TEMRo

Formal Robot Proposal

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Abstract

The objective of TEMRo is to maneuver around obstacles making its way to home base, while actively searching and identifying three stationary targets. Once it has identified a target it will navigate towards the target to align itself for firing. The targets will be programmed to spin around, effectively switching colors from red to green at a random time. When the target switches to green, the robot will fire at it. Once the targets have been "eliminated" the robot will complete its journey to home base.

Introduction

In combat situations sometimes there is a need to multitask, especially when it comes to treating wounded soldiers. This proof-of-concept robot vehicle will demonstrate the ability to autonomously navigate obstacles while searching and "destroying" enemy targets. The goal would be to transport wounded soldiers and medics who will treat them right away while the autonomous vehicle utilizes its turret to defend the vehicle and its passengers on its way out of a combat situation.

Integrated System

TEMRo will be using the Raspberry Pi 2 for the upper level processing. Its main usage will be in image processing for the targeting system. I also chose the raspberry pi camera module for my special sensor; its main function will be to search and identify the targets.

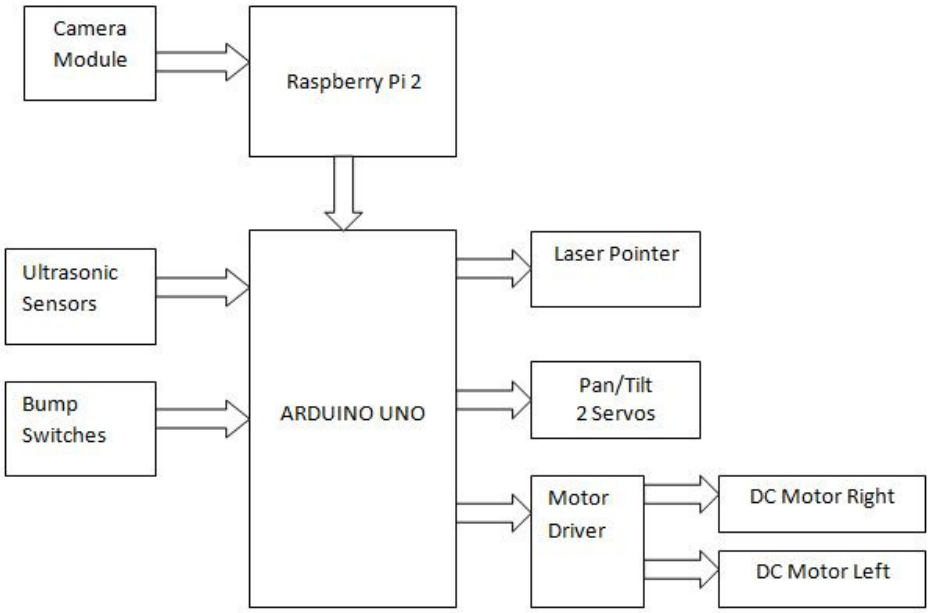

Fig. 1

Additionally the Raspberry Pi will interface with the drive and sensor systems via serial communication, giving instructions to be followed to an Arduino Uno. The DC motors will be driven by a motor driver controlled by the Arduino. The Arduino will take charge of the obstacle avoidance, leaving the Raspberry Pi for image processing from the camera module. A laser connected to the Arduino will be the firing mechanism attached to the pan/tilt servos. A block diagram outlining the system integration is given in Fig.1.

There will be three targets controlled by another Arduino Uno I was able to acquire. Each target will be a hexagon with two colored sides. One face will be red and the other green or an identifying color of my choosing that will signal the robot to shoot at the target. The laser will hit the photo resisters in the target and the Arduino controlling the targets will register the hit, and turn them around so the camera sees the red face. This process is briefly outlined in Fig. 2. TEMRo will know it has been hit from the change in color and thus search for other targets.

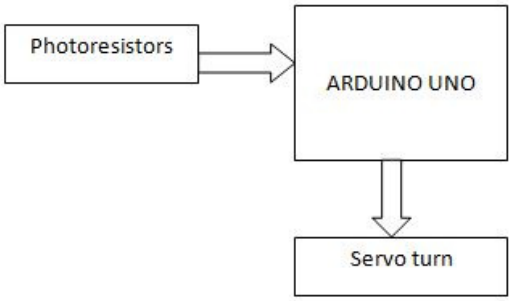

Fig. 2

Mobile Platform

The mobile platform will be a two-tier structure; the top tier will hold the mounts for the turret and camera. The lower platform will house the electronics, sensor mounts, DC motors, and battery. I will also locate my components on the lower platform to distribute the weight evenly and ensure TEMRo is not too heavy on any side. I will use the wood provided in lab as the platform material throughout the robot. Once I finalize my platform design, I will decide whether or not to 3D-print certain mounts for sensors, camera, turret, and wheels. Fig. 3 is a side view of the preliminary layout with the platform of TEMRo.

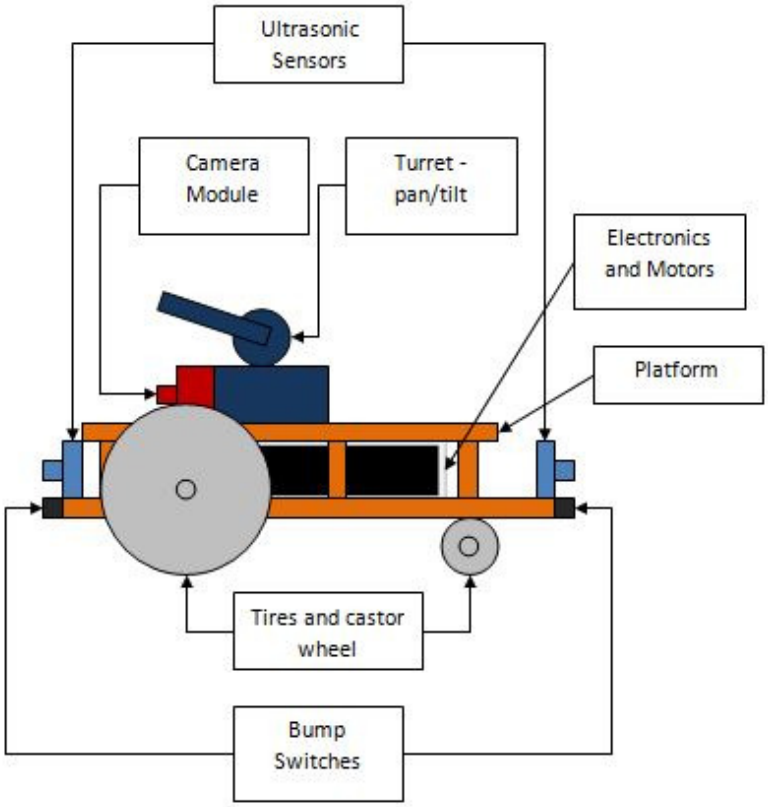

Figure 3

Actuation

TEMRo has two main actuation systems, the drive subsystem and the turret subsystem. The drive subsystem will consist of two DC motors in a differential configuration. This will allow for the Arduino to actuate each motor independently allowing for steering maneuvers and speed adjustments. The turret subsystem will comprise of two servos, one for pan motion and one for tilt motion.

To control the speed and turning maneuvers, the DC motors will have encoders that will provide velocity feedback so the Arduino can actuate each one appropriately. The castor wheel located in the rear of TEMRo can rotate the full 360 degrees. This can allow TEMRo to turn in place. I will be using a dual motor controller to interface the DC motors to the Arduino.

The servos can already be sent a command to turn to a specific angle. However, to actuate the servos smoothly I will need to consider different control techniques so the servos do not "jerk" from the fast deceleration they produce one the desired angle was reached. The control algorithms for both the drive subsystem and turret subsystem have not yet been developed.

Preliminary Parts List:
2x - Hi-tec servo motors for pan/tilt
2x - DC motors for driving tires
1x - Laser pointer 5mW for firing at target

Sensors

There are two systems that require sensors for this mission, TEMRo and the targets.
-TEMRo:
TEMRo will contain 4 ultrasonic sensors, 3 at the front and 1 placed in the rear for reversing maneuvers. These sensors will provide the Arduino with approximate distances to objects and will give TEMRo basic obstacle avoidance capabilities. Additionally, there will also be two bump switches as a final back-up in the event the ultrasonic sensors could not detect the object in front. The Raspberry PI camera module will be connected directly to the board and its purpose will be to search and identify the intended targets. The software used to process the images from the camera will be OpenCV.

Preliminary Parts List:
4x - HC-SR04 Ultrasonic sensors for obstacle avoidance

1x - Raspberry Pi Camera for targeting system

-Targets:
The targets will be placed on posts that are connected to servos. These servos will be controlled by another Arduino UNO to rotate the post 180 degrees at a predetermined time from the start of the mission. Photoresistor sensors will be placed at the top of the post in the middle of a hexagonal target. The resistance will change for these sensors when they are hit with a laser beam from TEMRo. Once this event occurs, the Arduino will give a signal to rotate 180 degrees back to its starting position (red face).

Preliminary Parts List:
1x - Arduino Uno
6x - Photoresistors (2 per target)

Behaviors

TEMRo will be placed in a closed course with cardboard boxes for obstacles. There will be a large tower at the other end of the course that it will try to reach. It will always be placed at a height so as to keep it constantly in the field of view of the camera. However the targets will be placed at different heights and initially hidden from its view. The robot will then begin maneuvering around obstacles in its aim to reach the home-tower. However, once the targets are in view and are identified, TEMRo will continue tracking the home-tower until the targets turn green. Once they do, TEMRo will switch into seek and "destroy" mode and begin firing at the targets until a hit is registered. If TEMRo misses it will attempt to move closer, align itself better, and fire once again. It will still require obstacle avoidance in case moving closer means moving around an object. Once the targets have been "eliminated" it will switch back to its original mission and continue its progress towards the home-tower. Once home-tower is reached it will stop in front of it and its mission will be complete.

In the event that it cannot hit a specific target, I will program TEMRo to give up after a certain amount of tries and then continue to move forward towards home-tower.

Experimental Layout and Results

The robot is not built yet and all the parts have not arrived either so no experiments can be done at the moment. I have only begun testing the ranges of servos and photoresistors to be able to control actuators based on these readings.

Conclusion

As of this proposal, the work completed has been refining the design to meet the proposed specifications and objectives. I have ordered and setup my high level processor the Raspberry Pi 2, and the lower level slave the Arduino UNO. I have completed each lab and have worked on my own to experiment with coding the Arduino to achieve a desired output based on my analog commands, (potentiometer, photoresistor, etc...). Now that I have refined my design, I can begin ordering parts for TEMRo. The platform I will begin in Solidworks so I can have it cut-out in lab. I am very excited to see TEMRo come together soon and I hope to exceed my expectations for its behaviors.

Documentation

N/A

Appendices

N/A