COLLEGE OF ENGINEERING & COMPUTER SCIENCE
UNIVERSITY OF MICHIGAN-DEARBORN

MDAS.AI DRIVE-BY-WIRE SUBSYSTEM WITH V2X FOR ENHANCED SAFETY

Advisor: Dr. Michael Putty

Team CLASSIFIED: Athanasios Argyris, Kayleigh James, Sarah Overbeck, and Josh Quejadas

THE OBJECTIVE:

Create a reliable and safe CAN-based Drive-by-Wire system, provide features which halt the system safely in the event of a malfunction and enhance that safety by incorporating V2X communication.

THE MOTIVATION:

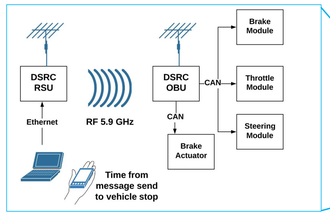
The next generation of human transportation is **AUTONOMY**: the ability of a vehicle to operate itself, detect objects and people and to make decisions in a variety of complex situations, all actions normally done by a human driver. However, in order for the vehicle "brain" to alter the states of main functions like speed and direction, it requires a reliable and responsive electronic control system of brakes, throttle and steering individually with feedback sensing and communication between them. This is accomplished by Drive-by-Wire, a system of microcontrollers implemented to command each vehicle system and communicate between one another. It is also pertinent to include failsafe procedures in the event the control is lost or in an emergency situation.

DESIGN APPROACH

For this project, a modular approach was used to simplify the design process and place more emphasis on the safety features implemented in the system. Each module has a microcontroller connected to a CAN bus via a standard CAN transceiver. A standardized CAN message set for the system is used to ensure proper communication between the individual boards. Each module is also specifically connected to sensors and control components which provide module-based feedback and control access. One example is the vehicle brake pressure sensor with an output connected to the brake module. The safety features implemented in the system include steering torque override, which disengages the system when someone turns the wheel, V2X communication using DSRC radios, and an Emergency Stop button, a hardware override function which disables the whole system and safely stops the vehicle.

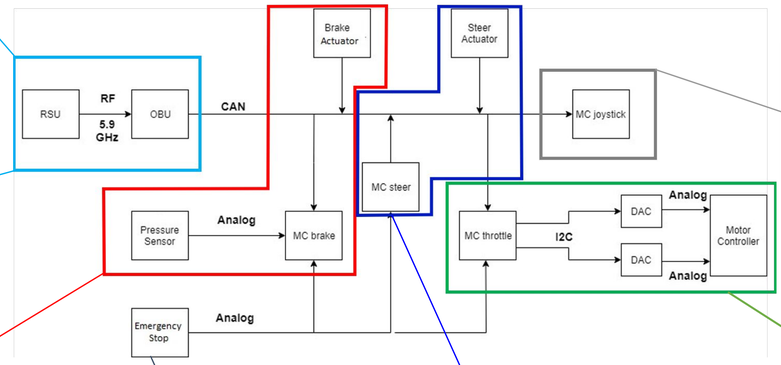
DESIGN, BUILD, AND TEST:

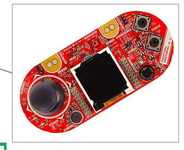
Complete development of the Drive-by-Wire system, communication protocol, and failsafe features.



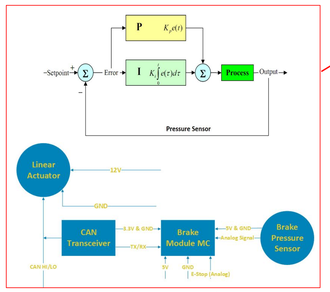
Directed Short Range Communication (DSRC):
Send a single CAN message and modules respond

MODULAR PROJECT OVERVIEW

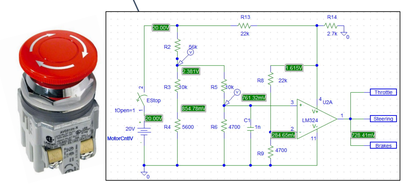




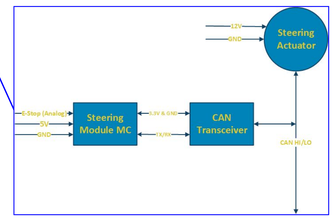
Joystick Module
Simulates autonomous control and will be replaced with neural network. Connected over CAN network to all other modules.



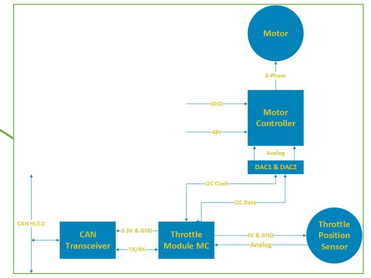
Brake Module
Control of brake pedal via installed linear actuator and with feedback from pressure sensor. Key module for safe vehicle stop for E-Stop and DSRC.



Emergency Stop Button and Circuit
Severs motor controller voltage line, triggers brakes to fully actuate, and sends disengage message to all modules



Steering Module
Control of steering wheel with feedback from Torque Pressure sensor.



Throttle Module
Control of throttle pedal with analog feedback from the throttle position sensor..

CAN Message Set

Highest priority messages tied to brake module due to connection between brakes and safety systems

Brake Module to Brake Actuator (4 Bytes)

Message from the brake module, to the brake actuator & Feedback pressure for the N-Net

CAN ID	DATA							
	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x0FF00000	Brake Data	Brake Data	Brake Data	Brake Data	Res	Res	Res	Res
267386880								

Joystick/PX2 to Brake Module (4 Bytes)

Control Message for Brake DbW Module

CAN ID	DATA							
	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x18DB0000	SRC ID	EVENT TYPE	BRAKE DATA (12 Bit) MSB = 0		Res	Res	Res	Res
417005568								

Steering Module to Steering Actuator (8 Bytes)

Message from the brake module, to the brake actuator & Feedback pressure for the N-Net

CAN ID	DATA							
	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x18FF00F9	0x05	0x00	Steer Data	Steer Data	Steer Data	Steer Data	0x75	0x00
419365113								

TESTING AND VALIDATION

1. E-Stop Test: Ensure brakes are functional for DbW and normal mode, verify correct voltage when E-Stop is pressed, measure time for wheels to fully stop when E-stop is pressed, and verify modules are unresponsive while E-stop is pressed.
2. Static Driving Test: Vehicle on jacks and controlled using joystick, gather voltage measurements and log CAN messages from each module.
3. DSRC - Pedestrian in the Crosswalk Test: Send a message via RSU and measure the time it will take for the vehicle to completely stop from full throttle. Latency calculation will also be done by the radio software and used to verify the age of the message.

CONCLUSION:

Overall, this project produced a viable Drive-by-Wire system with a fully-defined CAN message set, and safety functions that will prevent harm to passengers or pedestrians if the system ever malfunctions. Additionally, we were able to complete a proof-of-concept of V2X communication with the DSRC radio units. Despite extremely high risks to completion time because of limited access to the vehicle, the Drive-by-Wire subsystem on the MDAS.ai vehicle and all subsequent information it communicates, is ready for the next phase of the research project: implementing autonomous functions.