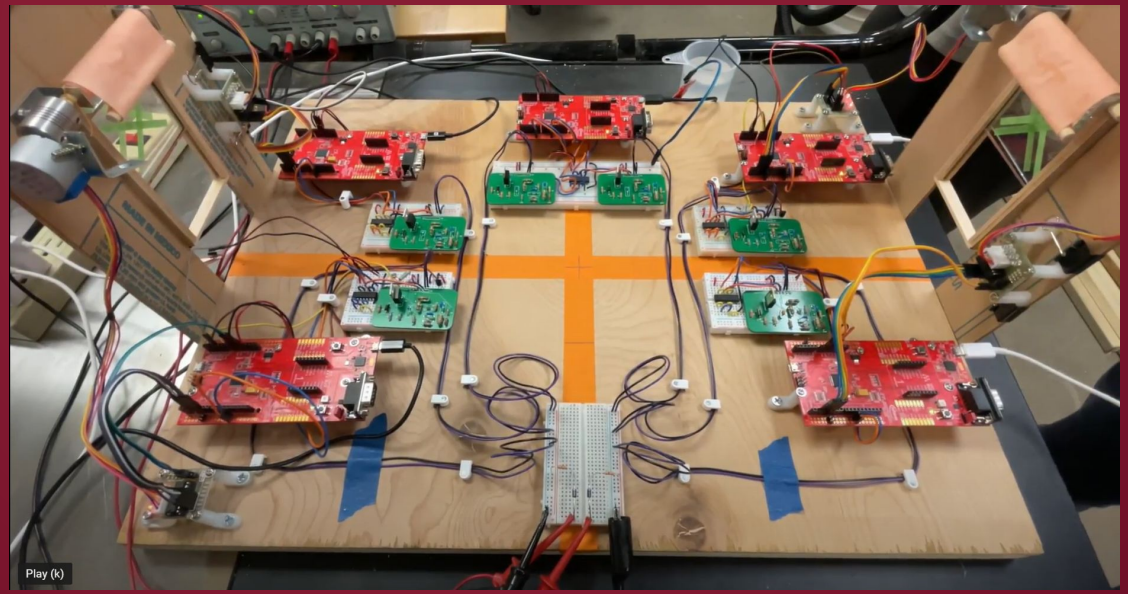
Final Project Review - March 2021

Active Windows Project

Team #15

Michael Chan, Dingbang Chen, Nathan Johnson, Tien Li Shen

Advised by Professor Yao

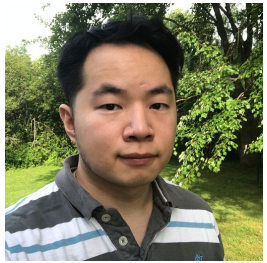


System from CDR

University of Massachusetts Amherst

Team members

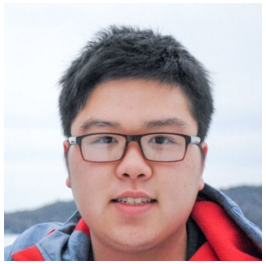
All



Michael Chan
EE

Dingbang Chen
CompE

Nathan Johnson
CompE



Tien Shen
CompE

Problem Statement

Tien

Building automation systems can help reduce operational costs and carbon emissions by improving energy efficiency. However, many current solutions are manufacturer specific and expensive, making widespread adoption difficult.

Our Solution

Tien

Our project aims to assist the non-profit Manhattan-2 company develop “electrical and communications standards that define how devices interconnect within the building of the future.”

This entails:

- Help with the development of an open-source software framework (BuildingBus) to enable easy smart home device development
- Develop a new CAN transceiver circuit that emphasizes smart building network priorities, particularly higher-reliability and lower operational power compared to existing CAN transceivers

FPR Deliverables

All

Michael Chan

- ❏ Team Coordinator
- ❏ System Wiring
- ❏ Protoboard soldering
- ❏ PCB to XMC4200 Integration

Nathan Johnson

- ❏ Analog sensor data collection
- ❏ Sensor databases
- ❏ More sophisticated stimulus/reaction logic
- ❏ Software Team Lead

Dingbang Chen

- ❏ Budget Management Lead
- ❏ Team Website
- ❏ Step Motor Implementation

Tien Shen

- ❏ Finely calibrate sensors
- ❏ Determine voltage/temperature thresholds for multiple output states.
- ❏ Design and build a better mounting system for water level sensor

Software Update for FPR

Nathan

- Modify sensor data acquisition to collect analog values - PARTIALLY MET
  - Current system decides if a sensor is in state 0 or 1 based on a decided voltage threshold
  - Binary data was fine for testing out basic network communication, but is very limiting in terms of possible system states
- Add databases to the motor nodes that store most recent sensor data from across the network - NOT MET
  - Enables nodes to make decisions based on multiple sensors
  - Current system is only capable of making instantaneous decisions on most recently seen sensor data

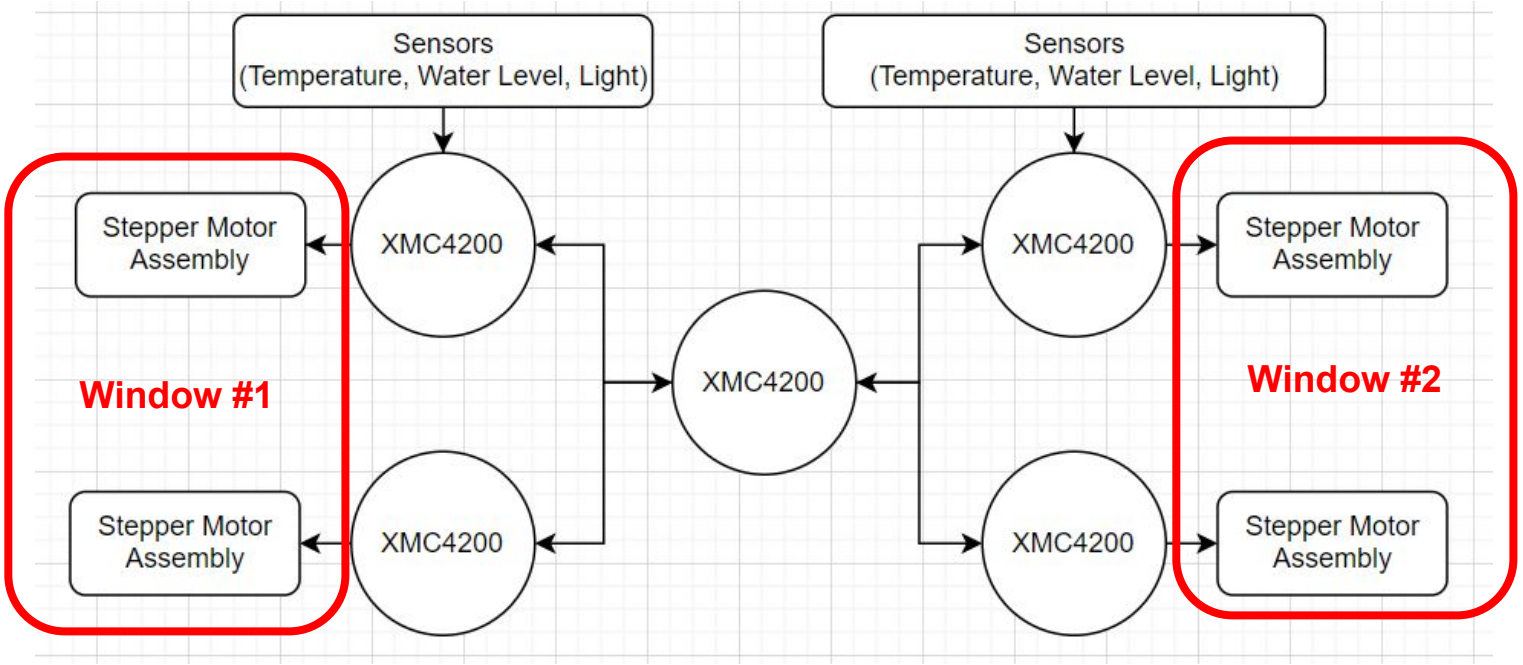
Hardware Updated for FPR

Chen

- ☑️ Replaced all transceiver breadboards with soldered protoboards
- ☑️ Moved sensors from breadboard to solder protoboard
- ☑️ Installed electrical junction boxes for home wiring
- ☑️ Added 500 ft spool of wire on each network
- ☑️ Replaced Dual Lab power supply with permanent 16 volt power supplies

Overall System Diagram

Nathan



Nathan

System Specifications

- Custom PCB CAN transceiver for physical layer communication

- 2 mock windows are driven by two stepper motors each
  - One motor drives the window itself
  - The other raises and lowers a cloth blind
  - These two motors are driven by two different microcontrollers

- 5 microcontroller (Infineon XMC4200) nodes in our network
  - 4 edge nodes on 2 different electrical CANBus networks
  - 1 repeater node to connect the two networks together

- Water level sensor, temperature sensor, light sensor provide stimulus to network
  - All three sensors on only 2 edge nodes
  - Other 2 edge nodes have no sensors

Nathan

System Specifications

- Satisfied Deliverables:
  - Rain/water level sensor
  - Temperature sensor
  - PCB designed, manufactured, in-hand
  - Tree topology CAN bus network (communication between 5 nodes)
  - Motor output demonstrating window actuation
- Unsatisfied Deliverables:
  - Node-to-node network addressing
  - Sensor table memory
  - Motion sensor
  - Transceiver active power draw of <5mA

Hardware List

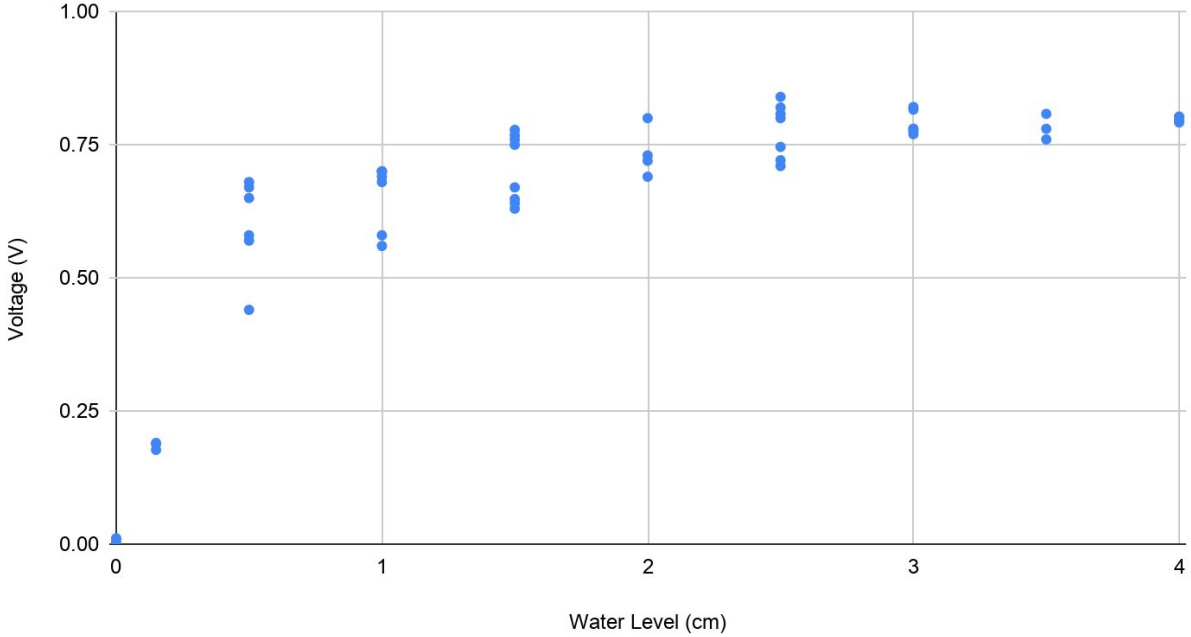
Mike

- 5 - Infineon XMC4200 development boards
- 6 - Custom CAN Transceiver on PCB inserted on a protoboard
- 2 - Electrical junction boxes - 1 per network
- 4 - Step motors and Drivers
- 2 - Photoresistor
- 2 - Water Level Sensor
- 2 - TMP36 temperature sensor
- 1 - Sparkfun Display
- 2 - 16 Volt Power supply - 1 per network

Software List

- DAVE IDE (Eclipse based IDE for programing and debugging embedded systems)
- TINA (Toolkit for Interactive Network Analysis - Circuit Simulator)
- Altium (PCB design tool)

Tien

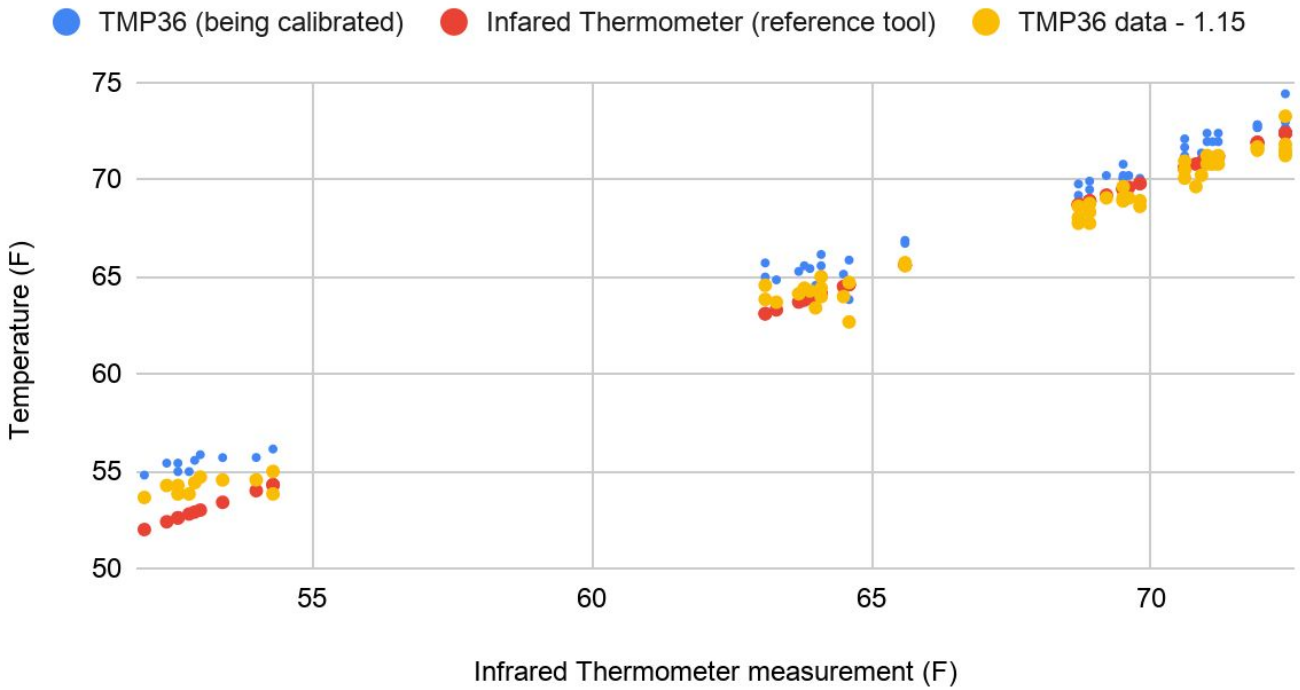


Water level sensor only has binary states

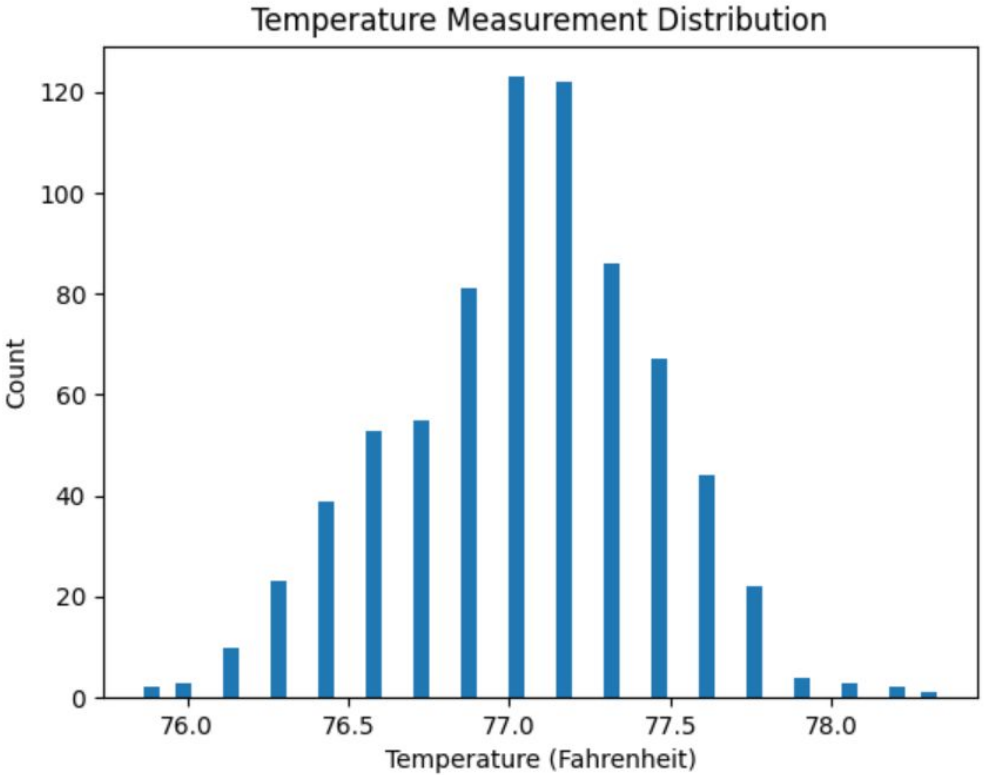
Difficult to formulate a intermediate state due to the logarithmic behavior of the water level sensor. No significant change to voltage when water level is higher than 1 cm.

Tien

Infared Thermometer (reference tool)



Tien



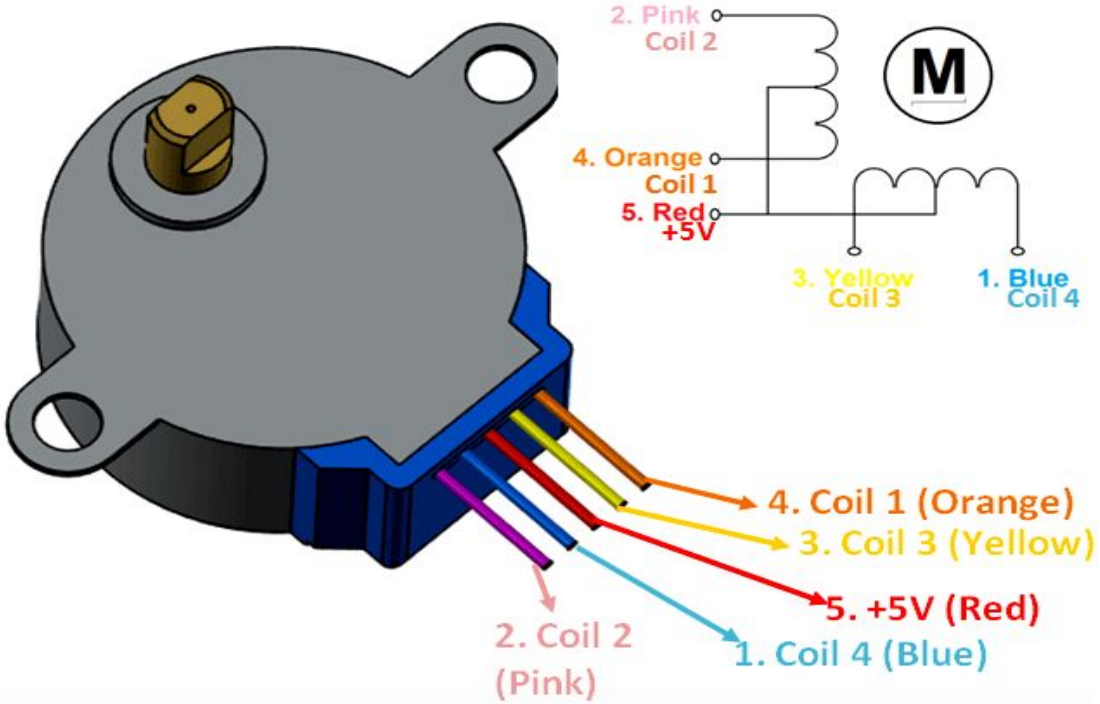
740 Data points, STD = 0.39, mean = 77.0

Precision: 95% confident that temperature measurement is going to be the mean +- 0.77

Documentation of Current Prototype

Chen

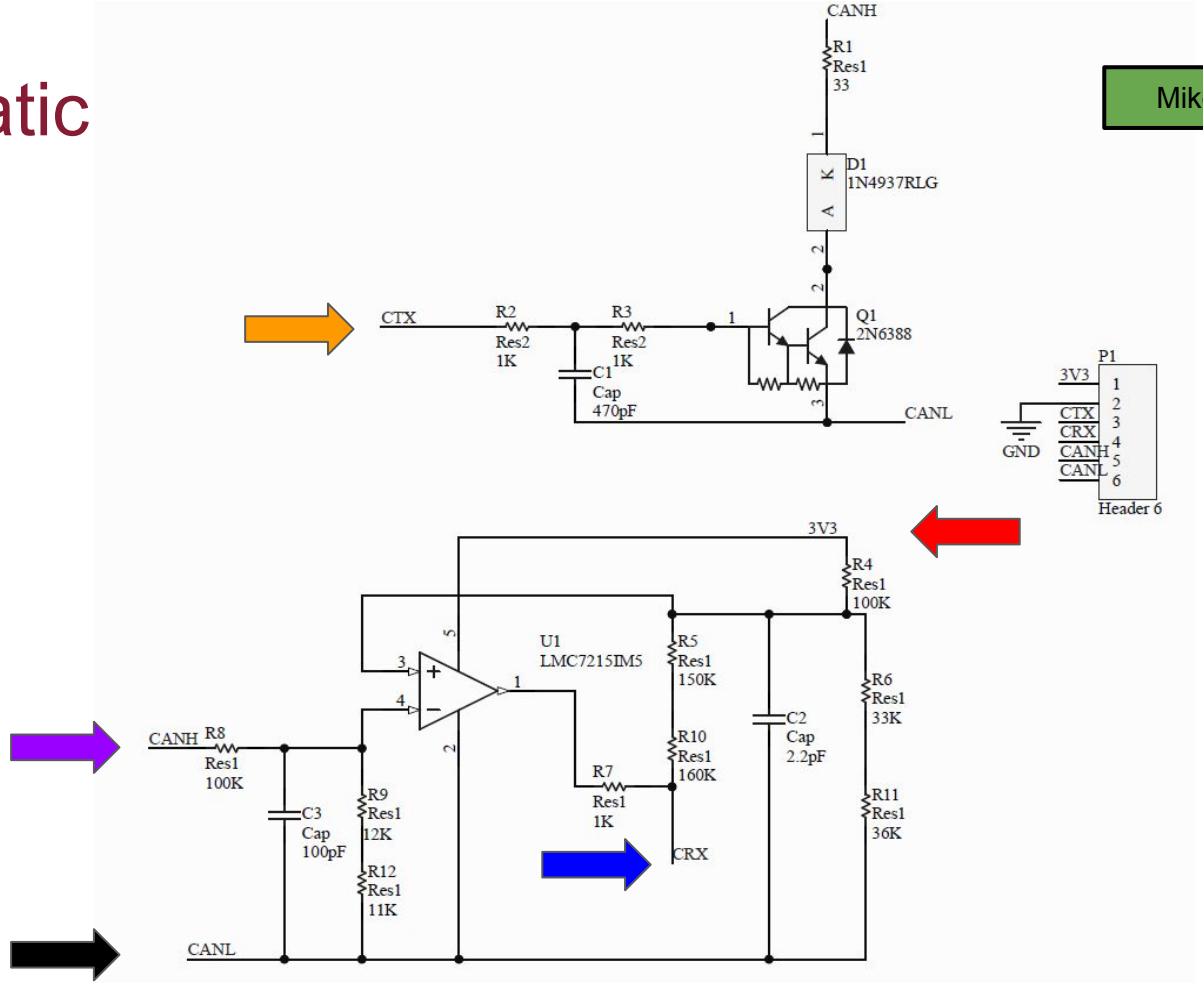
Step Motor



PCB Schematic

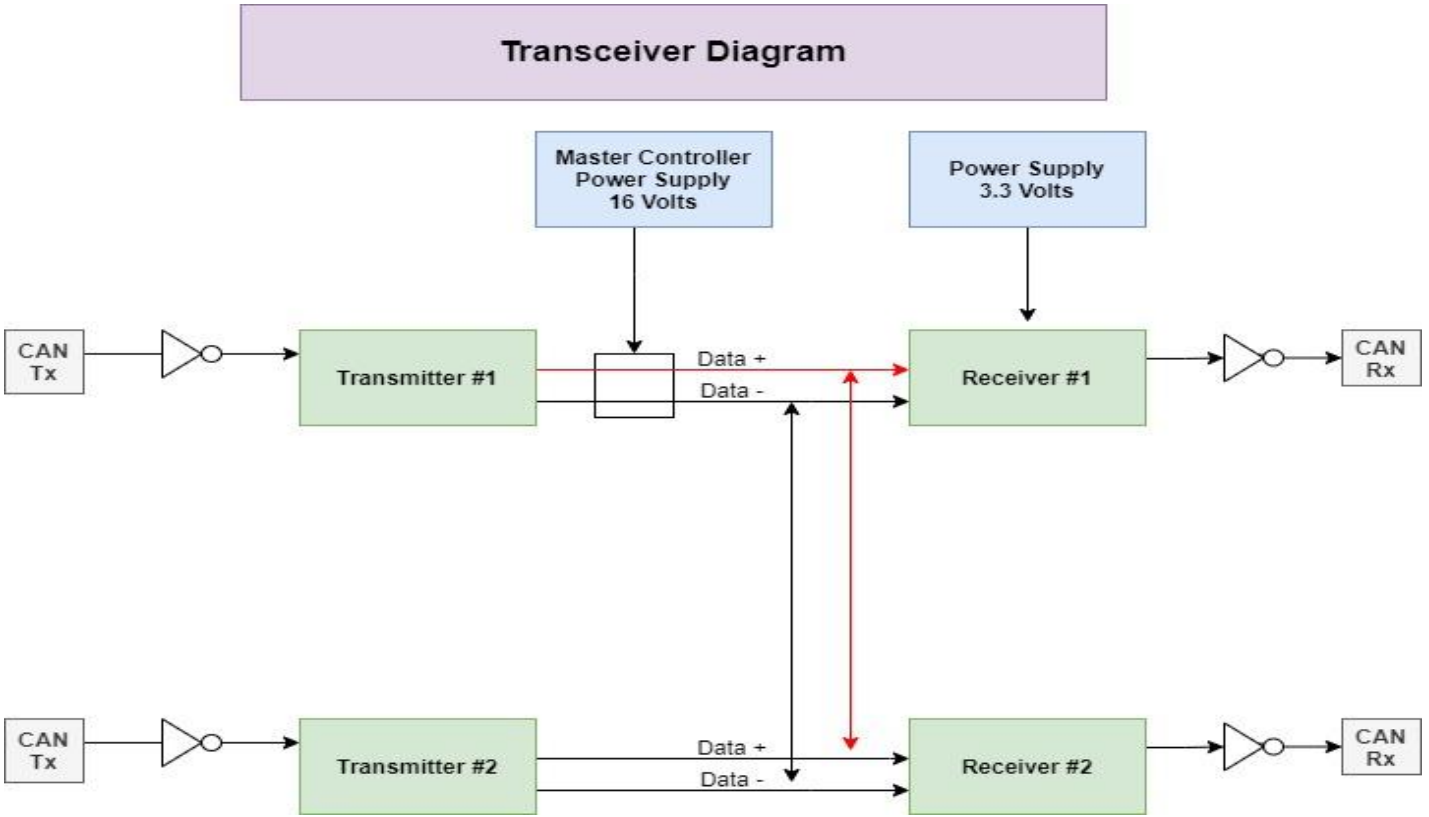
- CAN bus transceiver
  - Transmitter
  - Receiver
- Altium PCB designer

Mike



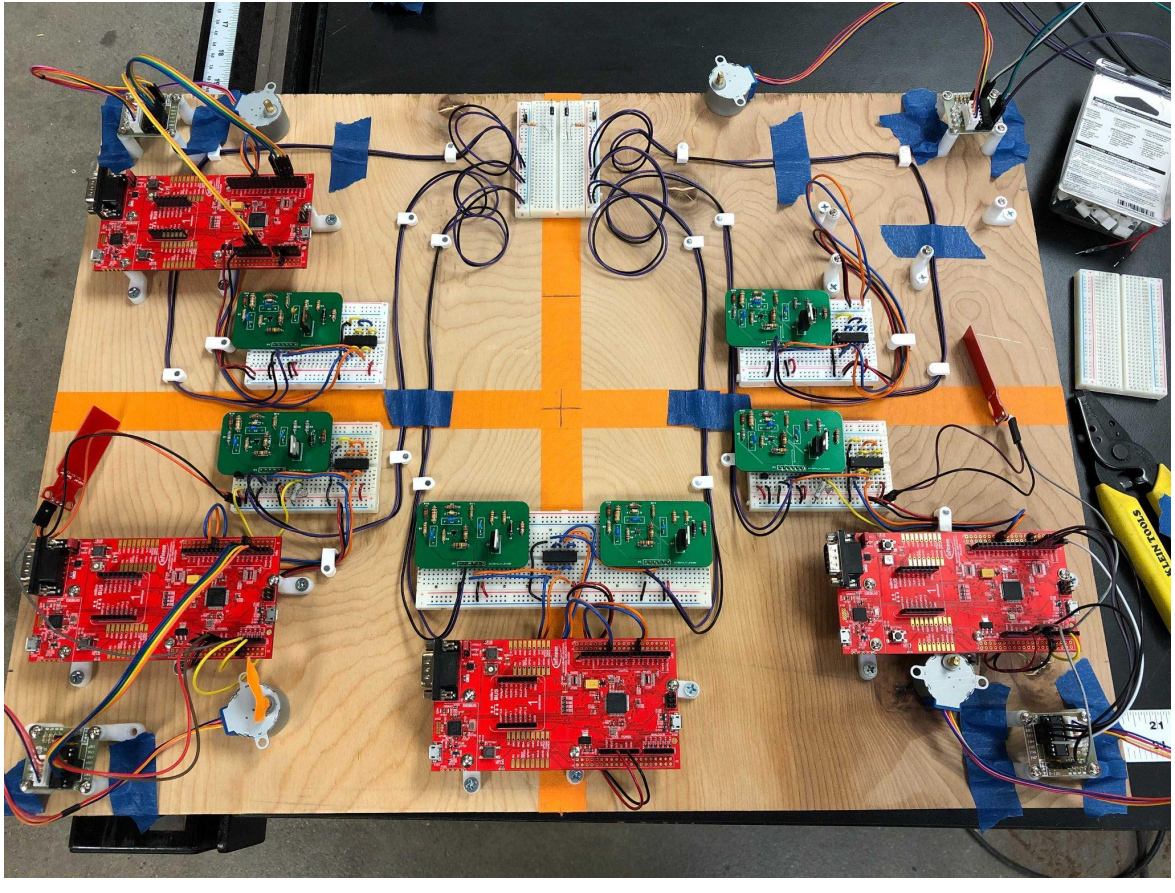
Transceiver Integration

Mike



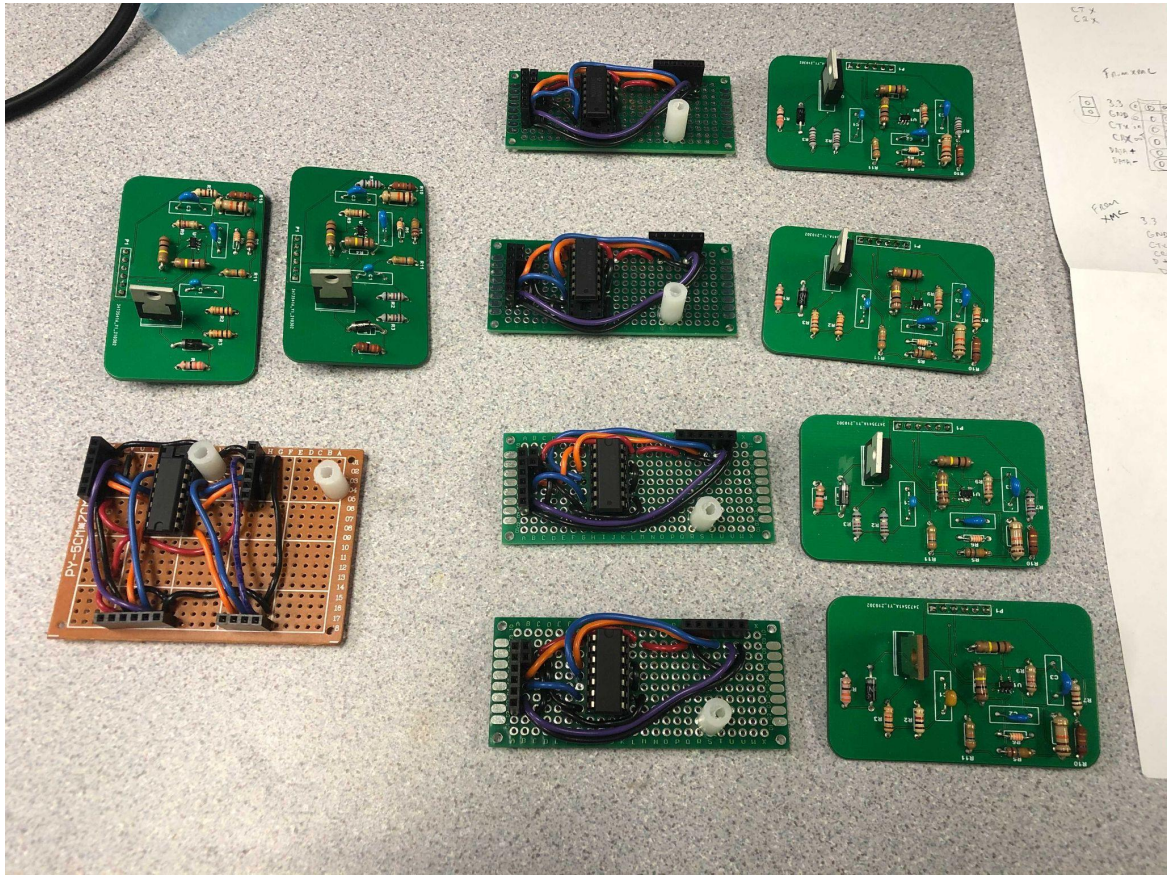
PCB and Breadboard

Mike



PCB and Protoboards

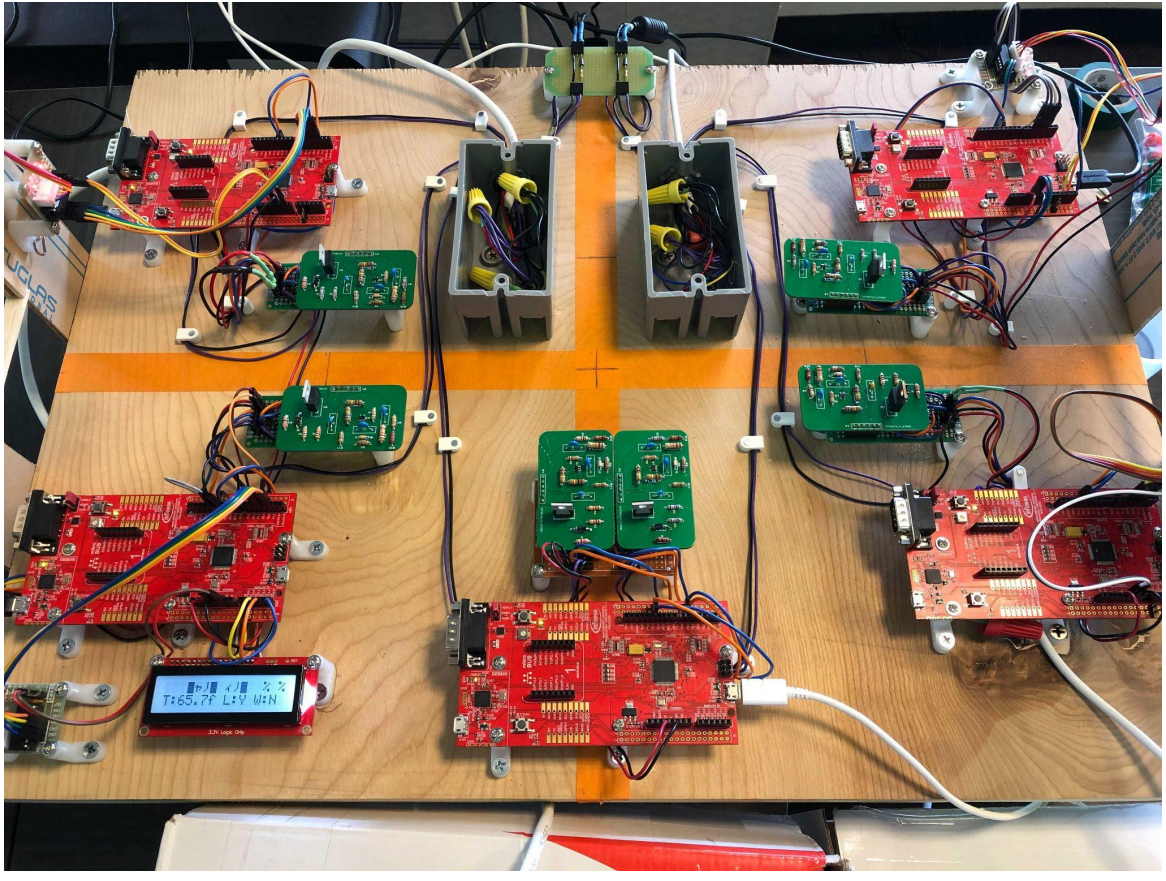
Mike



PCB and Protoboards

Mike

PCB in system



Project Expenditures

Chen

- 5 XMC4200 Dev. Board $ 298.10
- Transceiver components $ 18.92
- PCB Fabrication $ 23.34
- Step Motors $ 12.50

Back-up Demo Video

All

Thank you for your time

Questions?