Group 2 - Vehicle Assistance Embedded module

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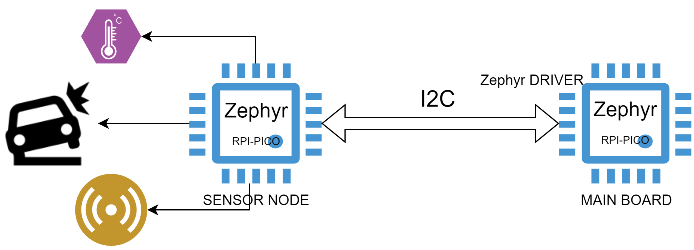
Description of project and main goals:

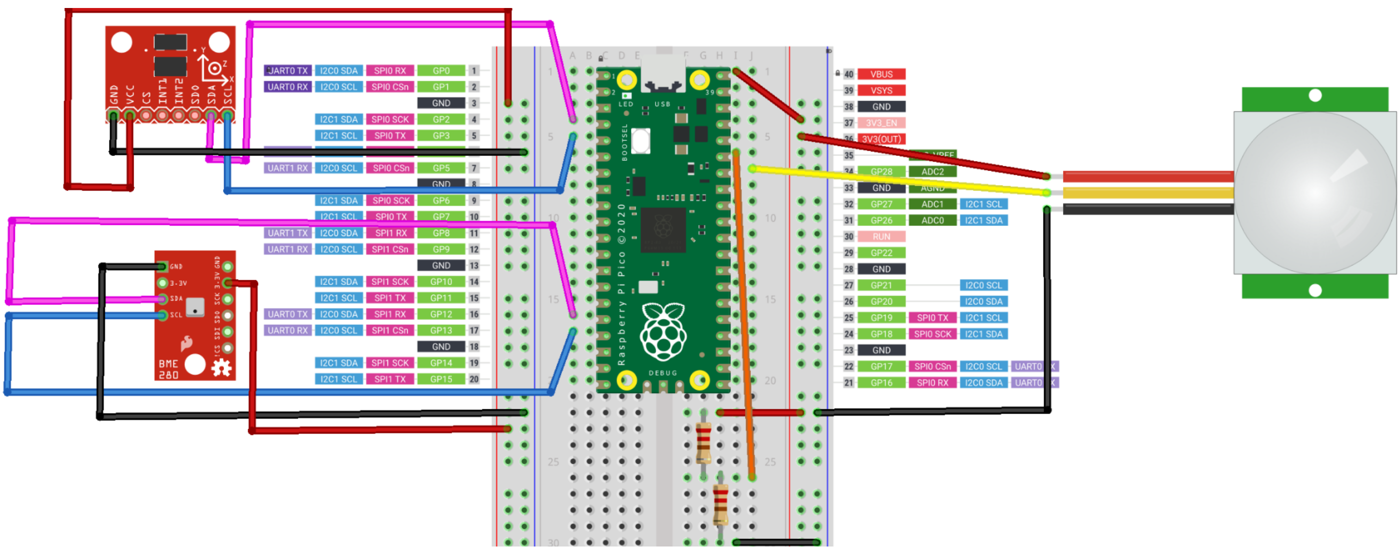
We want to create a sensor node that is coherent with the application we want to create at the end, our main theme is a vehicle assistance module. This module will have an accelerometer, a gas, pressure, humidity and temperature (already included in the lab kit), an accelerometer and a PIR for movement detection inside the vehicle. The applications of our sensor node will mainly be vehicle monitoring, like crash detection thanks to the accelerometer and then after the crash an outside entity can monitor the situation checking the temperature inside the vehicle, if there are any movements of the occupants or if there is a sudden pressure change.
Thanks to the PIR and the accelerometer we can set up the module as an anti theft device, if the user sets that mode it will alert in case the accelerometer detects that the vehicle is moving or if the PIR detects movement inside the cabin.

Design outline:

We will use two RPI-PICO, both of them will run Zephyr, one of them will be set up as the sensor node. The sensor node will perform the polling and then communicate with the main board through I2C. As the RPI-PICO has two cores we can set one to perform the polling and the other to handle the I2C communication. The main board will have a Zephyr driver for easy access to the sensor node through the Zephyr Sensor API.



Here is a general circuit diagram of the **sensor node**:



The BME680 and the ADXL345 will be connected to the two I2C channels of the sensor node while the communication with the main board will be through the GPIO pins where we can implement I2C in software. According to the datasheet, the PIR sensor will output an average voltage of ~1.1V. Since we cannot use the internal reference voltage of the PICO (3.3V) we will build a voltage divider in order to detect the voltage differences during the ADC conversion.

Hardware requirements:

These are the sensors we've chosen for our sensor node and why:

- BME680
    - Digital *(I2C communication)*
    - Voltage range: 1.71 - 3.6 V
    - Temperature, gas and pressure sensor.
    - Useful features:
        - Already included in the kit.
        - Useful for pressure changes in the vehicle cabin, check if there is a fire or a leak with the humidity and temperature sensors.
- ADXL345
    - Digital *(I2C communication)*
    - Voltage range: 2 - 3.6 V
    - Accelerometer 3-axis.
    - Useful features:
        - The accelerometers can detect shocks up to 16G, and typically if a vehicle gets to as high as 16G it means it's involved in a crash.
        - It can detect tilt for understanding how the board is placed.
        - Free-fall detection (if the car falls down a cliff).

- EKMC2605111K
    - Analog *(Voltage read)*
    - Voltage range: 3 - 5.5 V
    - PIR.
    - Features:
        - The range is 5 meters straight ahead which is more than enough for the typical size of a commercial vehicle like a large car or a truck.
        - It also has a very wide sensing area.
- 2x Raspberry PI PICO
- Resistors (100 Ω and 200 Ω)
- Breadboard

We've made sure to check that all the sensors can work with the 3V of the PICO Board so that they're compatible between them.

Time plan:

- **March 30th:** Defining node platform
- **Until around April 5th:** Defining SW protocol.
- **Until around April 15th (or when we receive the sensors):** Create prototype board.
- **Until around May 2th:** Write sensor board firmware and driver code.
- **Until around May 15th:** Integrate + test.

Sources:

- PIR_sensor (fritzing.org)
- Welcome to Farnell Global | Global Electronic Component Distributor
- Welcome to Fritzing