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NI AUTONOMOUS ROBOTICS COMPETITION

Each year, National Instruments (NI) sponsors an autonomous robotics competition to showcase NI products as well as the robotics capabilities of university students. In 2018, robots performed various tasks on a track that simulated terrain and traffic conditions that autonomous vehicles will experience in the future. This project investigates the use of multiple types of sensors, autonomous decision making, and data processing.

Background

Autonomous Transportation

By removing a human driver from behind the wheel of a vehicle, the likelihood of a crash due to human error is essentially eliminated. By utilising autonomous systems designed and rigorously tested by experienced automation engineers, passengers in autonomous vehicles will be able to use their commute time for work or leisure activities. By enabling communication between autonomous vehicles, traffic flow can be more efficient, and overall commute times can be reduced. Long-haul freight efficiency can also be increased as autonomous vehicles do not experience fatigue nor hunger, thereby travelling further in shorter times.

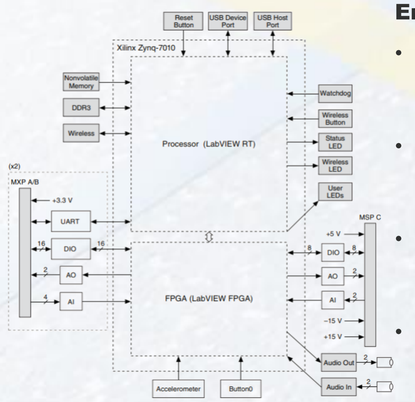
Processing Platform

NI MyRIO-1900 Real-Time Embedded Evaluation Board

- Xilinx Zynq 7010 FPGA - parallel sensor data acquisition and webcam image processing
- ARM microprocessor – computation, code execution and decision making.

NI LabVIEW 2017 Programming Environment

- System-design platform and graphical development environment provided by NI
- Expansive library of MyRIO toolkits, including FPGA, sensor I/O and data processing tools
- Real-time simulation of virtual instruments to predict real-world robot behaviour
- Graphical visualisation of code execution



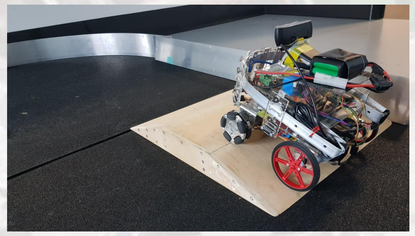
Aims and Objectives

Competition Milestones and Requirements

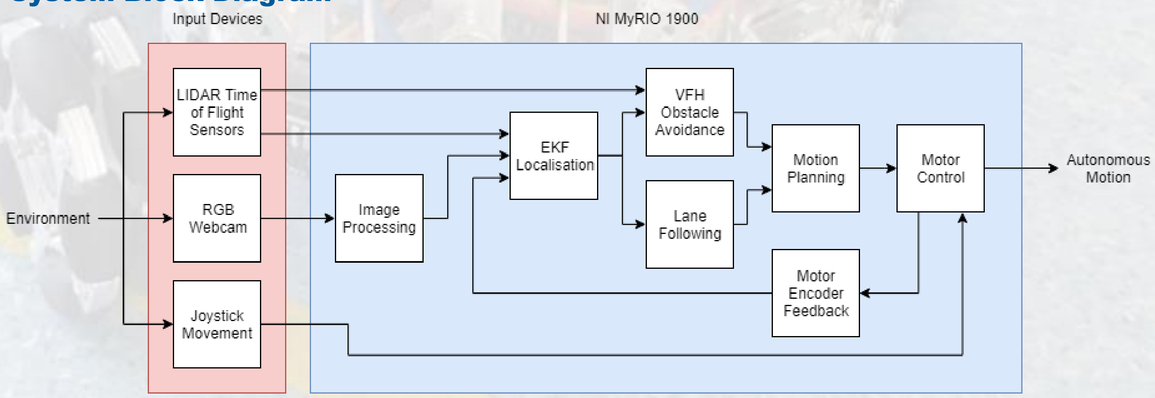
To qualify for the live competition, milestones set at regular intervals by NI were met. These milestones included completion of training courses, a project proposal, obstacle avoidance, navigation and localisation.

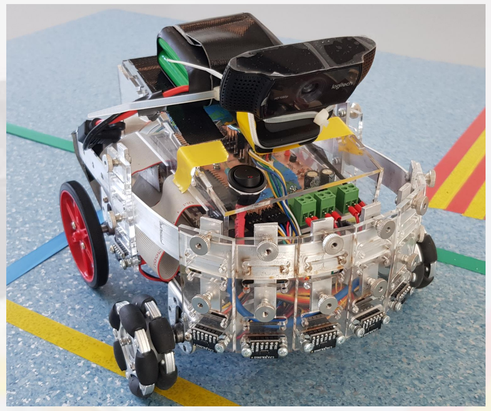
Extended Functionality

The team also decided to implement additional functionality to showcase at the project exhibition, including lane following using the RGB camera and manual control of the robot with a joystick. In both cases, the autonomous systems maintain obstacle avoidance.



System Block Diagram





Software Capabilities

Autonomous Environment Sensing

- Real time line detection and lane following using a Hough transform on webcam images and Extended Kalman Filter
- Localisation using motor encoders
- Obstacle detection and avoidance using Vector Field Histogram and LIDAR sensors
- Smooth autonomous acceleration, cornering and braking using Dynamic Window motor control and PID controllers

Robot Construction

Robot Frame

- Laser cut acrylic chassis designed in Autodesk AutoCAD
- Curved aluminium sensor mounting bar

Onboard Sensors and Actuators

- Logitech C922 webcam for capturing the track in front of the robot
- LIDAR time of flight sensor array for obstacle detection in front of the robot
- Independent DC motors with motor encoders for localisation and motor control

Achievements

Partial success at NIARC 2018

- The team completed all required competition milestones and group deliverables
- A faculty grant was awarded to the team to fund travel expenses for the live competition in Sydney after demonstration of the robot capabilities
- While the robot was quite capable, the robot was knocked out of contention in the elimination rounds