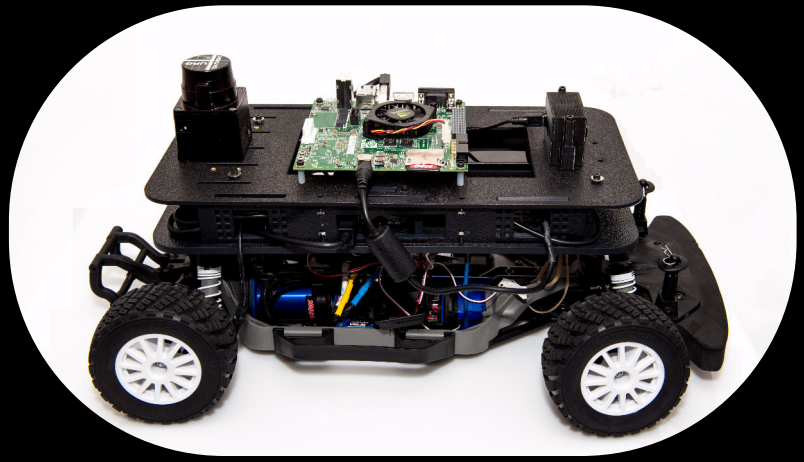
F1/10

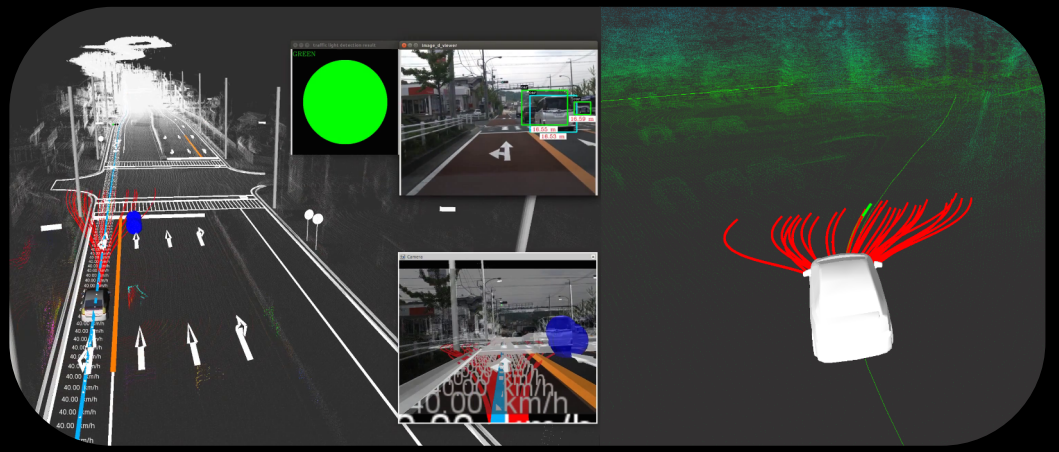
Autonomous Racing

1/10 the scale. 10 times the fun!

Build. Drive. Race.



Perception. Planning. Control



Spring 2018 | Instructor: Madhur Behl

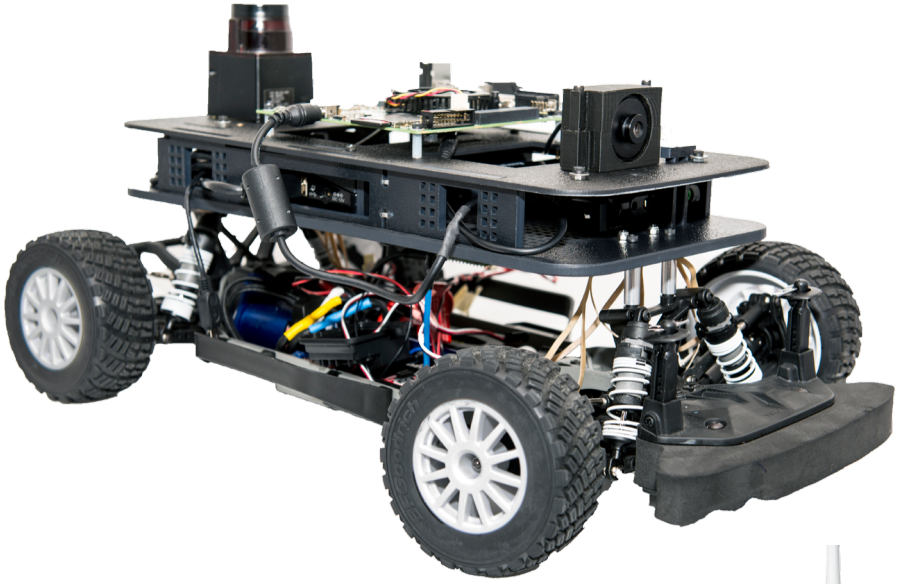
Do you have what it takes to build the fastest autonomous driver?

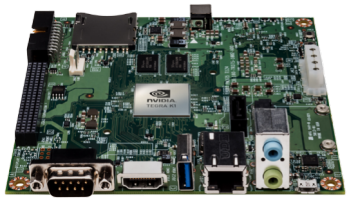
Platform

A 1/10th scale RC car provides the base vehicle.
Components are added to make the car fully autonomous.

For perception, a LIDAR, stereo, and depth cameras are added to a custom-built mounting frame.

An inertial measurement unit (IMU) is used to aid in vehicle control, while an embedded microcontroller provides the necessary support for controlling the motor.
All computation and motion planning is done using an on-board NVIDIA Jetson.





NVIDIA Jetson

LIDAR

Camera

Telemetry

IMU

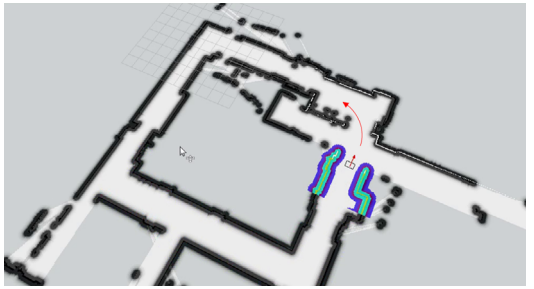
Motor Controller

Stereo Camera

Course

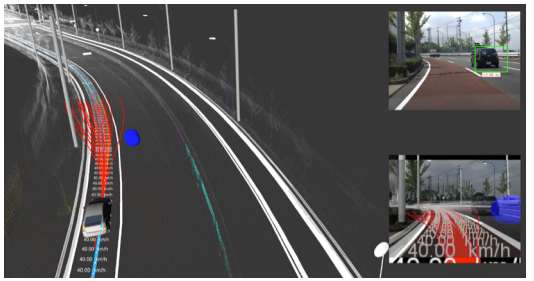
The F1/10 autonomous racing course focuses on learning how to build, drive, and race 1/10th scale F1 race cars (capable of speeds in excess of 20 mph all while learning about **perception, planning, and control** for autonomous navigation.

Learn about the technology behind slef driving cars while building one, on your own.



LIDAR scan map

Topics

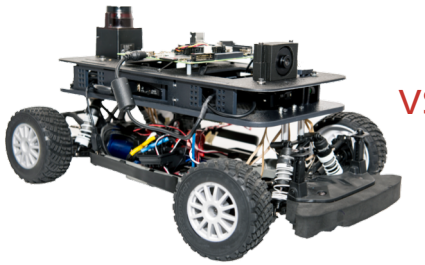


Motion planning simulation run in ROS

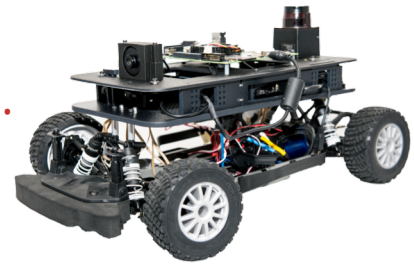
Robot Operating System
Perception pipeline using LIDAR, Cameras, and IMU.
Odometry Basics.
Localization and Planning using Scan matching, kalman filter, particle filter (AMCL), vanishing point.
Mapping using Hector SLAM
PID control.
Command the steeting and acceleration inputs of the car.
Data visualization and debugging tools.

Advanced topics in scene understanding: obstacle detection, lane detection
Collision avoidance
Optimal racing lines and racing strategies.

The course will end with a *battle of algorithms* F1/10 GP race amongst teams



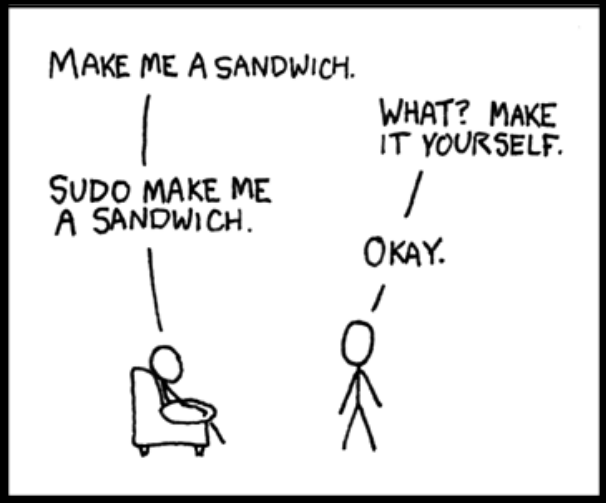
VS.

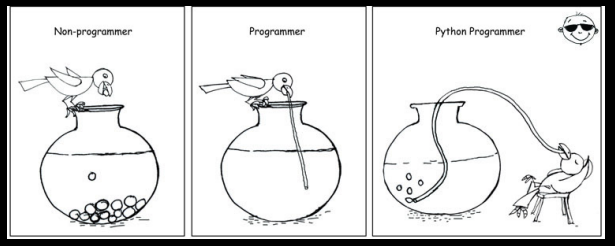


This is an *advanced* special topics class. Which means, that although, we will cover everything which is required to build, drive, and race the cars; it is assumed that students have some familiarity with the topics highlighted below.

To succeed in this course, you need to have some experience with the following topics:

- Calculus and linear algebra:
  - Single variable calculus and differential equations.
  - Matrix operations- transformations and rotations.
- Basic statistics and probability:
  - What is a probability distribution?
  - What is sampling? Mean, and variance of samples.
- Intermediate Python:
  - Function calls, conditional statements, loops and recursion
- Unix/linux command line/shell basics
  - File commands/file permissions: *ls, cd, pwd, mkdir, rm, cp,mv, touch, chmod, tar*
  - Process management: *ps, top, kill pid*
  - *ssh user@host.., grep, locate, echo*
  - Installation: *./configure, make, make install*
  - Ports: */dev/ttyACM**
- Basic physics (Newtonian mechanics)






```
int getRandomNumber()
{
    return 4;  // chosen by fair dice roll.
               // guaranteed to be random.
}
```

Background in the following is recommended, but not required:

- Intermediate C++
- ROS programming
- Integrating sensors with microcontrollers (master/slave configurations)
- Machine learning

If upon, looking at these topics, your conclusion is: *I'm qualified, but not* **that** *qualified.* Then it is likely that you are qualified.
If you are still unsure, feel free to email the instructor for permission to register.