Gator Aider Parking Attendant

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Abstract

The purpose of this robotic platform is to provide a means of clearing a parking lot of unauthorized vehicles. Authorized vehicles are defined to be those belonging to gator fans meaning they are either orange or blue in color. Offending vehicles will be crushed and removed from the parking space.

This robot will patrol a mock parking lot. As it makes its rounds a color sensor will determine the eligibility of parking for each vehicle. The vehicles will be painted aluminum foil which has been molded into the shape of an average car.

Executive Summary

The Gator Aider Parking Attendant (GAPA) is a robot designed to patrol a mock parking lot. It searches for illegally parked vehicles (i.e. non gator fans) which are signified by colors neither orange nor blue. On finding an illegal vehicle, GAPA picks up the offender, loads it into a crushing unit, and continues its search around the parking lot.

An array of sensors are used. CDS cells are used for line following with a proportional control to the drive wheels (so no jerky motion). Sharp IR distance sensors are used to scan the road ahead and behind the robot to avoid collisions. An AVRCam camera is used for color detection and object position. Lastly a smart power management board was designed to protect lithium polymer batteries.

The robot works quite well using the integrated systems. It does in fact locate offending vehicles, crushes them, and continues its patrol.

Introduction

The availability of parking on the University of Florida campus has become a plague on the school. This problem is further exacerbated on game days as obnoxious out-of-state fans unrightfully take student parking (especially in on-campus housing lots).

This platform will help remedy such situations by patrolling lots of high priority and removing offending vehicles. A color sensor will determine whether vehicles are eligible for parking in such said lots. Eligible vehicles are defined to be those belonging to gator fans. It is assumed true gator fans will have either orange or blue cars.

When a non-eligible vehicle is found, a robot manipulator will deal with the offending vehicle through a crushing process. After the vehicle is crushed, it will be removed from the parking space to be recycled in order to promote a green campus.

In the following report, the various aspects of this project will be discussed including the mechanical design of the platform, the employed sensors, and the behaviors of the overall system.

Integrated System

The main chassis forms the base of the robot. It is rectangular in shape with a motor/wheel at each corner. It forms a box suitable for holding electronics as well as forming a steady foundation for the manipulator.

The manipulator sits on top of the base chassis. This allows for a long reach due to its height and easy access to the crusher/recycle bin which will also be placed atop the base chassis.

Mobile Platform

The overall mechanical system is composed of two or three main components. The primary component is the platform chassis. This component is primarily the means of locomotion for the entire system. It consists of four motor and wheel sets. This will allow the robot to have full time four wheel drive in order to maintain the greatest traction as well as maximizing the available payload weight. At the time of this writing, the chassis could carry in excess of four pounds with good performance.

The secondary mechanical system is that of the manipulator. This component will be modeled as an arm with two or three joints to allow for both picking up and removing the offending vehicles.

If a third mechanical system is used, it will serve as a crushing unit. The design of this device is based on counter rotating drums. The manipulator arm will place the offending vehicle between the drums. As they spin, they will both pull the vehicle off the manipulator and crush it.

Actuation

As mentioned in the Mobile Platform section, the actuators responsible for locomotion are four motors providing four wheel drive. These motors are brushed DC motors with a 30:1 gear ratio. These are bolted onto 2.5 inch diameter foam wheels. The motors are paired to one another so that only two H-bridges are required. This saves both cost and volume on the part of the electronics.

The manipulator will most likely be constructed using high torque servos. These provide both gear trains and control for the built-in motors. Upon looking at prebuilt designs, these seem to be adequate for the requirements of the project.

There will most likely be another servo motor to pan/tilt the color sensor/camera. This will allow the robot to look in multiple directions without changing its current heading. In addition, by moving the sensor independently of the drive train, the robot can obtain multiple vantage points for positioning the manipulator.

If a discrete crushing mechanism is used, the crushing walls of the unit will most likely be driven by a screw mechanism as it both provides high force and lateral motion (as opposed to rotational).

Sensors

The robot will utilize a variety of sensors to complete its task. The base chassis uses infrared sensors for obstacle avoidance. The infrared sensors are manufactured by Sharp. These modules are unique in that they measure the angle of the reflected IR beam rather than intensity. This allows for high immunity to changing environmental changes such as ambient light or non-uniform reflectivities.

The platform will follow white lines of the mock parking lot. To accomplish this task, CDS cells are used. An algorithm was designed and written (a PI controller) for the line following functionality.

The project also needed a color sensor to discriminate the various vehicles and determine the eligibility of parking. This sensor came in the form of an AVRCam camera. This sensor was used due to its relative low cost and ability to provide both color and object position information.

Lastly, because lithium polymer batteries are used to power GAPA, an advanced power management board was designed and built. This board monitors battery voltage and when it determines the voltage falls below a preset threshold, shuts down power to most of the high current devices (crusher, and manipulator servos). In addition, because servos require relatively high currents at five volts, the power management board also contains a high efficiency DC-DC converter to provide five volts from the twelve volt battery pack.

Behaviors

The default behavior of the robot will be to patrol the parking area. This will consist of driving down straight paths perpendicular to the parked cars. During this behavior, the robot will avoid obstacles and identify offending vehicles.

When an offending vehicle is located, the robot will position itself to remove the vehicle. The manipulator will then pick up the car via a magnet and place it in the crushing unit. The car is then stored in a recycle bin to be emptied by the end user.

After a vehicle has been crushed, the robot will continue is patrol around the parking lot searching for more vehicles. This behavior continues indefinately.

Conclusion

At the time of this writing, the robot is complete. The chassis contains the arm to pickup the vehicles, the crushing unit, obstacle avoidance sensors, and CDS line following

sensors. The robot can successfully patrol a parking lot, locate illegal vehicles, pick them up, and crush them.

A key challenge of the robot was discriminating colors. The color red is very close the color orange. This is a serious problem because GAPA may accidentally crush a gator fan's vehicle. In addition, lighting greatly affects the performance of the camera module.

Another challenge overcome is four wheel drive. Initially the robot was working on two wheel drive with two casters. This, however, proved to be problematic on uneven floors as the robot lost traction and then over corrected. This problem was overcome by implementing four wheel drive.

In the future, it would be advised to use a dedicated servo controller due to the sheer number of servos in use on this robot. This functionality was included on the power management board, however, glitches are somewhat common resulting in the operator having to manually turn off the robot to avoid damage.

In addition, the camera module is operating in a relatively dumb mode in which the illegal colors must be programmed prior to the robot patrolling an area. Future work would include reprogramming the camera module to recognize colors which are neither orange nor blue. This is more along the lines of the spirit of GAPA rather than just looking for bad colors known a priori.

Appendix

Source code is provided as a soft copy.