University of Florida
Department of Electrical and Computer Engineering

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“PANTERA”

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Abstract

Executive Summary

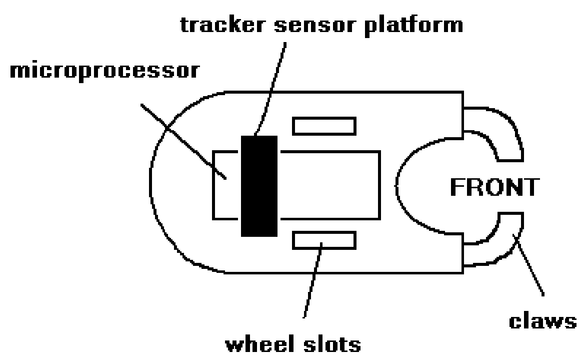
Introduction

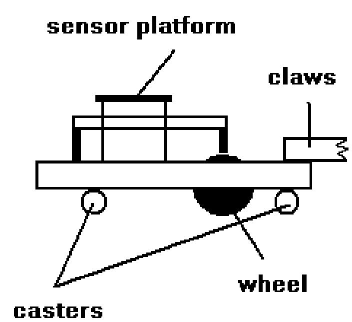
The objective of this project was to design a predator/prey system. The predator Pantera's goal was to detect the prey and capture it, while trying to avoid other possible obstacles. This paper will explain the structure of the robot, the sensors it uses for collision avoidance, tracking, and trapping, and the behavior algorithms used to integrate these sensors into one system.

Integrated System

Mobile Platform

The design of the platform plays an important role in the objectives of the predator. The following figures show the platform structure with the specifications.





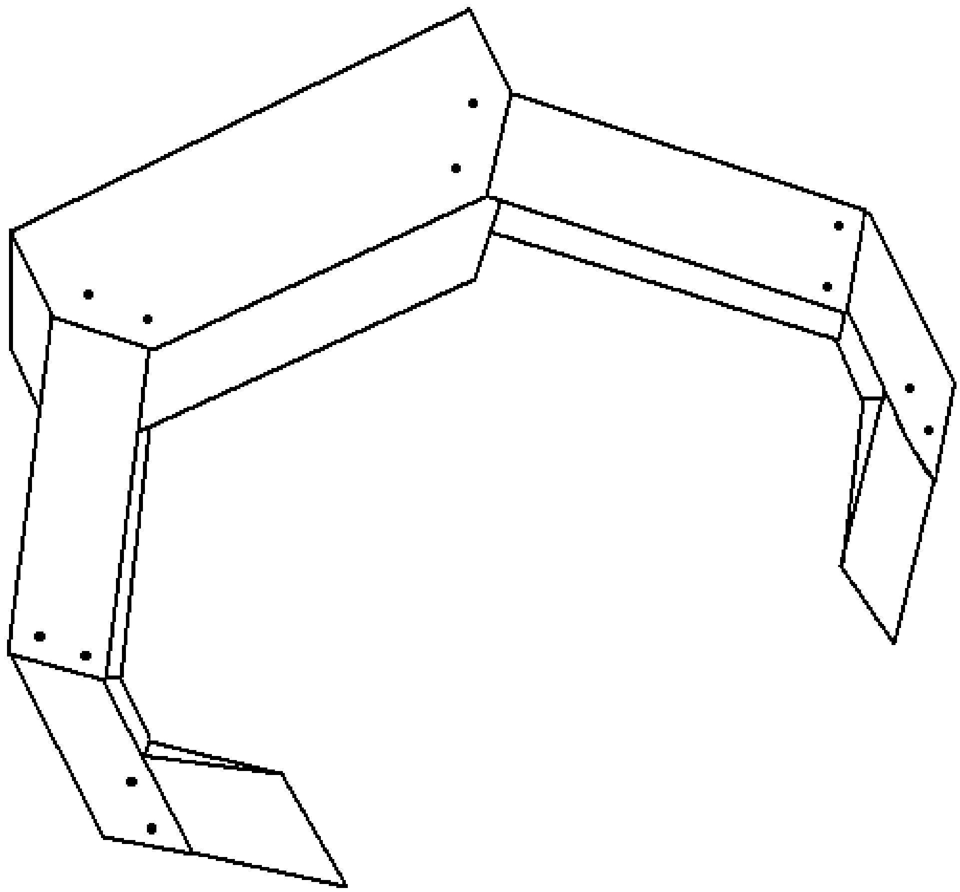
The top view shows a 7” semicircular cut on the front end of the robot. The “claws” of the robot extend outwards forming a circle. The prey robot has a diameter of about 6 ½”. This allows the prey to fit into the semicircular area and get trapped by Pantera. The rounded back of the platform makes it easier to put a bumper around the outer edge. The large body was designed to accommodate the Motorola MC68HC11E9 microprocessor. The side view shows a smaller elevated platform which holds the tracking system of the predator. It needed to be high enough to check the surrounding areas of the robot, without being blocked by the robot body.

Pantera is powered by a 9.6V battery pack located on the underside of the platform. It uses 8 AA rechargeable batteries.

Designing the platform was relatively easy when I only had to visualize what I wanted. Once the platform was cut I realized I had made some miscalculations. The wheel slots were cut too far back making the board severely unbalanced. I compensated the problem by adding an extra caster in the front. The structure is very stable and can support a lot of weight.

Actuation

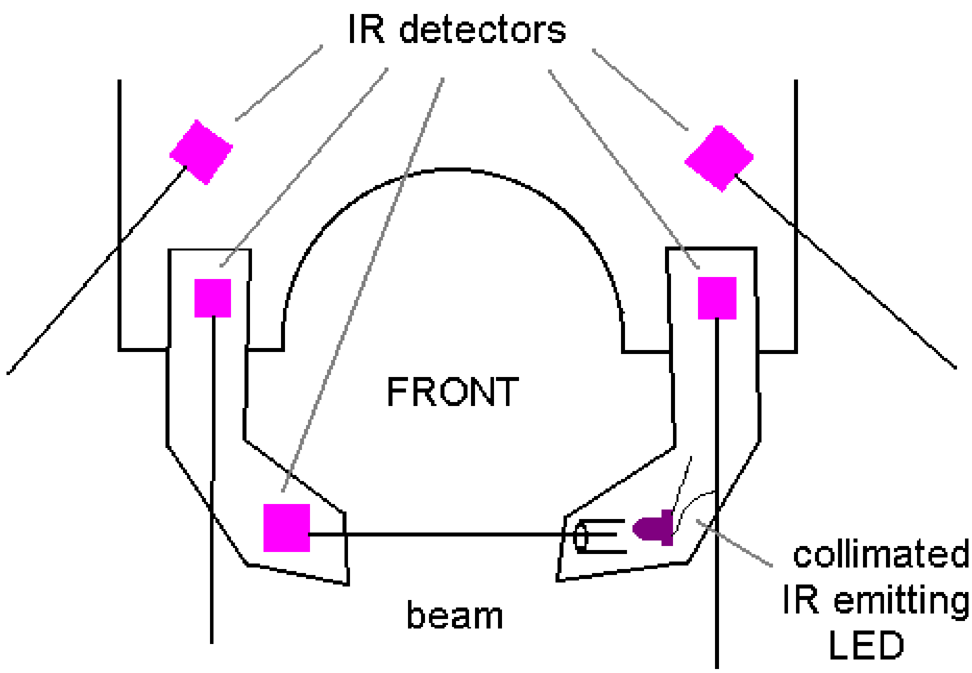
Pantera uses four Aristo-Craft Tracker 03-410 servo motors for its actuation. These motors are easy to hack, require simple programming, and are low in cost compared to other motors. The servos were hacked to remove the gear stop to allow them to spin continuously. This method was developed by Scott Jantz. Two were hacked and used to spin the wheels. Each individual motor can be programmed to go forward or in reverse as needed. Another hacked servo was used to allow the tracking sensor to have a full range of vision (360°). The design of the “claws” of the predator (Figure < >) are a variation of the gripper on the Mini Mover 5 by Microbot, Inc. I had some assistance from Chris Beattie in redesigning the gripper to fit Pantera. I used an unhacked servo to pull the “claws” shut. The reason the servo was not hacked is that it needed to spin and stop, not spin continuously like in the other applications.



Sensors

Pantera uses only three main sensor types: infrared emitters and detectors, switches, and light detecting sensors.

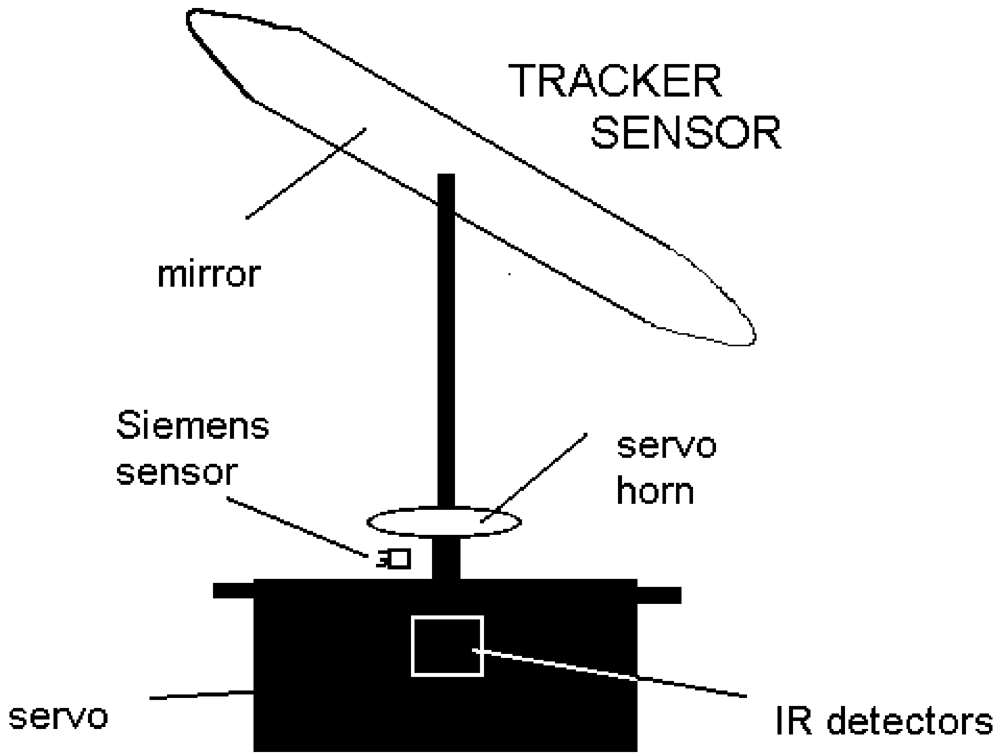
I used Sharp 40kHz infrared detectors for collision avoidance. These sensors were hacked to make them analog instead of digital in a method developed by Ariel Bentolila. Figure < > shows the placement of the five sensors on the platform. The “beam” sensor uses a collimated IR emitter across from the detector to create a beam across the semicircular area. When the beam is broken, the robot moves back to avoid collision with the object.



The outer edge of Pantera has switches covered by a strip of lexan. This forms a bumper which also assists in collision avoidance. The following circuit is a simple voltage divider that allows me to detect which switch has been closed.

Tracker

The “tracker” sensor, shown in Figure < >, is a simple sensor composed of two IR detectors and a Siemens SFH900 light-detecting sensor. The “Tracker” was modeled after Charles Barker’s “Cyclops Vision” sensor, which in turn was modeled after the “Cyclops” robot made by Rosa Maria Charneca Pasadas and Rui Jorge Ferreira da Costa.



This sensor is used to track 32.75kHz IR being emitted by another robot, instead of being used for collision avoidance (40kHz). I used two Sharp 32.75kHz infrared detectors placed at the bottom of a rotating, angled silicon wafer that acts as a mirror. The IR emitted by the prey robot is reflected off the mirror and into the IR detectors. In he original design, the Siemens sensor read stripe on the servo horn to maintain timing and for calibration of the servo's speed. The new design has one half of the horn black and the other half white creating two pulses instead of one. Both designs have a rate better than a full scan per second, but the new design is faster. This also allows the robot to detect the position of the mirror at the time the IR was detected, thus locating the source and allowing Pantera to head in the appropriate direction. Figure < > shows the circuit diagram for the sensor.

Table 1 shows the range of vision of the "tracker" sensor. Readings taken from the same distance at different angles show that the sensor is capable of detecting IR in all directions. Table 2 shows the sensitivity of the sensor. The sensor can detect IR up to <distance> away.

Behaviors

Pantera exhibits four different behaviors: object avoidance, infrared tracking, trapping, and collision detection.

Object Avoidance

The object avoidance behavior uses the 40kHz IR emitters and detectors to avoid colliding into obstacles. PNTERA.C (found in the appendix) is the collision avoidance program. The program monitors the five IR detectors checking that their thresholds are not surpassed. If a threshold is surpassed, that detector "sees" an object and the program causes the motors to respond accordingly.

Infrared Tracking

The tracking behavior monitors the periphery of the predator looking for 32.75kHz IR and locates the direction of the source. TRACKER.C maintains the timing and directs the wheels of the robot to turn in the direction of the IR emitter. The prey robot emits 32.75kHz IR for its collision avoidance. This makes it a good target since its infrared emitters act as a beacon for Pantera.

Trapping

The trapping behavior occurs when Pantera believes it has the prey in its reach. TRAP.C (found in the appendix) causes the servo to turn fully closing the claws around the prey when both the IR beam is broken, and the set of switches within the semicircular area have been closed.

Collision Detection (Bumper)

The collision detection behavior is simply a bumper around the outer edge of Pantera. When one of the switches is pressed, a voltage value is returned. BUMP.C (code in appendix) compares it and determines which set of switches was closed and tells the motors to go forward or turn away from the object.

PANTERA.C is the final program which integrates all of the behaviors.

Experimental Layout and Results

Conclusion

Appendices