waves and measures time taken for the echo to return
- More time it takes for the echo to return the further the distance is
- Outputs a pulse whose width corresponds to distance measured

Goal

Present

Search & Rescue Dog
- Takes years to train
- Can't enter high risk situations
- Comparatively few in number
- Very expensive

Future



Search and Rescue Agent
- Can be made on an assembly line
- Can be specialized for high risk situations
- Very inexpensive

DSP vs. Conventional Microprocessor

- Higher MIPS/Watt rating
- Processor speed (600 MHz vs. 20 MHz for basic stamp microcontroller)
- Can be made parallel using state-space equations to describe dynamic scenarios (i.e. movement)

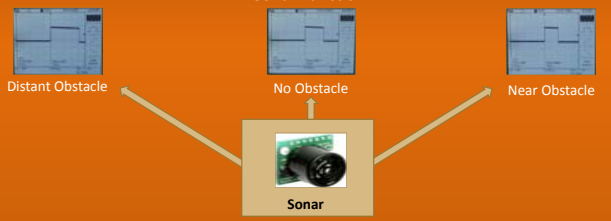
Future Work

- Implementation of autonomous agent via state space models (systems of non-linear differential equations).
- Improvement of object scaling/avoidance algorithm.
- Improvement of object/body position sensing.
- Realization of multi-agent sensing.
- Streamline agent body for movement regardless of "right-side up" orientation.

Results

Servo Function

Sonar Function



Obstacle Avoidance Program

```
while (1)
{
a=sonar(1);      Here we are initiating the sonar module. The SRV-1 board tells the sensor to sonicate and the output is fed into the SRV1 input as x.
delay(50);
if (x<20)        If the object is less than a certain distance:
{
servos(45,45);   Pass a PWM signal to the servos and motors corresponding to a center and stop.
delay(100);      Wait one hundred milliseconds and
servos(27,90);   Pass a PWM signal to the servos and motors corresponding to a turn left and reverse.
delay(500);
}
else
servos(55,45)    If there is no object in front, advance forward slowly.
}
```


Acknowledgements

This work is supported by Texas A&M University and the National Science Foundation.

The authors of this work also acknowledge Professor Karen Butler-Purry, Ph.D. candidate Fabian Marcel, and Graduate Students: Ian Horbaczewski, Brian Bellace for valuable assistance throughout the program.

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