Intelligent Ground Vehicle Competition (IGVC) Robot

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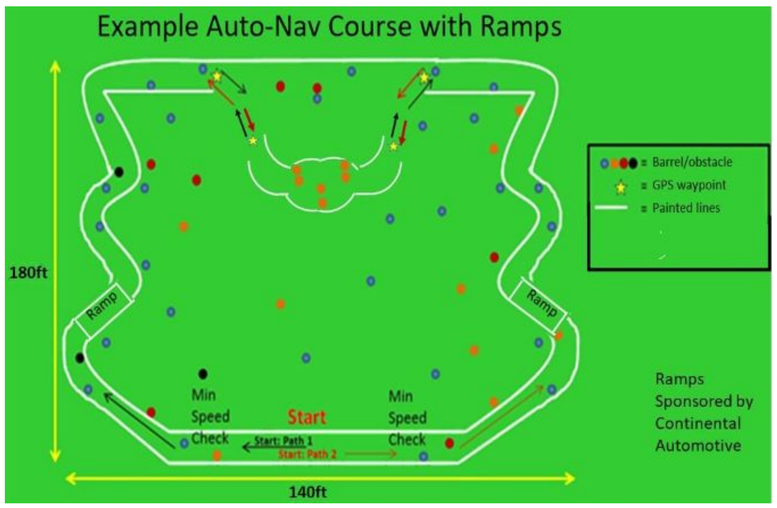
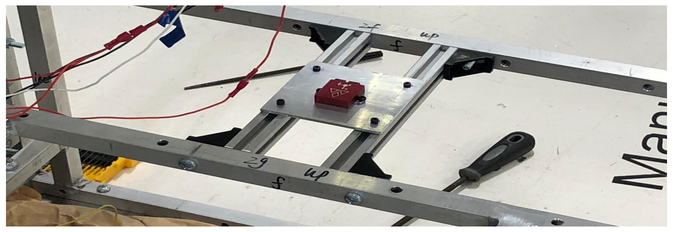
What is IGVC?

The Intelligent Ground Vehicle Competition, or IGVC, is a competition where teams build and assemble an autonomous robot that can navigate a Course, dodging Obstacles and staying within Lanes.



Mechanical Design

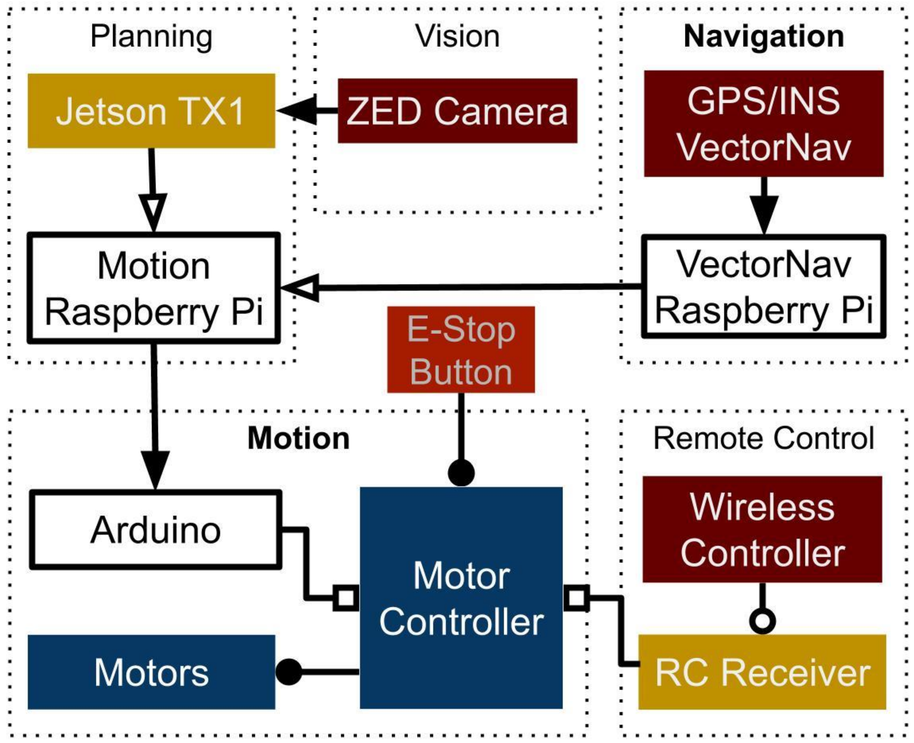
Steering – Tricycle, Tank-style turns, front tire steers
Body – Aluminum Chassis, Thin Steel Sides, Epoxy Top, 3D- Printed Fan shrouds
Doors – Access to 20lb weight, battery, router
Lid – Aluminum frame with plastic center, access to Electrical Platform from above
Camera – Dual Post for vibration stability, detachable for transportation
Emergency Stop – Waterproof Stop Button, Motor-Enable Switch, Reset Button
VectorNav IMU- Mounted to the center of rotation



Networking

The robot contains multiple processors which communicate via The three Raspberry Pis, along with the TX1 are interconnected via Ethernet to an onboard Router. The three Raspberry Pis use the **Robot Operating System, or ROS.**

Subsystem Flow Chart



Vision – This Object and Lane Detection Subsystem contains the ZED Camera & Nvidia Jetson TX1. The ZED Camera sends data to the TX1. This subsystem detects the Objects and Lanes and then publishes that data to the Planning system.
Navigation – This Subsystem contains the VectorNav GPS/IMU and a Pi. The Pi receives GPS data and then publishes it to the Motion Planning Subsystem.
Planning – This Subsystem contains the TX1 and the Motion PI. The Mapping software collects data from the vision and navigation Subsystems to produce a Course Map.
Remote Control – Containing the RC Receiver and an Arduino, this Subsystem receives data from the RC Remote Control, which then sends this data to the Arduino and finally to the Motion Planning Pi which then moves the robot according to the RC controller inputs.
Motion – The Roboclaw receives instructions from the Arduino and Remote Control System, through the Multiplexer, and controls the motors. The Emergency Stop has a switch that will interrupt power to the motors and the motor controller, stopping the robot.

Lane & Object Detection

Filtering – Utilizes a Convolutional Neural Network (CNN) to perform semantic segmentation to identify lanes.
Thresholding – Used to remove noise produced by the CNN and remove entities the algorithm poorly differentiates such as shadows.

Mapping & Path Planning

Mapping – Objects locations are recorded within a matrix. The matrix representing the map enlarges as new information is discovered.
Path Planning – D* algorithm is used to navigate the environment.

For pathplanning image

Testing & Verification

Simulation - Gazebo simulation is a robotics software testing tool. The software subsystems are tested within it on a simulated course and robot.
Testing Course – Materials were acquired to construct small practice courses to physically test and verify the functionality of the robot.