ARC Problem Statement

Senior Capstone Project

Oregon State University

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Abstract

Currently, autonomous vehicles are built with many custom parts and assemblies and are very expensive. The cost of entry to autonomous vehicles is often prohibitive for the average consumer. The purpose of this project is to determine if it is possible to build an autonomous RC vehicle using commodity hardware. This will be accomplished using commodity hardware, including cameras, computers, and the RC vehicle used as the base, with minimal fabrication.

I. Problem Definition

Autonomous vehicles often cost thousands of dollars to build, and there are few options available that can be easily retrofitted. Our goal is to find out whether or not it is possible to take commodity hardware, retrofit it onto a RC car, and have it be able to navigate obstacles at speed. We also want to create a list of hardware components and a software solution that can be retrofitted onto at least one model of RC car, in order to enable autonomous navigation and operation.

This implementation would be a small scale version of the DARPA grand challenge, where autonomous vehicles navigate themselves 100 miles through the Mojave Desert, in under 10 hours. Our goal is to implement a RC car able to navigate to a given point as fast as possible, which is a small scale version of the challenge. The RC car should be able to navigate through a room or space, without prior knowledge to the environment, within a set amount of time and parallel park. Stretch goals for the project would be high-speed obstacle avoidance and drifting on a dirt track.

As this is a research project, we do not know if it is possible to implement these features. Millions, if not billions of dollars have been allocated for research of autonomous vehicles. A lot of the hardware is very specialized, and often very expensive. Our challenge is to see if it is possible to replicate a small subset of the expensive system's abilities, at a small scale, using hardware that costs hundreds of dollars instead of thousands or hundreds of thousands.

II. Proposed Solution

Our solution will prove if it is possible to implement autonomous point-to-point navigation of a RC vehicle in low-speed and high-speed scenarios using off-the-shelf retail/commodity hardware (i.e. something you could purchase from Best Buy, Radio Shack, Amazon, etc.). The software will be an implementation of readily available open-source distributions, such as Georgia Tech's GT AutoRally. For hardware, we will use a retail RC vehicle as the base with additional hardware for computation, such as the Intel NUC micro-pc, and control, such as the BeagleBone micro-pc with cape. The major components including cameras, GPS, accelerometers, etc. will be kept as close to retail as possible. Certain hardware, such as mounts, may need to be fabricated to attach components, like the mini-pc, to the RC vehicle.

This project will be successful if the RC vehicle is able to autonomously navigate point-to-point using low-speed obstacle avoidance and high-speed maneuvering when appropriate. Examples of low-speed scenarios are ninety-degree corners, tight s-turns, or multiple offset obstacles in the path. High-speed scenarios will include straight-line acceleration and drifting through large-radius corners.

While a successful result is the desired outcome, an unsuccessful result, if accompanied by enough data and documentation, will prove that it is not yet possible to implement autonomy at the RC model scale using only off-the-shelf, retail/commodity hardware (as described above).

Our presentation at expo will be a booth that will either show successful autonomy of an RC vehicle, or show why it is not yet possible to produce the autonomous requirements specified in the problem definition. The presentation will include

a large poster with the team/project name and smaller displays depicting elements of the project process. There will be video comprised of the final capstone presentation video and also video of the project taken throughout the term and will have basic editing and formatting for appearance. We will have our final capstone report available for those interested and will display the RC vehicle used in the project. The project team members will accompany the expo presentation and will interact with those interested.

III. Performance Metrics

Basic Criteria:

- Self-navigate from point to point.
- Low speed obstacle avoidance
- Parallel parking

Advanced Criteria and Stretch Goals:

- Obstacle avoidance at high speed.
- Drifting (Dust track)
- Track current position with respect to the location of base station in order to not have the car drive away.

At the end of Spring 2017 (before the Engineering Expo), all the basic objectives above should be accomplished on the RC vehicle provided, with minimal specialized hardware and fabrication. Advanced Criteria and Stretch goals will be used to provide additional criteria if the basic criteria are finished early. If a final product is not delivered on time (before the Engineering Expo), we shall provide strong reasonings on why an objective was not feasible with the time and resources given.

The outcome of this project will be measured on the completeness of the final product or the soundness of the reasonings if any of the objectives are not achieved.

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