CPSRC/HSL Drive-by-Wire

Problem Statement:
The Cyber-Physical Systems Research Center currently lacks a platform to test self-driving algorithms. The capstone team will convert a Polaris GEM e2 to be controllable remotely via joystick, algorithmic input, and manual control.

Figure 1: Polaris GEM e2 via Polaris

Purpose & Background:
The purpose of this project is to ultimately build a self-driving electric vehicle for the Hybrid Systems Labratory in order to do research on sensing, control, and networking in collaboration with Corporate Partners. Partial funding comes from Seed Funding for Center Scale Research Initiatives to build a framework for merging feedback control algorithms with computing system designs to reduce operational risks and optimize performance for intelligent transportation systems and other cyber-physical systems. The short-term goal is to enable joystick control of the vehicle, and the long-term goal is to prepare the platform for safe and autonomous navigation within the UC Santa Cruz extended campus. The vehicle will be utilized as a testbed to develop practical on- and off-campus applications, such as autonomous delivery and transportation vehicles.

Target End User:
The target end user is Hybrid Systems Laboratory (HSL) at UC Santa Cruz. The HSL intends to use the drive-by-wire platform to work on autonomous driving algorithms and controls which will be carried out by other students and researchers in future projects. This testbed will provide a wide range of research collaboration opportunities with corporate partners who will be able to test new technologies on the platform.

Objectives:
Our objective is to deliver a system that will enable the control of the GEM e2 via software commands while also providing manual override as a failsafe. The SDP team will be responsible for designing and implementing the modifications to the vehicle necessary for software control. This will include modifications to the steering, braking, and accelerator as well as a microcontroller infrastructure in order to allow for manual control via a joystic as well as complex digital control through a laptop that will eventually be running autonomous algorythms.

Client Profile:
The client organization is the Hybrid Systems Laboratory of UC Santa Cruz. Our team will be communicating with the following people:
Prof. Ricardo Sanfelice <ricardo@ucsc.edu>
Eric Partika <epartika@ucsc.edu>
Jovita Martinez <jmart262@ucsc.edu>
Eric Guerrieri <eguerrie@ucsc.edu>

Project Timeline and Milestones

Action items for this project are:

1. Identifying architecture already present on the vehicle
2. Choosing hardware to supplement what is already on the vehicle
3. Installing actuators and sensors needed for driving, braking and steering
4. Writing embedded code to control motors and receive sensor input.
5. Log data from GPS and IMU to store data for analytics and basic mapping
6. Configure a computer running the Robot Operating System (ROS) in order to manage multiple inputs and potential automation tasks

Stretch Goals:

- Implementation of basic SLAM algorithms
- Addition of LIDAR and CV cameras
- Setting up software for computer vision, begin identifying basic road milestones such as stop signs, lanes crosswalks, etc.
- Write control logic to make the vehicle follow identified markers

Project Location and Contact:
The project work will be done at UCSC campus and UCSC Westside Research Park.

SDP Team Composition:
Micah Herbert

Walter Teitelbaum
Arturo Gamboa-Gonzalez
Sriram Venkataraman
Sutter Lum

Project Budget and Materials:
Funding for drive-by-wire equipment is available, in particular, for the purchase of embedded hardware for steering, braking, acceleration; actuator for braking; electric powered steering; communication systems/buses; and sensors. The project is currently funded through support by AFOSR, CPSRC, HSL, and UCSC.