ESS-CAR/NW

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MF2063 Embedded Systems Design Project

Introduction

- This project is about the implementation of an autonomous car that utilizes a software-defined network (SDN) for communication between a set of nodes. SDN is a new type of technology that moves the control part in the switches to a separate controlling node. Communication over the network is done via the VSOME/IP middleware. It is an application middleware that is designed for the car industry and is compatible with AUTOSAR. On the car are different types of sensors used to monitor the car performance and its surrounding. The sensor and actuator communication is done via controllers and the SDN network.

Network

- Software defined network (SDN) is a type of network configuration that moves the intelligence from the switches to a controller unit. This makes the network smarter and more dynamic. It can sort packages depending on their priorities and traffic load to different paths, to enable faster computing and a better distribution of the network load. It is self-configured when a link goes down or a new link opens up. The SDN is implemented using the OpenFlow protocol for controlling the switches.
- Three SDN enabled switches from Zodiac FX is used in this project and the network is configured according to the topology in figure 1. The controller is a Raspberry Pi model 3 that uses the RYU SDN framework to control the switches and to gather network information.
- Information is sent between the nodes using a middleware application called VSOME/IP which is designed for automotive products e.g. cars and is compatible with AUTOSAR.
- Arduinos are used on the edge of the network, to control sensors and actuators. The data is then passed via an SPI interface to a BeagleBone Black that for processing and transporation out in the SDN.

Network Figure

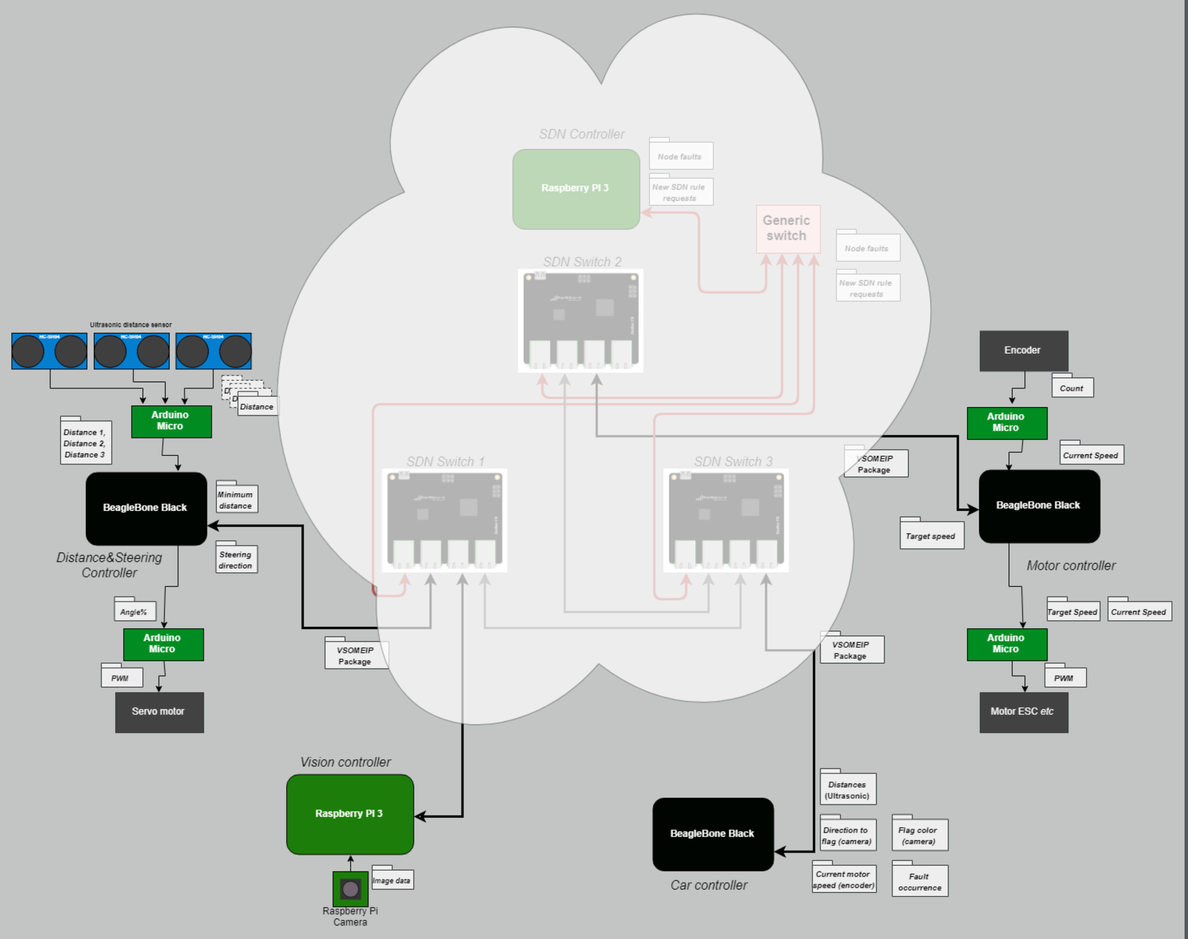

Figure 1:Network topology

Control and sensors

- There are three ultrasonic distance sensors placed in front of the car to detect obstacles. The three sensors are placed so that they provide directional distance data, to enable fast avoidance if obstacles are detected on the left or right hand side of the cars heading.
- By using a Raspberry Pi camera, the car should be able to detect traffic signs, but a simplification was made to only detect a set of colours. If there is a green sign in the field of view of the car, it will follow the sign. If the sign is red, the car will stop.
- An IR sensor placed close to the left rear wheel to measure the speed. Aluminium tape is placed evenly spaced inside the wheel to reflect the light from the sensor so that it registers a pulse. By counting the pulses and measuring time one can extract speed information.

Assembly

- The car was assembled with laser cut acrylic plastic, designed to secure the hardware on top of the frame. A test rig using the partially assembled car is shown in figure 1.
- The design of the assembly platform was done in Autodesk Fusion 360.
- The car is powered by a lipo battery with 2 cells. This is used to power the engine and all the components of the car via the PCB designs. One switch requires 9v to run so a boost converter is used to convert the otherwise required 5v supply.

Figure of the car

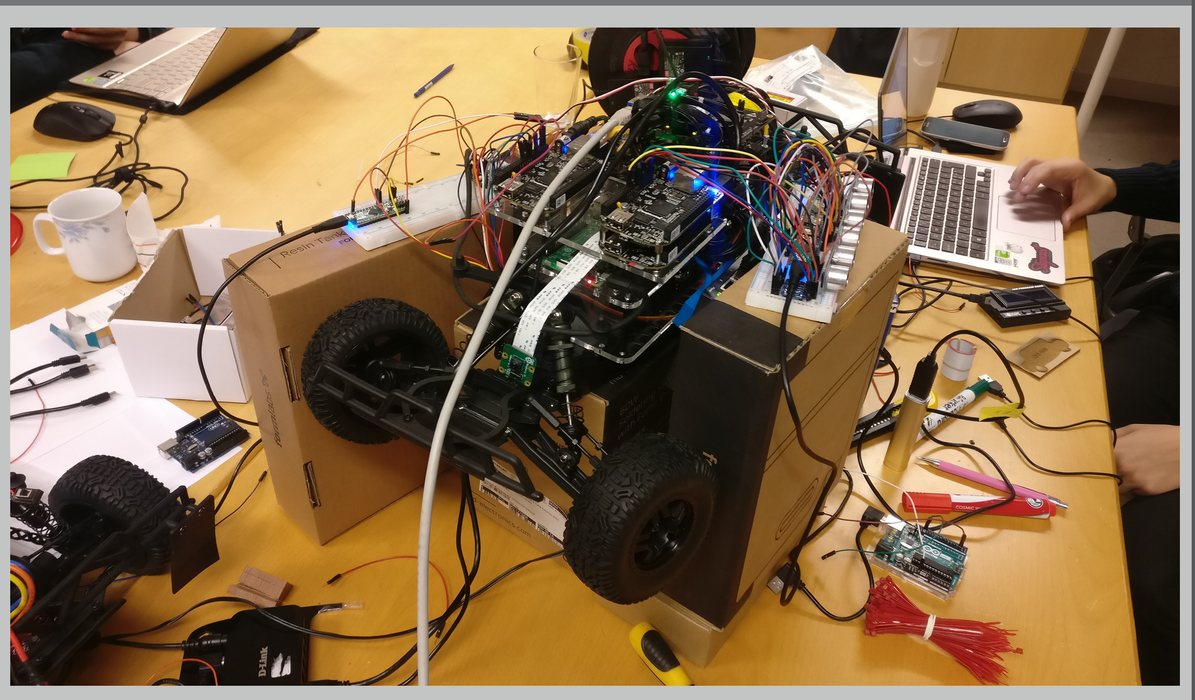

Figure 2:Picture of the car

Acknowledgments

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Prodject Information

- Github: https://github.com/fhyy/MF2063-ESS-NW-CAR