Search and Destroy

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**Abstract**

This paper will cover the design of Search and Destroy which is an autonomous mobile agent or robot. The integrated system, platform, actuation, sensors, and behaviors of Search and Destroy will be covered. Additionally, successes and failures in the creation of Search and Destroy will be discussed.

**Executive Summary**

The robot Search and Destroy is a compilation of various sensors and actuators controlled by an Atmel Atmega128 microprocessor on the Mavric-IIB board. Sensors include a sonar and CMUCam for distance measuring and color tracking respectively. Various servos were used for actuation throughout the robot as well as two motors used to shoot the ping-pong ball. C language code was used to program the robot as well as Atmel's AVR Studio 4.

**Introduction**

Search and Destroy is a robot that tracks the color of a person's shirt standing in front of its camera, turns appropriately until the target is centered, and then fires a ping-pong ball in the direction of the person. Its main component is the CMUCam which has the ability to track a color and relay the information back to a microprocessor via serial communication (RS232). The mobility of the robot is limited to turning left and right as well as taking small steps forward and backward, thusly making it more of a turret typed shooter than a tank.

**Integrated System**

Using the Atmega128 processor on the Mavric-IIB board, controlling all the servos/motors and sensors was relatively simple. The CMUCam is connected to the board via RS232 serial connection. The sonar is simply one input pin and one output pin, while the servos/motors are controlled using the timer system that creates pulses of varying widths. The board is powered using batteries in the form of

4 NiMH rechargeable batteries for the servo ports providing around 4.8-5 volts at around 2500 mAh and 6 of the same batteries providing around 7.2 volts regulated down to 5 volts for the board itself.

**Mobile Platform**

The platform of the robot is a tilting hinge for angle adjustments of the shooter, sitting on a flat base that houses most of the electronics and has wheels on the sides for turning of the robot. There is also and extension coming out of the front for counterbalance that has the sensors on the front of it. The hinged part comes off rather easily for access to the microprocessor board and all cabling attached to it. Since the robot does not move very much, it is a big heavy for stability and rigidity. The hinged part has a PVC tube which has slots for the wheels on the motors to go through for shooting the ping-pong ball out.

**Actuation**

The actuators of the robot are in the form of servos and motors. The servos control the wheels which change the direction the robot is facing, as well as the gate that releases the balls and the geared down more powerful servo controls the tilt of the launch angle. The motors are connected to the board via speed controller which converts the PWM signal from the board into varying voltages to the motor and so controlling the speed and direction. The motors are spaced apart so that the ping-pong ball can be shot through them in a PVC tube when they are running.

**Sensors**

There are two sensors used by Search and Destroy. The first is an SRF05 Sonar used to detect the distance the closest cup is to the robot. The sonar sends data to the Mavric-IIB board by sending a pulse, with the length of the pulse varying by how far the object is from the sonar. By counting clock cycles that pass while the pulse remains logically high, the distance can be determined experimentally. The number of clock cycles for various distances are shown in the table below:

| Distance (Inches) | Sonar Reading |
|---|---|
| 6 | 599 |
| 12 | 1174 |
| 18 | 1785 |
| 24 | 2391 |
| 30 | 3001 |
| 36 | 3627 |
| 42 | 4256 |
| 48 | 4900 |

The second sensor used is the CMUCam developed by Carnegie Melon University (CMU). It is a basic CMOS camera integrated with a micro-controller board that allows it to have several built in functions. The function used for Search and Destroy is the color tracking ability. By using this function, data is sent to the board that tells if the color is centered in the camera's window and if not, how far off either left or right it is. By interpreting this data using software, the wheels can be turned to face left or right and so point to the center of the color. Through testing it was determined that blue is tracked best so blue will almost always be used to demonstrate this function.

**Behaviors**

The behaviors of Search and Destroy are in the form of steps. The first step is to calibrate the camera and begin to track whatever color is in the center of the camera's window (usually blue for

demonstration purposes). Once tracking has begun, the camera is polled periodically and a counter increases if the color stays centered and is reset if the color moves out of the center. If the color is out of the center, the servos controlling the two wheels turn appropriately to recenter the color. If the counter reaches five, then the color has been centered for five polls of the camera and the shooting process can begin. In the shooting process the sonar is used to find the distance away the person is from the robot. Depending on the distance the angle is then adjusted for the shooter. Once this is complete the motors are warmed up and begin spinning then the gate is opened and the ball is released and shot. Upon completion of the shot, the robot goes back into tracking mode with the counter reset.

**Experimental Layout and Results**

Through experimentation, most functions of the robot were determined to be successful. The sonar and turning abilities of the robot worked quite well almost immediately. The CMUCam however is very finicky when it comes to different lighting environments as well as with the colors it tracks well or not. The tracking of the color blue in a lighted room was found to work the best, but its still not great and needs to be helped along sometimes by moving back to the center. The most difficult part of the robot was adjusting the angle since the gears slip even with a stronger servo. Also shooting the ping-pong ball is no more accurate than just in the general direction of the target. For a simple demonstration though, these problems are acceptable and produce fair enough results to say that the robot was completed in a satisfactory manner.

**Conclusion**

Search and Destroy has various abilities, some functioning better than others. The CMUCam adequately tracks a color and the sonar can accurately tell how far away that color is. In this respect,

the sensors are the most successful part of the robot. Turning to point in the direction of the color is the most successful of the actuation aspect of the robot. Problems in the shooting and tilting of the launch angle make the actuation mediocre, but the shooting is more for demonstration purposes anyway and is not the key to the robot's overall success. The purpose of this robot was to put together a combination of actuation and sensors to create an autonomous system and in that respect the robot was very successful in reaching its goal.

**Special Thanks**

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**Appendix**

Source code is available in accompanying files.