Communications & Data Acquisition Module

(Document every single thing you learn!)

Introduction

We hope you have an understanding of what is used in our car for communication from the sessions we took.

In this particular module we will dive deeper into the communication protocols used in general and those specific to our car. We shall also perform basic data processing and visualization using our own data obtained from one of our test runs.

Communications

Communication involves the exchange of data between different objects. A fixed set of rules that govern this data exchange is termed as a **communication protocol**.

Reading Assignment :

- Understand what serial communication is and the major serial communication protocols used (SPI , I2C , UART & CAN) from here.
- Basics of the CAN protocol - here, Youtube
- To understand the need for such a protocol and some more features - here.
- Here is the Texas Instruments CAN datasheet. Read section 3 to get an understanding of a message frame. While some fields might not make sense to you try appreciating the important fields like ID , DLC , Data etc. Read section 4 to understand a very important feature of the CAN bus which is Arbitration.

After having read the above material, check whether you can answer these questions:

- The main data processing is done by the microcontroller. Then why do we need the can transceiver? (The transceiver we use is : SN65HVD230)
- Why do we need 120 ohms resistors at both the ends of the can bus?
- What happens when multiple nodes try to send data on the bus at the same time? How is it decided which one sends first?
- Bonus - If 2 CAN nodes , say A and B , start transmitting messages with ID 120 at the same time what will happen?

Task 1 :

Communicate between 2 Arduinos using I2C or SPI (choice is yours). You should be able to send and receive data. You should also be able to turn on the LED on one side when the switch is pressed on the other side (LED and switch are connected externally).
You can refer to this playlist to learn coding in Arduino IDE (Based on C++ with additional features). You can install Arduino IDE 1.8.19 from the given link.

Resources :
https://circuitdigest.com/microcontroller-projects/arduino-spi-communication-tutorial
https://circuitdigest.com/microcontroller-projects/arduino-i2c-tutorial-communication-between-two-arduino

By now you are aware that a transceiver is required for CAN communication and in this case MCP 2515 is used. Download the ZIP file of Arduino CAN MCP2515 Library. From the Arduino IDE: Sketch -> Include Library -> Add .ZIP Library.

Resource :
https://circuitdigest.com/microcontroller-projects/arduino-can-tutorial-interfacing-mcp2515-can-bus-module-with-arduino

Note: For the above simulate it on tinkercad, if you face any problem send your final code.

Data Acquisition

Task 1 - Data Analysis :

You have to write a CAN program to encode data from a sensor into CSV format. You will be getting 4 data, and the sensors you use will have a CAN ID 104. After encoding you will get the CSV file in this format linked.

- Time : It is the timestamp at which data was received.
- CAN: It is the CAN bus line at which the data is transmitted, here it is CAN line 2.
- CAN ID: It is the ID of sensor.
- Type: It tells if the data was transmitted to or received from the sensor.
- DLC: It is the length of the data received.

For CAN IDs 112 and 128:
Now for the example CSV file given, which are the yaw sensor IDs from our car- decode them from the datasheet linked. Use the datasheet to understand what each byte means and perform decoding of Yaw rate, Yaw angular acceleration and accelerations in X and Y directions. (*Note: Use quantization values from the data sheet and also note that signed encoding has been used.*)

Now you have to write a code for decoding. Your answer should be a CSV file with decoded values of above mentioned quantities along with their respective timestamps.

Use any plotting tool of your choice(python , MATLAB etc.) and plot the quantities against time. Try and infer what this dataset represents.

Task 2 - Data Acquisition :

Explore and explain how wireless communication / live telemetry can be implemented in our car. You can provide multiple choices with pros and cons.

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