EEL 5934
INTELLIGENT MACHINES DESIGN LABORATORY
"Faith" the Security Robot

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Abstract

Throughout this semester I planned to design a security robot, "Faith." Faith is a female robot that not only looks good, but will be effective in protecting the home. Faith's platform is designed to be beautiful and sturdy. Her motors, which are Servos, are reliable for the purpose of movement. Faith will incorporate some of the various security devices that are used in a home. She will have a variety of sensors, an IR detector, a smoke detector, and a receiver to help her accomplish her task of object avoidance, smoke detection, and intruder detection respectively. This task was to great to be accomplished in one semester. Therefore for the first stage in Faith's design I concentrated on the object avoidance, smoke detection, and alerting. These task were accomplished through the use of the IR detector, smoke detector, and CdS cells respectively. Faith is able to roam around a house and provide some security to its occupants. Eventually Faith will be able to not only detect, but also track any intruders thus becoming an all-in-one security device.

Executive Summary

At the beginning of this semester a task was created. That task was to create Faith, the quintessential security robot. Faith's purpose is to utilize all the security devices that would normally be used in a household. This task however was too much for one semester, therefore Faith will be created in stages. The first stage is to create the circuitry that will enable smoke detection and alerting.

Throughout the semester, I have laid the foundation for Faith. The first thing that was done was the memory expansion. After this, Faith's platform and motors were put together. Once the motors were working correctly, the sensors were added. The first sensor used was the Sharp IR detector. These sensors were used for object avoidance. If Faith is more than about 6 inches

from an object, she will turn away from that object and move in an opposite direction. Once the object avoidance algorithm was working correctly, the CdS cells and the smoke detector were added. The two sensors were used for line following and smoke detection respectively. Utilizing these sensors and writing code that will give the desired behaviors are the main goals. Once all of these goals are accomplished, Faith can move into stage two, intruder detection.

Introduction

In order to make homes safe, different devices are being built to detect various things. These devices can detect thing
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limitation is that most of these detectors are sold separately. Given the fact that robots are being built to accomplish many tasks these days, I decided to build a robot that will incorporate these detectors in a single unit.

"Faith" will be a security robot capable of obstacle avoidance, intruder detection, smoke detection, and line-following. Not only will she be designed for performance, but also beauty. Faith will consist of:

1) a platform designed to be sleek and attractive
2) servo motors to drive her wheels
3) an infrared emitter/receiver system to protect her from getting hurt

5) a smoke detector and

6) CdS photocells

All of the objective could not be accomplished in one semester. Faith will be designed in stages, the first stage taking place this semester. Throughout this semester, the smoke detection and line following features will be designed. These features will work together to increase Faith’s ability to detect fire and efficiently alert the residents in a house. Once the first stage is completed, I will work on my own to include intruder detection, and ultimately voice recognition.

"Pret

The main objective behind Faith's platform is beauty. The platform looks like a slice of bread, but it has enough space for the M68HC11 and any other devices that may be included. The sturdy plywood platform is painted teal, giving Faith a feminine, yet sophisticated look. Once cut, the edges were curved to add some beauty to the design.

Servo Motors

The purpose of the motors are for motion. Since Faith’s motion is like that of a car, motors were needed to drive the wheels. Servo motors were used for this purpose. The reasoning behind the servo motors were not only the availability, but also because they were known to efficiently handle the necessary

tasks. The motors were driven by the 293’ motor driver. Through coding Faith’s motors were able to go forward or backward.

Originally I had 1.5" wheels, but they were too small. Since the servo motors are not very fast, the size of the wheels will determine how fast the robot could go. The larger the wheels, the faster the robot can go. Since Faith is a security robot, she needs to have some speed. I replaced the 1.5" wheels with some that were 2 5/8".

The servo motor

Since the microprocessor will control the motors in the design, a hack was done to remove the circuit board. Once the circuit is removed, the servo operates like a regular motor, and the control line on the servo is no longer used. Since the motors are being used for the wheels, the way that it is placed will determine the motor direction. By reversing the polarity, one of the motors was able to go forward, and the other in reverse.

Sharp Infrared Sensor

The main use of the Sharp sensor is object detection. The sensor consists of an amplifier, a filter, a limiter, and a trigger to make the output a TTL signal. The sensor is modulated to pick up signals in the 40 kHz range. The sensor has an active low digital output. In order to utilize the A/D port on the M68HC11, we did a hack on the sensors. Through this hack the digital output was disabled and an analog output signal is used.

On the front of the platform there will be three infrared emitters. The M68HC11 along with a 574’ is used to send a 40 kHz pulse. The emitters are set to emit in the infrared range. By connecting the emitters to the 40 kHz pulses, a signal is sent that can be picked up by the Sharp detectors. If an object is in front of the robot, the IR s

sensors, which are connected to the A/D converter, will pick up the intensity of the reflected signal. Once the intensity is at a certain level, Faith will know that she is too close to the object. She will then turn and move in the opposite direction.

Smoke Detector

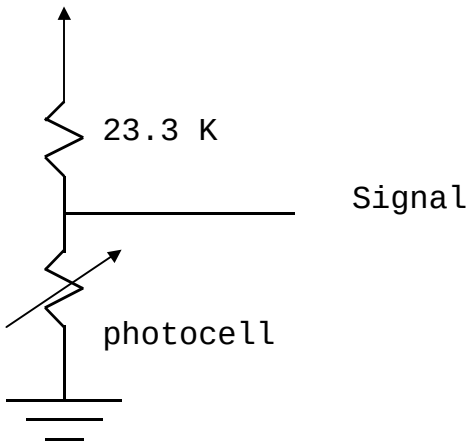
Smoke can be detected through the use of IR beams. If an IR signal is aimed straight, and a polygon shaped box is in it’s path, the box should capture all of the signal. If smoke enters the path of the beam, there would be some reflection. This reflection would be picked up by a IR detector. This theory works, however designing the polygon box to pick up all of the signal is difficult. I tried to build a smoke detector using this method but I could not build a box that would pick up all the signal. The stray reflections would be registered by the IR detectors. This gave the illusion that smoke was detected.

Since I couldn’t build a smoke detector, I purchased one. The sensor operates on 9V. The sensor has two pins, power, and output. The output is digital. The sensor basically operates

like a switch. When smoke is present the switch closes. The sensor is light sensitive. When there is no casing present the sensor gave inaccurate readings. The casing, which is grounded, shields the sensor from noise.

The sensor is connected to digital port A0. Once smoke is detected, a 8 Ohm speaker will emit a tone. This tone will be continuously emitted until all the residents are alerted.

Cadmium-Sulfide Photocells



The photocell is a special type of resistor that responds to light. The more light hitting the photocell, the lower its resistance. The output of the photocell is an analog value corresponding to the amount of light hitting the cell. Higher values corresponding to less light. The output is found from the equation, Signal = VCC * (photocell / (photocell + 47K Ohms)). Each cell was shielded with black heat shrink tubing. This was necessary to prevent outside light from corrupting the data.

The value of resistor that was chosen, was used because the cell’s resistance varied from about 20K Ohms to 40K Ohms depending on the light. The CdS cells were used for line following. Three CdS cells were placed on the bottom front of Faith. The cells gave readings of between 90 and 96 when the sell was on the black line, and 107 - 120 when the cell was over the white area. The cells are not calibrated exactly alike, therefore the code has to utilize this fact to give accurate line following.

Behaviors

Faith has three basic behaviors, object avoidance, smoke detection, and line following. These behaviors will be arbitrated through coding. Upon reset, Faith will be in object avoidance and smoke detection mode. In order for Faith to be a more productive security robot, there had to be a way for residents to be alerted. Once Faith sounds her alarm, she will follow a black line throughout a house in order to alert all the residents. Once in the line following mode, Faith will deactivate the smoke detector. She will follow a line until she gets bored. Boredom occurs after a specified time in which Faith can alert all rooms and safely exit a building.

Conclusion

Currently, Faith is capable of object avoidance and smoke detection. The code fro the line following has some glitches in it. The code has been redone a couple of times and getting the perfect code is hard. I have come across a couple of roadblocks this semester. I lost a couple of weeks because my board wouldn’t run IC. Once this was taken care of I was able to get some work done. I lost some more time trying to build my own smoke detector. From this I learned the old adage of not reinventing the wheel. Since I was not monetarily stable throughout most of this semester, I had to use sensors that really did not cost a great deal. My main limitation throughout this semester was time. This is not a class that I would suggest that a graduating senior take. The class is very interesting, however, it takes a great deal of time. As a graduating senior, I have been pre-occupied with interviewing for a job.

Even though I had a few roadblocks, I was able to lay a foundation for Faith that I can explore in my free time. I will like to add an intruder detection circuitry and voice recognition in the future. This project has excited me and I am motivated to finish it once the semester is over.

References

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Appendices

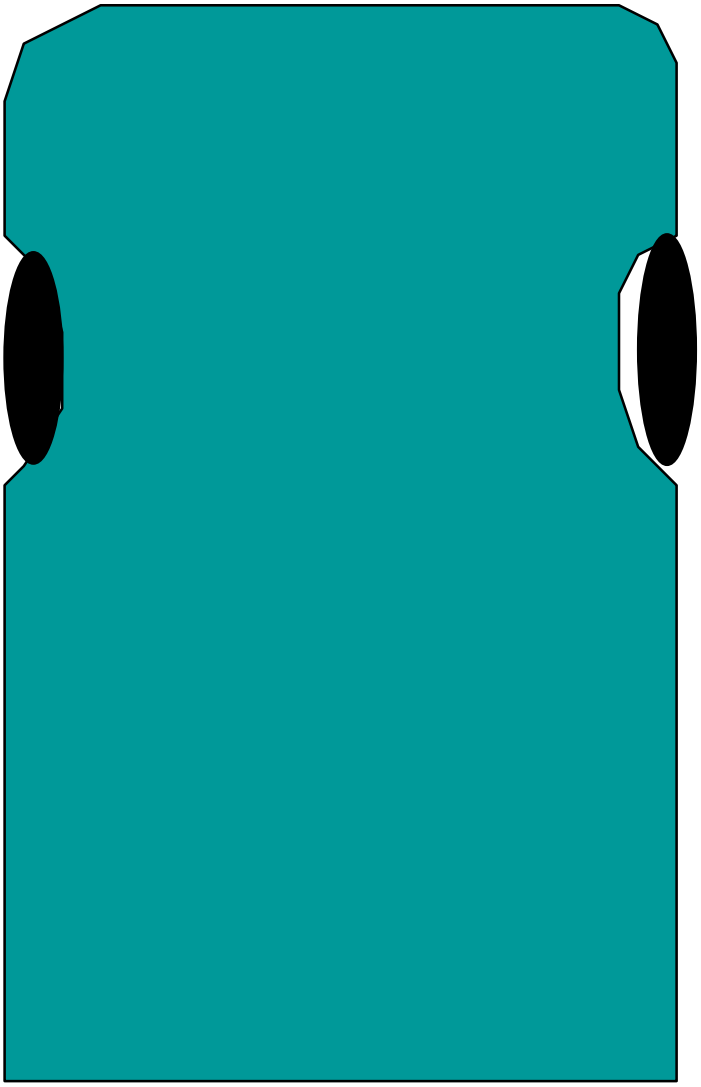

Fig. 2 Faith’s Platform