An Autonomous Shuttle Platform for Evaluating Control and Obstacle Avoidance Strategies

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Abstract
We have a drive-by-wire electric shuttle equipped with several basic sensors needed for autonomous operation. The shuttle is capable of following a predetermined GPS waypoint path at speeds of around 10 kph. Roof-mounted 3D LIDAR is used for obstacle detection, and a forward-facing camera is used for object classification. We believe that Autonomous Shuttles can solve the last mile problem effectively and cheaply. Towards this end, we plan on deploying the first shuttle on Texas A&M Campus in August.

Plan
We would like to implement and evaluate various control strategies for autonomous vehicles, and test them in a real world environment. Our goal is to develop and deploy a fleet of Autonomous Electric Shuttles on Campus for on-demand, cheap, shared transportation.

Architecture
Sensor data is processed in ROS to facilitate interoperability of control packages. Basic versions of all key subsystems have been implemented. Speed and angular velocity commands are generated from the waypoint follower. The obstacle detection package modifies these commands based on detected obstacles. The command is finally fed into the vehicle controller which outputs throttle/brake and steering commands over CAN bus.

Sensors Mounted:
- Velodyne VLP-16
- Novatel Propak6 GPS
- Sensonor STIM300 IMU
- ZED stereo camera

Onboard Computer:
- Intel i7 CPU
- Nvidia 1080ti GPU
- Ubuntu 16.04
- ROS Kinetic

Shuttle Specifications:
- Capacity: 4 People
- Top Speed: 25 mph
- Propulsion: Electric
- Range: 30 km
- Length: 144 in
- Wheelbase: 101 in
- Width: 60 in
- Height: 80 in

Future Work
- Improved path following
- GPS denied planning
- Robust path planning
- Obstacle path tracking
- LIDAR sign detection

Control and Planning Evaluation
Presented are plots detailing path tracking accuracy for a simple proportional-control waypoint follower. There is consistently high cross-track error suggesting the need for improved control.

Path Tracking
- Error vs Speed
- Speed Control
- Angular Control

In July we will be providing shuttle service between a hotel and golf course near Texas A&M to get a baseline evaluation of the shuttle’s operation.