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Autobot Racing

Project Backlog

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TEAM #

Problem Statement

Autonomous vehicles are an area of active research, and our team would like to contribute to the growing body of knowledge in that area. The aim of this project is to create an automated car racing system, with centralized control of all vehicles. While similar systems may already exist, this new “Autobots” system will implement advanced behaviors such as lane-keeping and passing capabilities, along with collision and obstacle avoidance. This will be achieved with one sensor: an overhead camera tracking all vehicles.

Background Info

As autonomous vehicles are becoming more prevalent in today's society, researchers need to understand the complexities and difficulties of developing algorithms for autonomous vehicles. As automobiles are expensive, it is cost prohibitive to create a full-scale research setup. To fix this, a cheap, small-scale testing environment is needed to save money and better understand the intricacies involved. While this system is targeted towards researchers wishing to pursue autonomous vehicle development, the Autobot Racing development team will be performing its own research using the framework it establishes, including development of autonomous driving algorithms. The team will thus serve as both developers and as researchers. After the project is completed, the framework will be made available for future research by other interested parties.

While similar systems have been created, including a well-developed one at ETH Zurich, this system aims to be cheaper to build, use fewer custom components, and be easier to set up. Unlike the system built by ETH Zurich, which involved custom PCBs with microcontrollers and digital radios on each car, Autobots will use off-the-shelf RC cars, requiring no modification to the vehicles themselves. This significantly decreases hardware costs.

Functional Requirements

As a researcher...

- I would like the cars to navigate a set course.
- I would like to implement autonomous lane-keeping behavior.
- I would like to implement autonomous passing behavior.
- I would like to implement speed or cruise-control behavior.
- I would like to implement immobile obstacle avoidance. (if time allows)
- I would like to implement moving object avoidance. (if time allows)
- I would like to record race statistics, such as lap times.

As a developer...

- I would like to provide a framework for performing research.
- I would like to determine the course followed by the cars.
- I would like to develop a test track for the cars
- I would like to interact with an RF controller to send signals to the cars.
- I would like to control a minimum of three cars simultaneously.
- I would like to identify obstacles and other items on the track using computer vision. (if time allows)
- I would like to read QR codes (or other visual identifiers) placed on the track and on vehicles.
- I would like to differentiate vehicles based on their QR code or identifier.
- I would like to use a single camera, mounted above the course, for all object tracking and localization.
- I would like to control the entire system using a PC or web-based interface.

Non-Functional Requirements

As a developer...

- I would like to have code that is sufficiently documented and well formatted.
- I would like code that is modular and built to accommodate updates in the near or far future.
- I would like the application programming interface (allowing researchers to control cars) to be flexible and well-designed.
- I would like to use a Raspberry Pi, or similar board, for interfacing with the RF transceiver.
- I would like the commands sent to the cars to be received virtually instantaneous. This is important due to the fact that commands will help drive the car around the track keeping it on course and avoiding collisions. Delays in reception or sending of commands could result in a collision with another car or obstacle
- I would like to use OpenCV for vision processing, due to its open-source code, lack of licensing fees, and large support community.

As a project owner...

- I would like hardware costs to be reasonable and well-controlled.
- I would like for off-the-shelf hardware to be used in development, in order to decrease construction costs.