Seeker

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EEL 5666: Intelligent Machines Design Laboratory

Final Report

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Abstract

The complete fabrication of the autonomous agent Seeker is explained in full detail including a description of the demo. Also the actuation, sensors, control systems and special circuits are presented. The premise of Seeker is that he actively patrols a moon colony, searching for red aliens, which he then neutralizes with his laser.

Executive Summary

This prototype seek and destroy autonomous platform utilizes edge of the world detection to stay within its boundary and two different types of infra red sensors to perform obstacle avoidance. Seeker tracks the red aliens with a Cmucam 3 through serial communication to the microcontroller. Gear motors are used in conjunction with a dual IC motor driver for the method of propulsion. 6 AA batteries provide all necessary voltage for Seeker.

Introduction

The need to preserve one's territory is a consistent dilemma. More specifically, the desire to facilitate the entrance of particular beings or objects while deterring the entrance of the unwanted. This situation can range from simply keeping squirrels out of your yard from eating bird seed, to monitoring a futuristic metropolis to keep out hostile aliens. The intention of Seeker is to provide this service constantly so there is a lesser chance of an unwelcome guest within specified vicinities.

Integrated Systems

Seeker uses the ATXMEGA128A1 as the primary microcontroller in conjunction with the LPC2106 ARM microcontroller that operates the Cmucam3. Seeker was initially planned to be a roaming cart with a short rage projectile launcher. The projectile launcher, after some deliberation, became a laser, which will be fixed above the Cmucam3 but integrated with the ATXMEGA128A1. The circuit is shown below. A FET transistor is used to provide current control for the switching on and off of the laser throughout the duration that Seeker is active. An LCD screen is interfaced to provide debugging services. The Cmucam3 will be on a fixed pan and tilt system transmitting information to the ATXMEGA128A1. Seeker functions on a battery pack with 6 AA NiMH batteries. The LPC2106 ARM microcontroller also functions from this single battery back.

Below is a macro chart of the integrated processes of Seeker.

LCD Display
IR Sensor

ATXMega128A1

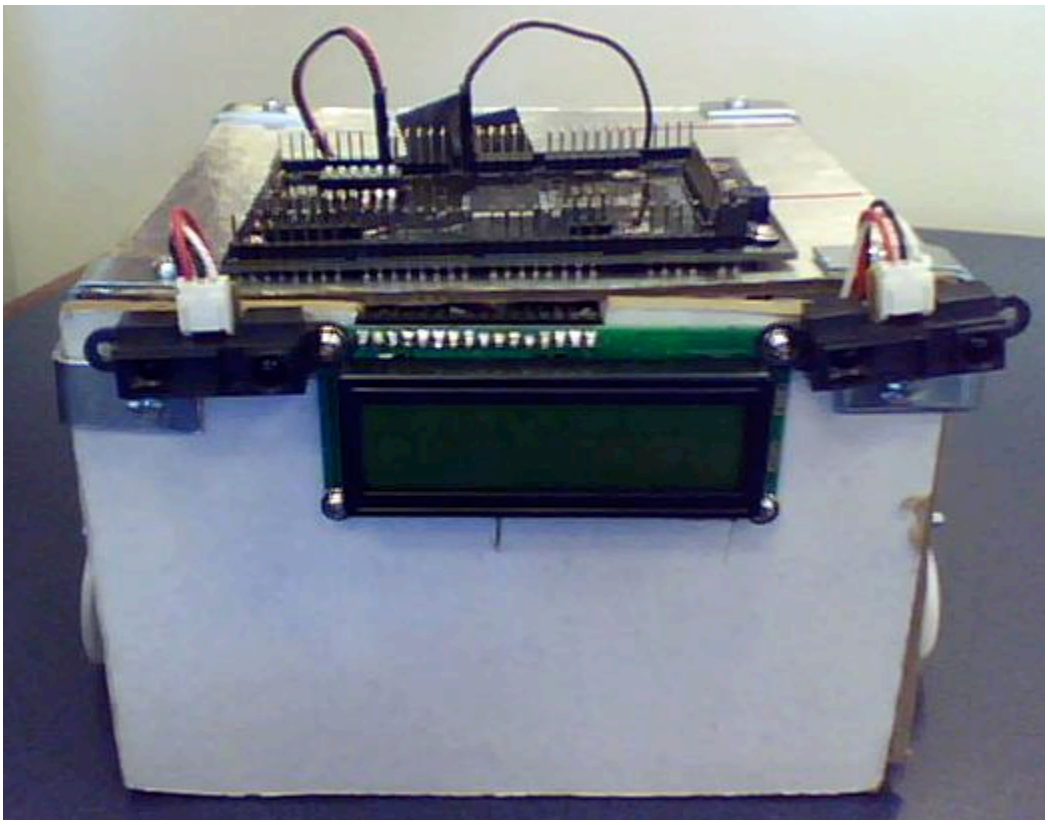
CdS cell
Laser
Motors

Motor Driver
Cmucam3

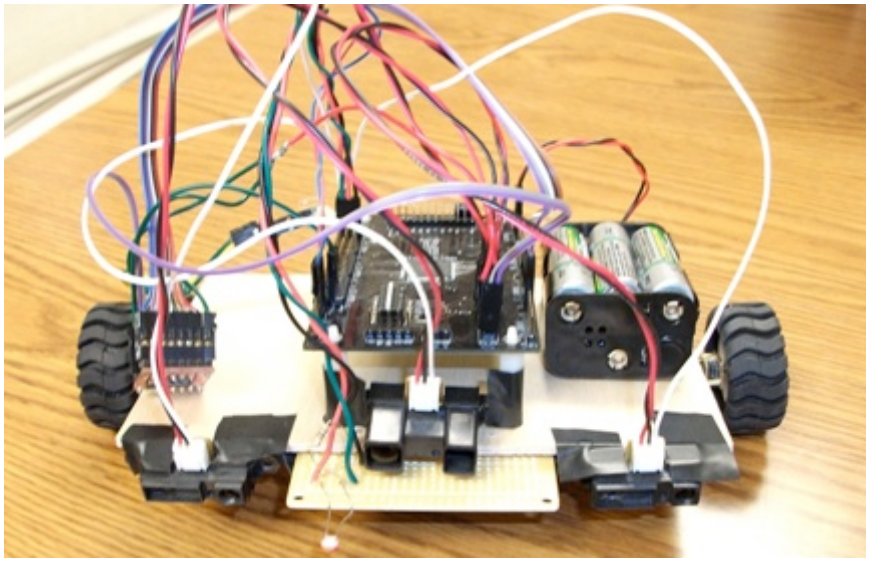
Mobile Platform

The mobile platform for Seeker is rectangular and composed of balsa wood. Throughout the design process it was intended for seeker to be as small as possible for enhanced maneuverability and would require smaller servos. A prototype platform was created to test functionality of designs. This prototype was constructed out of thermo-ply. The cubic design is intended to have an easily detachable top for easy access to the volume enclosed. All sensors attach directly to the platform. This is to simplify the manufacturing and assembly of the platform. Proceeding is a picture of the prototype platform followed by the finalization stages of the completed platform and sensors.

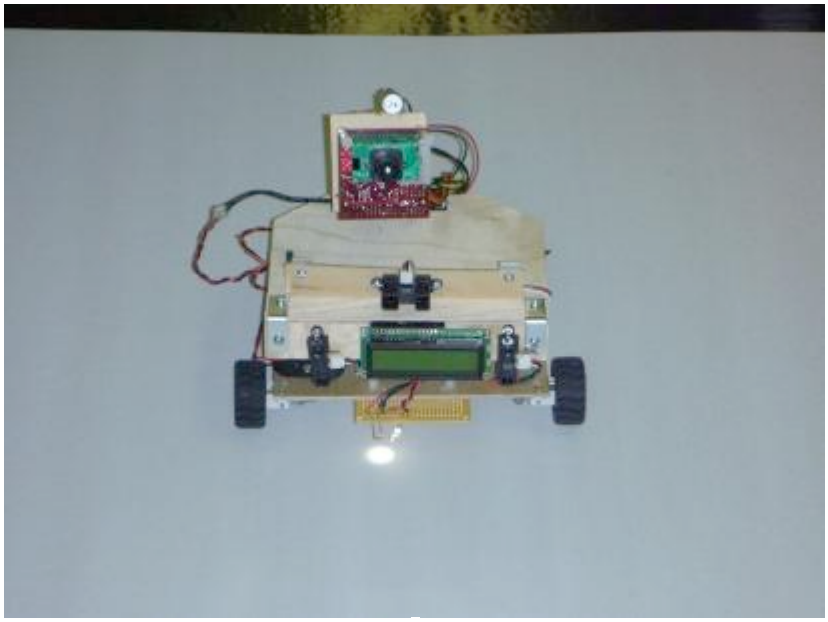
Prototype:



Early stage of Final design:



Final design:



Commentary

Throughout this semester I wanted to keep the platform simple and easy to manufacture so a majority of the work can be done by hand. Also, the task Seeker performs does not require a custom platform. With this is consideration the mobile platform was only tailored to the sensors used as the integration became more complex.

Actuators

Seeker was initially propelled by 2 high torque servo motors. Through the prototyping phase, these servos were too large to be suitable for the compact design. Small motors have replaced the servos. These motors have a gear ratio of 100:1. The experimental data values with only a wheel attached are as follows for 5 volts:

Angular velocity = 75 rev/min; stall current = 310mA;

Linear velocity = 3.9 in/s;

Commentary

These motors are driven with a 20 ms period and adjustable duty cycle to control the speed through the different behaviors Seeker performs. These motors are optimally run at 6V, however, I ran them at 5V from the PVR board and at half speed and they still provided enough torque and speed for me to be very satisfied with.

Sensors

Seeker will actively use the combination of sensors to perform its task. The use of IR sensors and bump switches will be used for obstacle avoidance. Photoresistors will be utilized so Seeker will be contained within his territory. The Cmucam3 will "see" for Seeker to identify between an allowed and not allowed object. Seeker will use a laser to ward away objects that should not be there. For testing purposes, an LED board was used to display the readings. Datasets for the sensors used are as follows:

7 in – 3204; 12 in -3121; 17 in – 3093; 22 in- 2178; 27in –1829; 32in –837; 37in –789; 42in

Long Range IR: The initial starting distance was chosen when the value if the IR sensor changed and held constant for 10 cycles. Each value is the average value read by the sensor after 10 cycles. The ending values were determined when the same value was read for 10 cycles at two different distances. From this graph the 3000 – 1000 sensor range will be the working range.

1in – 3312; 3in- 3124; 5in- 3048; 7in – 2160; 9in – 1557; 11in – 797; 13in – 785;

15in – 765>x>640; 17 in 520>x>500; 19in 490> x>450; 21in 490>x>450

Short Range IR: The initial starting distance was chosen when the value if the IR sensor changed and held constant for 10 cycles. Each value is the average value read by the sensor after 10 cycles. The ending values were determined when the same value was read for 10 cycles at two different distances. For this sensor the 3200 – 1000 sensor range will be the working range.

Photoresistor: The photorsistor circuit was held against a light source and kept there for 10 cycles.

1 in – 1800; 45 in – 436 (Max and min values with the associated distances since this dataset depends on the luminosity of the source.)

Cmucam3: The Cmucam3 sensor will detect red light in the range of 240>Red >200 within the MX2 range I have defined through experiments to be between 0 and 86.

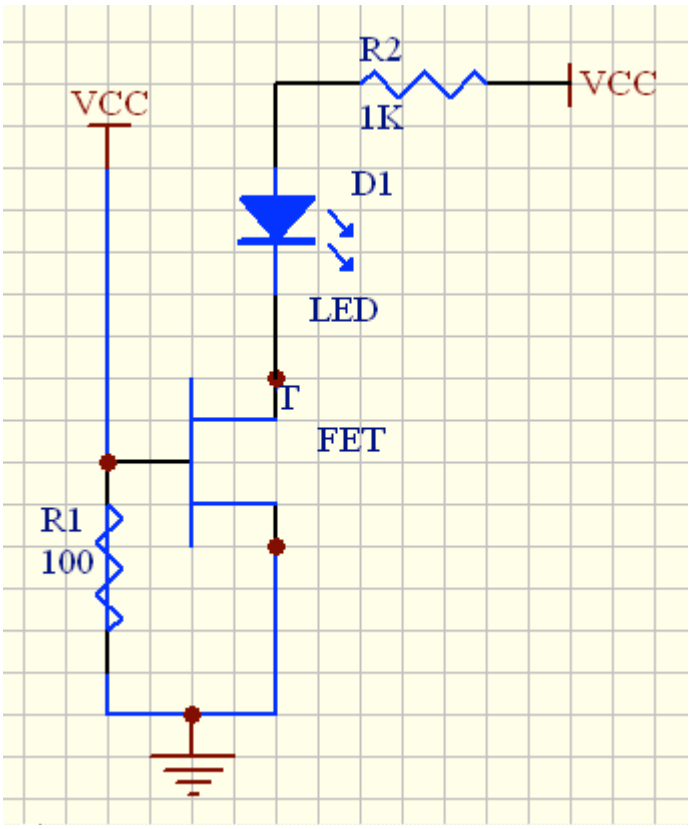
Behaviors

Seeker avoids impending obstacles while identifying when he is at the boundary of his territory and retreats back. Seeker also tracks his target and attempts to prevent it from entry by firing his laser at them. Seeker is very aggressive within the optimal values of detection. He tracks vigorously while the alien is within his peripherals, however, once the alien goes outside this range he goes back into seeking mode. This range was simply chosen through experimental procedures in his environment.

Experimental Layout

Various experiments were performed on Seekers arena to allow optimal performance. Adjusting the CdS cell and the Cmucam 3 were the primary focus. The Cmucam 3 was very touchy in different lightings. In order to avoid the Cmucam 3 to pick up erroneous values and get stuck in a loop, it must be pre-calibrated before Seeker starts his behavior. With this, Seeker will track the red alien in almost any type of lighting.

Also through experiments the resistors were chosen for the laser circuit. The 1K ohm resistor was chosen through experiment to provide a reasonable amount of brightness for the laser.



Conclusion

All phases are complete. I would have hoped that I would have my platform and sensors integrated at this point. The time spent on the sensors and time trying to minimize the platform, Seeker is optimally small. Integration of all of the circuits was fairly simple; however faulty wiring and soldering led to a lot of setbacks. I would have liked to have done more with his arena, however, wiring issues, primarily with the laser circuit did allow for this. My final demo went very well in my opinion. Obstacle avoidance went very smoothly along with color tracking. When Seeker get at the edge he performed well, however, I think with a little more programming he could react better at the edge. Overall I feel as though this was a successful project.

Appendicies

Code for Seeker can be viewed at my webpage
http://plaza.ufl.edu/tphilipp1/Seeker%20Site/Index.html
Most of my parts came from Sparkfun.com.
My IR sensors came from Junun.com

I would like to give a special thanks to the people who helped me:
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