Teaching and development project for an eMobility bachelor course.

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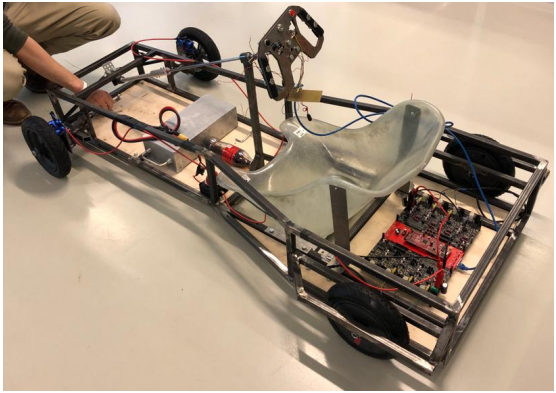
Introduction

Task: Develop an electric kart for training eMobility to bachelor electrical engineering students

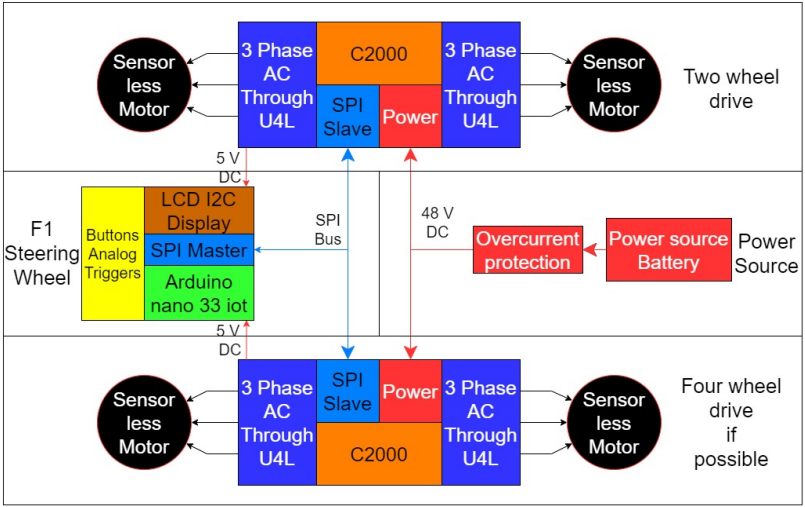
- Motor control
- System control
- Communication



System overview

Combining motor control with steering wheel controls

- Two Permanent Magnet Synchronous wheel hub motors
- Low Voltage inverters and Li-Ion Battery
- C2000 Sensorless Field Oriented Control
- Arduino-C2000 communication via SPI

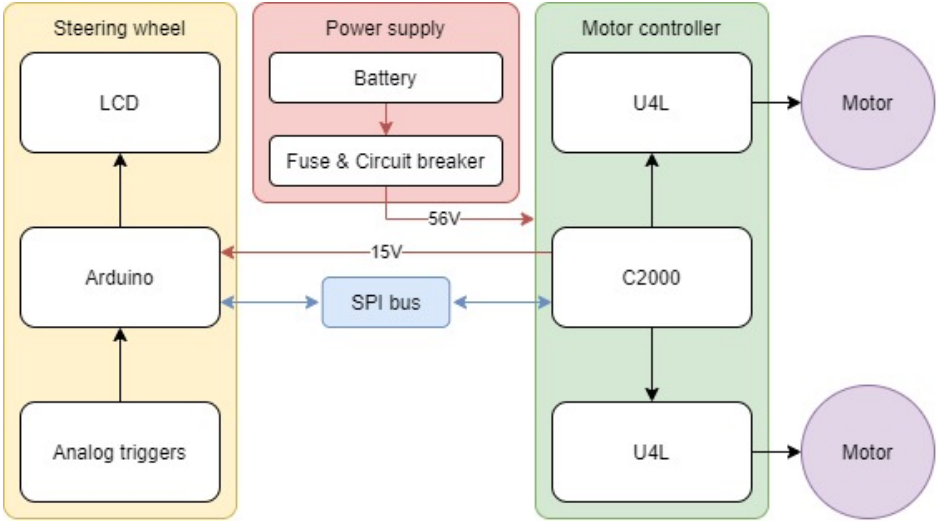


Hardware to drive two or four wheel hub motors.

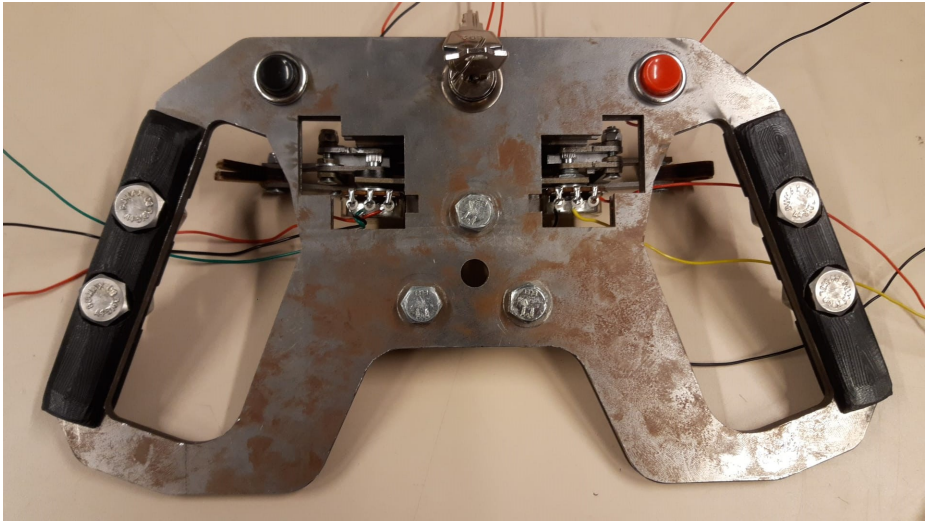
Steering Wheel

Steering wheel has all controls and communication with motor controller

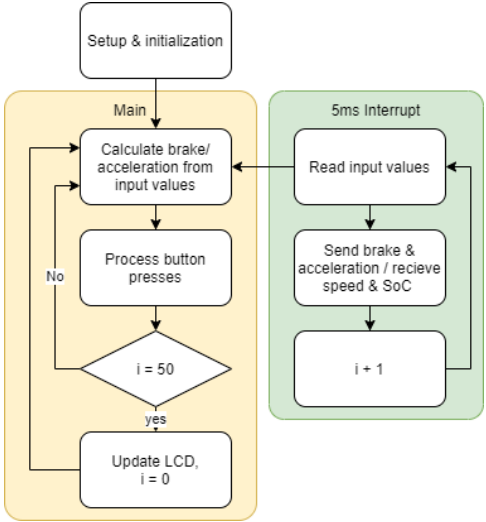
- Acceleration and breaking pedals
- Communication via SPI with C2000 motor control
- 7-bit acceleration or breaking value
- bit-8 is for choosing acceleration or braking
- Every 5ms pedal values send to motor control



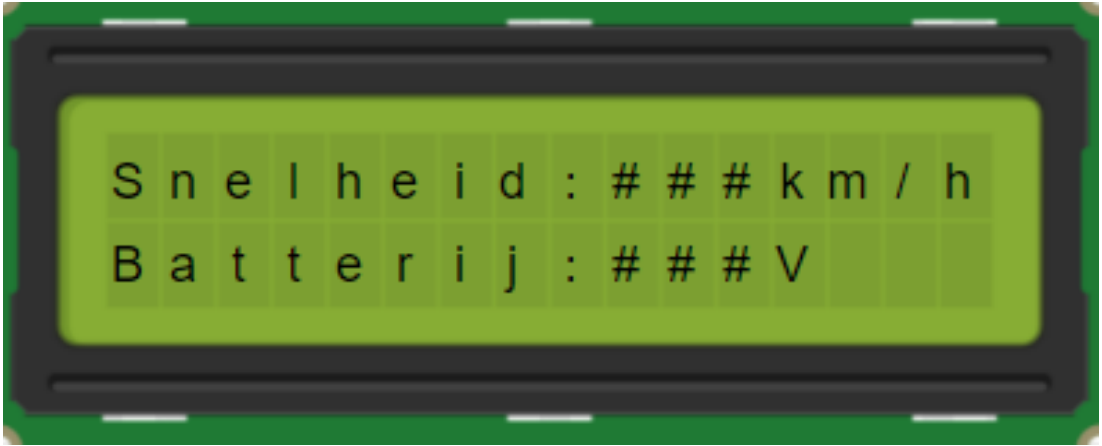
System Overview



Steering wheel with controls



Block diagram arduino code



LCD control

CAN Communication Protocol

Advantage CAN communication

- Provide a very good price/performance ratio.
- Data transmission is very quick, up to 1Mb/s.
- The data is very reliable and has a very sophsticated and robust error detection

Disadvantage CAN communication

- Network must be wired in topology that limits stubs(a length of transmission line that is connected at one end only) as much as possible.
- High cost for software development and maintenance.
- possibility of signal integrity issues.

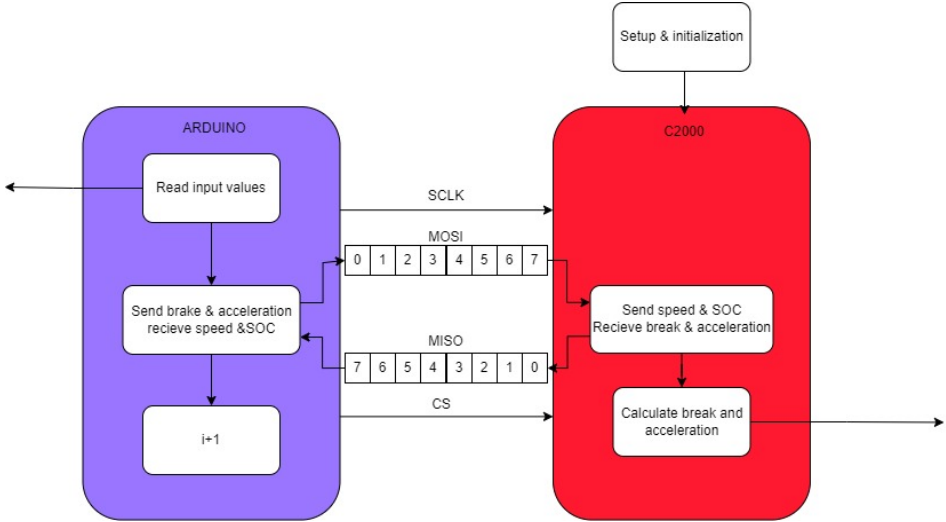
SPI Communication Protocol

Advantage SPI communication

- No start or stop bits, stream continuously
- Higher transfer rate compared to UART and I2C
- Dual communication way

Disadvantage SPI communication

- Only well structured data packages
- No direct communication between peripherals
- Separate CS lines to each peripheral

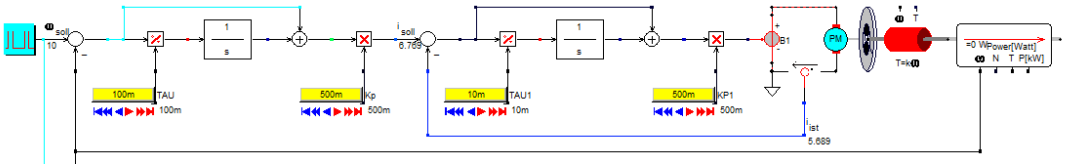


Block diagram SPI Communication

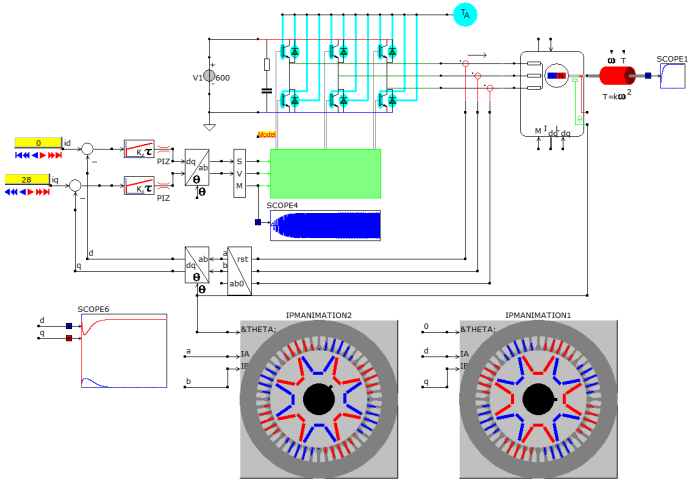
Motor controller

Sensorless Field Oriented Control of Wheel-hub motors

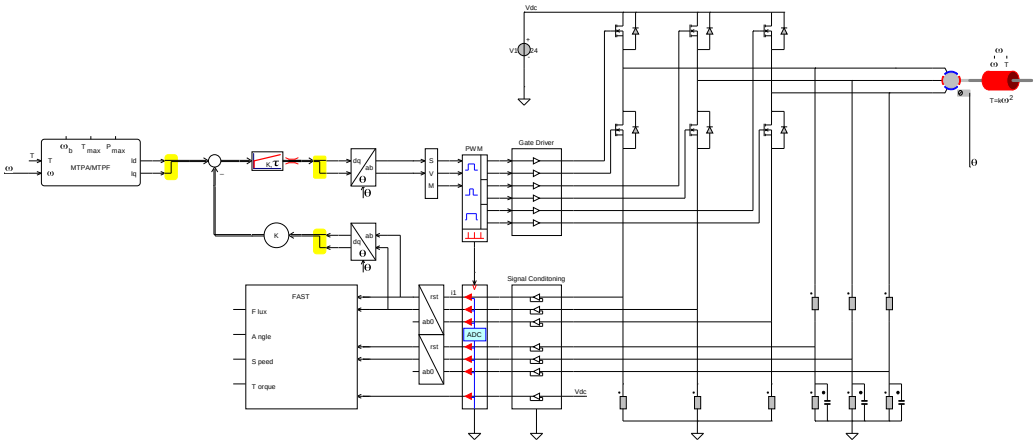
- Motor controller using cascaded current speed regulation using PI controllers
- Sensorless Field Oriented Control, no need for position sensor
- Permanent magnet synchronous machine wheel-hub motors



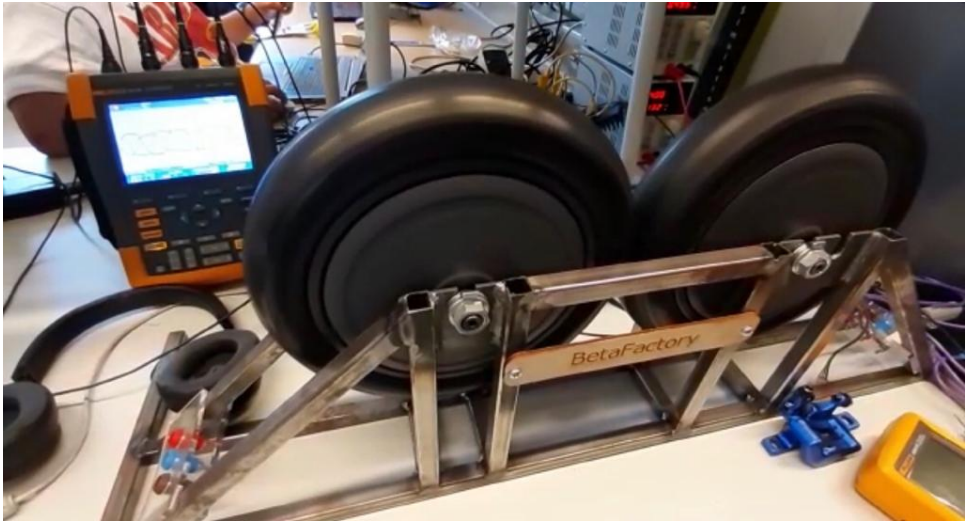
Simple Caspoc simulation to demonstrate the PI controllers



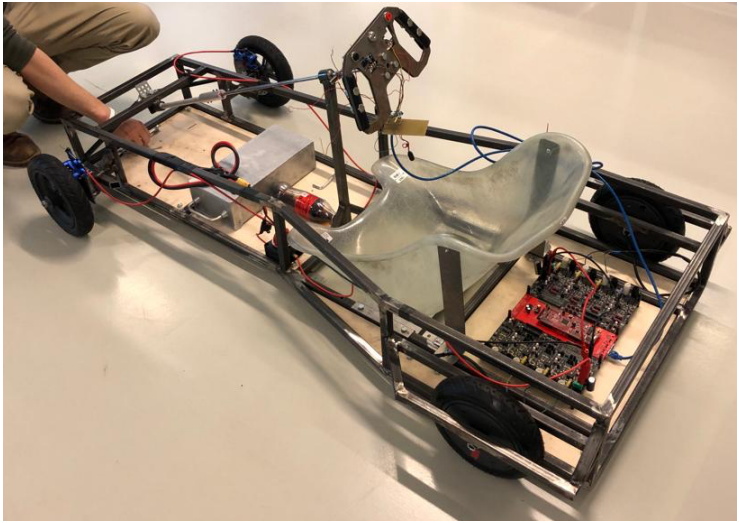
Caspoc simulation of the Field Oriented Control



C2000 implementation of the Field Oriented Control



Test setup to control the motors



Kart with steering wheel and motor controllers

Conclusion

- Wheel-hub motors with sensorless FOC.
- SPI Communication between motor controller and pedals.
- Low voltage, being safe during bachelor laboratory assignment.

Thank you!
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