University of Florida
Department of Electrical and Computer Engineering
EEL 5666
Intelligent Machines Design Laboratory

Small-Bot

Final Report

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Abstract

I will endeavor to construct a small four-wheel robot with the purpose of adding a three-axis accelerometer for navigating inclines. The behaviors that I will implement that will demonstrate this autonomy will be for the robot to switch back and fourth once it detects that it is on the incline. If time and money allow it, I will implement other behaviors to guide the direction of the robot autonomously.

Executive Summary

The platform that I chose to work on, with Dr. Arroyo's approval, was robot purchased from Diversified Electronics. To this platform, originally called Pocket-Bot, I would add my three-axis accelerometer. The Pocket-Bot platform already came with other sensors such as CdS cells and bump switches. These sensors send data to a Basic Stamp 2 (BS2) microcontroller. In addition to the BS2, I added a PIC16C711 to the platform for its A/D. This A/D would take information from the accelerometer and the PIC would send it serially to the BS2. Combined with the CdS cells and bump switches, my robot, now called Small-Bot, would detect inclines and then move up or down the incline in a sinusoidal motion while performing obstacle avoidance. These behaviors, however, had to be modified over the course of the project due to unforeseen difficulties in sensor and software integration.

Introduction

Originally I was going to try to build an autonomous helicopter that hovered. However, after doing much research, I found that this was not feasible both financially and time wise. But, I already had purchased the accelerometer from Digi-Key with the intent of using it on the helicopter. Since I could not continue with the helicopter idea, I decided that a small ground unit using the accelerometer would be appropriate. With Dr. Arroyo's approval, I purchased a small mobile robot kit of the web with the intent of adding to it the necessary hardware and software to complete my goal of having the bot search for, and navigate to, the nearest light source after detecting an impact.

Integrated System

The integrated system will consist of a Parallax BS2-IC microcontroller, a PIC16C711, and a ACH-04-08-05 Accelerometer. This control unit will then be mounted on the Small-Bot. A 9-volt battery will power the entire unit. The accelerometer will send analog data to one A/D pin in the PIC16C711 for impact detection along the Z-axis. Also, two other pins on the A/D will be interfaced with CdS cells for light detection. Then, the BS2-IC microcontroller will take the data from the PIC16C711 and control the robot accordingly. The BS2-IC microcontroller will also receive data directly from two bump sensors and three other CdS cells for obstacle avoidance and line following.
It should be noted that the speed of this platform is controlled via a potentiometer, not through software. This lack of control in software makes the calibration for the accelerometer difficult if not impossible.

Mobile Platform

The mobile platform is the small-bot itself (see Fig.1).

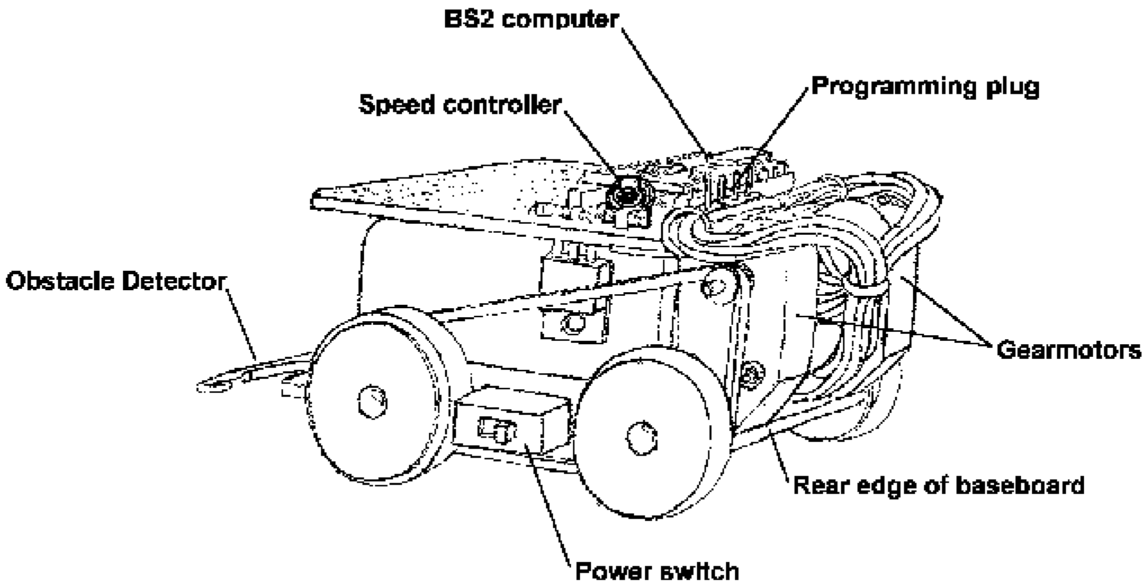


Fig. 1

What this figure does not show is the PIC16C711, which will be placed on the PCB in front of the BS2-IC microcontroller, and the accelerometer, which will be mounted above both the PIC and the BS2. Also, CdS cells will be mounted on the front and center of the PCB.

Actuation

Small-bot is made mobile through the use of gearboxes (see Fig. 1). A signal is sent from pins P0-P3 of the BS2 to a L293 motor driver which intern sends information to the gearbox encoders. The combinations of these signals allow the bot to move left, right, or straight given the proper output from the BS2. Speed, however, is controlled through a potentiometer which is interfaced with the L293 motor driver.

Sensors

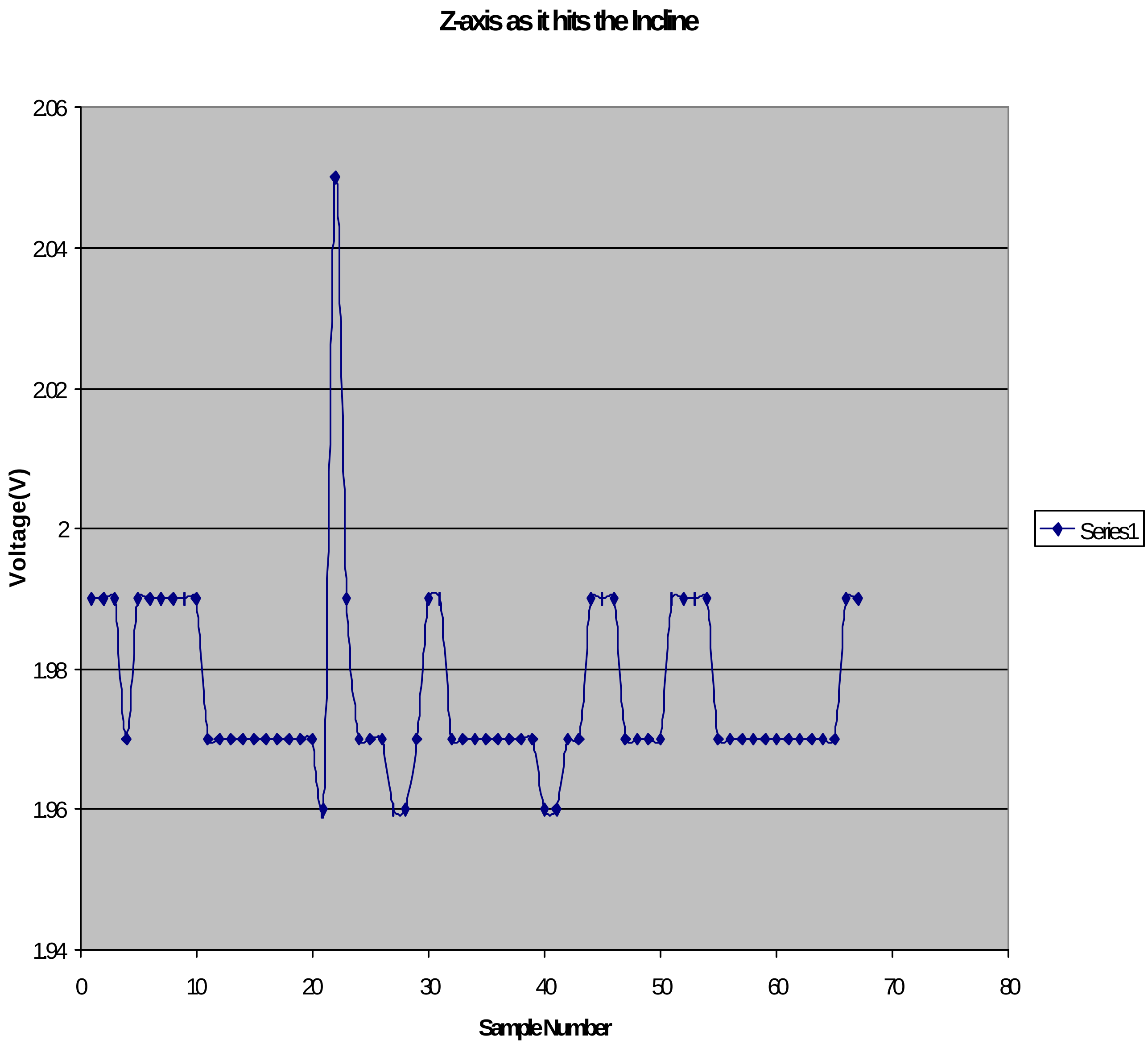
The sensor suite includes a three-axis accelerometer, five CdS cells, and two bump switches. The accelerometer has a maximum range of 35 g's. This sensor can only be used for high impact detection although the experimental data on this sensor suggests otherwise. There are two CdS cells mounted in the front. These sensors are used for line following. The remaining CdS cells are used for light detection. Finally, two bump switches are mounted in the front for obstacle avoidance.

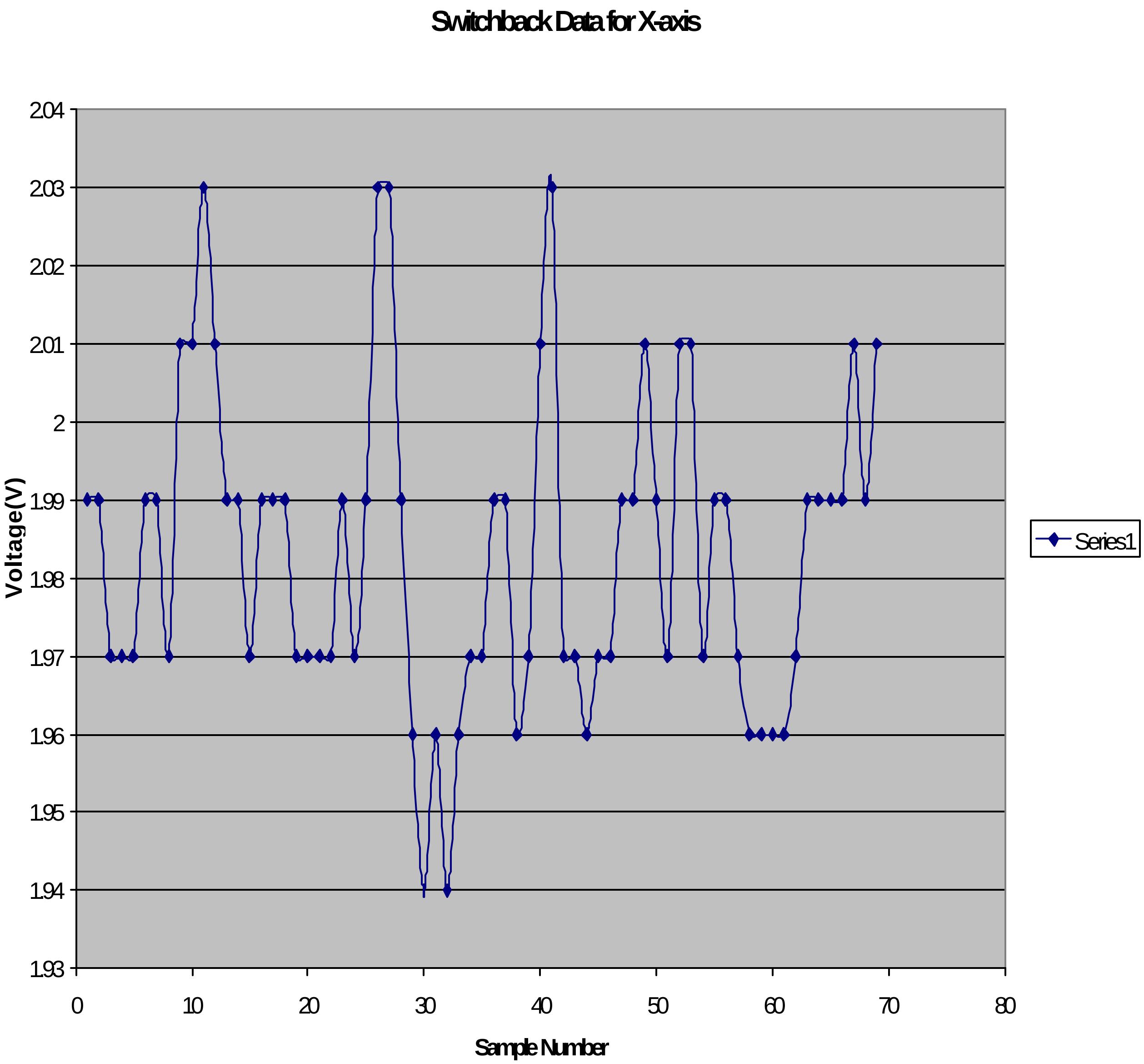
Behaviors

As simple as it may sound, Small-Bot will detect an impact . This, however, is not a trivial task because the accelerometer floats between a range of values. However, this difficulty is corrected in software. More specifically, two values are constantly updated so that a long-term average of ten values from the accelerometer is known as well as a short-term value consisting of the last two values received from the accelerometer. These two values allow Small-Bot to detect impact regardless of the current floating values from the accelerometer. Once the impact is detected, Small-Bot will seek out the most luminous light source and navigate towards it. In addition, if a light is not detected and a black line on the floor is, then Small-Bot will follow the black. Finally, both light and line following will have obstacle avoidance embedded in their respective routines.

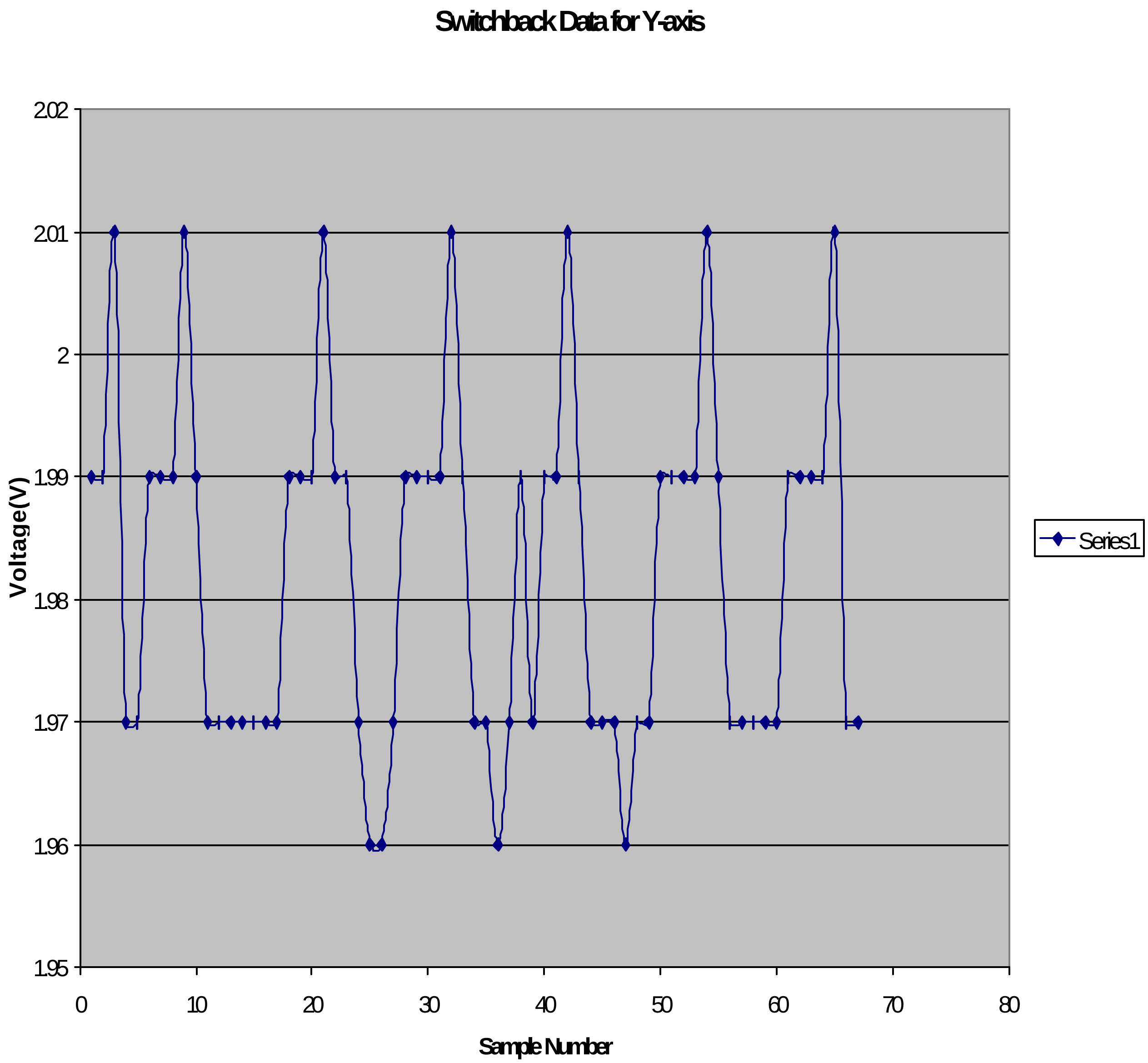
Experimental Layout and Results

Initially, Small-Bot was going to detect inclines with the aid of the Z-axis output from the accelerometer. An initial test was performed with the accelerometer mounted on a piece of plastic which was then moved by my hand in a “reasonable” motion. The following data was collected:


Z-axis as it hits the Incline
Voltage(V)
2.06
2.04
2.02
2
1.98
1.96
1.94
0
10
20
30
40
50
60
70
80
Sample Number
Series1



Switchback Data for X-axis
2.04
2.03
2.02
2.01
2
1.99
1.98
1.97
1.96
1.95
1.94
1.93
Voltage(V)
0
10
20
30
40
50
60
70
80
Sample Number
Series1



Similar data for the X, and Y-axis was gathered. This data suggests that Small-Bot should have been able to detect the incline and then go up it using a sinusoidal motion. However, this was not the case. This original behavior was changed to a behavior that searches for light after detecting high impacts. This behavior, however, has not been integrated with line-following and obstacle avoidance behaviors with any degree of success.

Conclusion

A larger platform would have facilitated the implementation of the accelerometer as well as other sensors. Also, an accelerometer with a maximum rating of 1g used in conjunction with a tilt sensor would have been better for incline detection. I could only get two behaviors to work at a time instead of the intended four behaviors working in unison. I think that I have done everything that Dr. Arroyo warned not to do during the course of this project. If I had to do it over again, I would not have used the Pocket-Bot platform. The size and price of this platform was a hindrance more than it was helpful. The only reason why I chose this platform was because my original idea of doing an autonomous helicopter had consumed over half the semester in research alone with the final realization that it was not a feasible endeavor. In the end, none of my original goals were achieved and compromises became commonplace. I just hope I've done enough to pass the course.

Documentation

Fred Martin, *The 6.270 Robot Builder's Guide* 2nd edition, MIT Media Lab, Cambridge, MA, 1992.

Pocket Bot Assembly Manual, Greg Kiskaden, Diversified Technologies, www.divent.com

Basic Stamp Programming Manual, Parallax Inc., www.parallax.com

IMDL class: Instruction from Dr. Arroyo, Dr. Schwartz, Rand Chandler, and Scott Nortman

IMDL Web Page: http://mil.ufl.edu/imdl/handouts.