PES Final Project Report

Topic – Weather Monitoring Station

Name- Gauriech Ishaan Pilla

1. OBJECTIVE

As there have been many cases of fire in and around boulder, I came up with the idea of making a weather monitoring station. This project aims to continuously monitor climate using a temperature/humidity sensor (SHT21) to continuously monitor temperature and an MQ7 sensor that is suitable for sensing CO concentrations in the air.

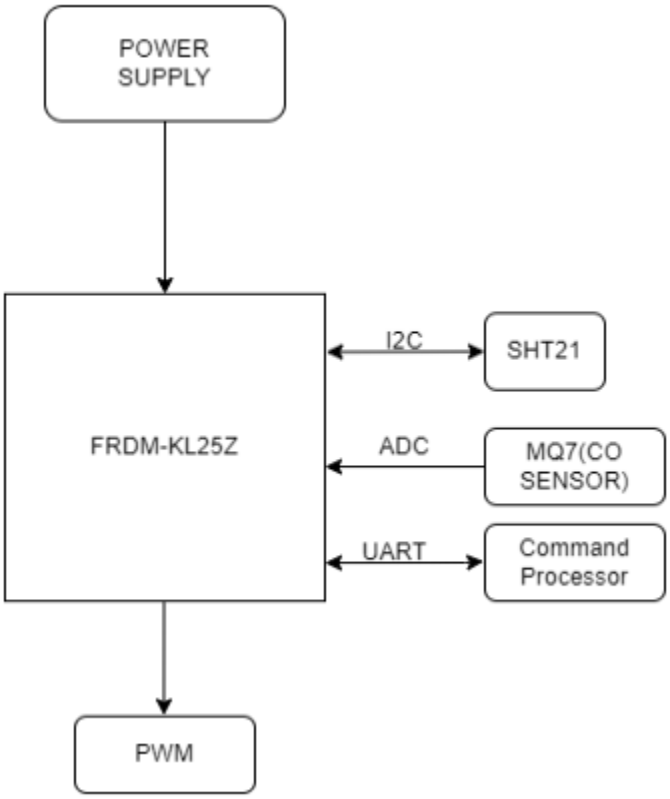
2. IMPLEMENTATION

1) FRDM-KL25Z initializes PWM and runs automated tests of PWM for different values of RGB LED in Danger, warning and safe states before the start of the main function.
2) Initialization of all other modules used in the project and then run automated tests for circular buffer.
3) FRDM-KL25Z reads the temperature, humidity and CO level values from the SHT21 (Temperature/Humidity sensor) and MQ7 (CO Sensor).
4) The interfacing of SHT21 is done over the I2C communication protocol. I2C1 is used for SHT21.
5) The interfacing of MQ7 is done with the help of internal ADC.
6) Starting command processor. The command processor can take different inputs and produce corresponding outputs for it. The menu looks like this:-

1. Type ‘Author’ to get the Author's name
2. Type ‘Dump’ with Arguments: (Start, Len) to get a hex dump of the memory requested
3. Type ‘Temperature’ to Print surrounding temperature
4. Type ‘Humidity’ to Print surrounding Humidity levels
5. Type ‘CO’ to Print surrounding CO levels
6. Type ‘Weather’ for Starting Weather Monitoring station
7. Type ‘Help’ to see weather options

7) Type ‘weather’ to start weather monitoring station.
8) UART is used to display the values of temperature, humidity and CO levels when the weather monitoring station starts. Also Warning message like danger, warning and safe are printed.
9) PWM is used for RGB LEDs that are used to indicate different situations.
- GREEN: indicates the safe state.
- YELLOW: indicates the warning state.
- RED: indicates the danger state.
10) Systick timer and delay function is used to get the delay.

3. BLOCK DIAGRAM



4. FUNCTIONALITY OF THE PROJECT

The temperature sensor (SHT21) and the CO sensor (MQ7) have been utilized in this project, which is based on bare-metal programming. The I2C (Inter-Integrated Circuit) communication protocol has been used to connect SHT21 to the FRDM-KL25Z, while ADC is used to connect MQ7 to the FRDM-KL25Z. In this project, I have first read the data from both sensors. Then, using PWM (Pulse Width Modulation), RGB LED will glow according to the data read by the CO and temperature sensors, representing the state of the climate around this model. In addition, along with the data read by both sensors, an alarm message is shown on the terminal window via the UART (Universal Asynchronous Receiver-Transmitter).

For Example – If the climate around the model is healthy, Green led would glow and according to the temperature and CO concentration, the LED would change from yellow to the final red state indicating the level can be harmful to humans.

5. TESTING STRATEGY

1. Arduino was used for testing the working of both the sensor initially. After getting the proper values and validating the hardware, I started working on FRDM-KL25Z.
2. The measured values of FRDM-KL25Z were compared with the values received from the Arduino to validate the working of both the sensors on FRDM-KL25Z.
3. Circular buffer testing is performed at the start of the program using the test cases from the previous Assignment.
4. PWM and RGB LED were checked by running automated tests of PWM for different values of RGB in Danger, warning and safe states before the start of the main function.

6. PROJECT DEMO

Google Drive link- https://drive.google.com/file/d/1QSVkafFUy4M6mZ3zhJoB_b7JH6yf-uSr/view?usp=sharing

a) Introduction to my project hardware
b) Showing testing of PWM and Cbfifo
c) UART command processor starts. Showing output of temperature and CO levels
d) The weather monitoring station starts.
e) Showing MQ7 output for weather monitoring using a lighter. As I am pointing lighter directly towards the sensor, the CO levels fluctuate very quickly but I could capture all three states.
f) Showing SHT21 output by blowing hot air on the sensor. I was able to demonstrate all 3 levels of my project in this video.
g) Do let me know if something was not clear. I can demonstrate the output again.

7. FILES USED FROM PREVIOUS ASSIGNMENTS

a) Accumulate_Line.c & Accumulate_Line.h
b) cbfifo.c & cbfifo.h
c) hexdump.c & hexdump.h
d) process_command.c & process_command.h
e) pwm.c & pwm.h
f) rgb_led.c & rgb_led.h
g) sysclock.c & sysclock.h
h) test_cbfifo.c & test_cbfifo.h
i) timer.c & timer.h
j) uart.c & uart.h

8. BONUS IMPLEMENTATION

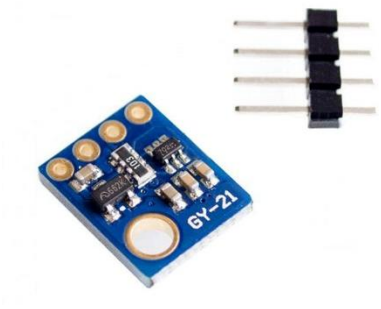
My idea was to extract only temperature values from SHT21 to represent the weather monitoring but along with temperature and CO levels, humidity sensing is also implemented and the data of humidity is extracted from the SHT21 sensor along with the temperature values.

9. HARDWARE USED

Two external sensors will be interfaced with the NXP FRDM-KL25Z Development Board that are:-

1. **SHT21**

   Link-https://www.amazon.com/HiLetgo-Digital-Humidity-Temperature-Replace/dp/B01N53H8SI/ref=sr_1_8?crid=3LJFB509SXVZ8&keywords=sht21&qid=1649803039&sprefix=sht21%2Caps%2C121&sr=8-8



This will be interfaced with the microcontroller over I2C protocol.

2. **MQ7**

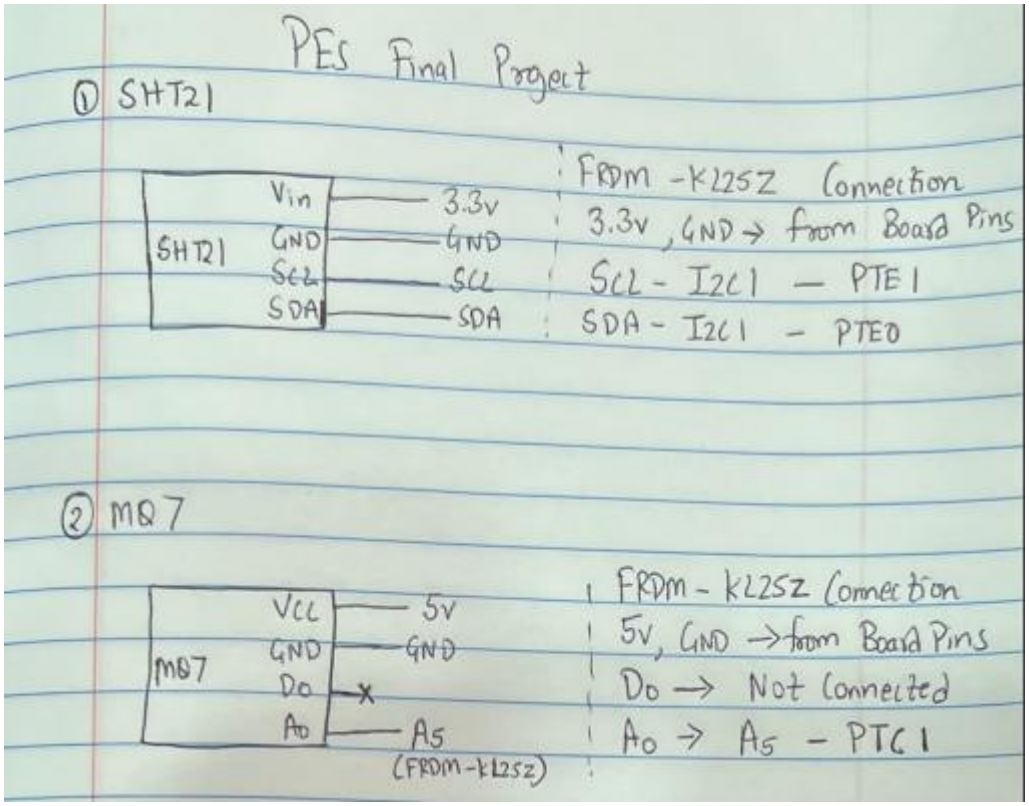
   Link-https://www.amazon.com/ACEIRMC-Detector-Monitor-Arduino-Raspberry/dp/B0978KTWS3/ref=sr_1_2?crid=3UCCQ7ETKZX4&keywords=mq7&qid=1649803064&sprefix=mq7%2Caps%2C99&sr=8-2&th=1

This will be interfaced with the microcontroller using ADC

10. UART CONFIGURATION

a) Baud Rate - 38400
b) data bits -8
c) stop bit- 2
d) Parity – None

11.HARDWARE CONNECTIONS



12.REFERENCES

The textbook Embedded Systems Fundamentals with ARM Cortex-M based Microcontrollers: A Practical Approach by Alexander G. Dean covers the implementation and dealing with the UART, ADC, I2C, and PWM. The NXP FRDM-KL25Z Reference Manual will be used to configure and work with the above-mentioned peripherals, as well as to learn about the architecture and use of various registers. For interfacing sensors, I plan to read the datasheets for both sensors and figure out how to integrate them on my board using the NXP FRDM-KL25Z datasheet and reference manual.

13.GITHUB URL

https://github.com/Anoydyne/Pes_Final_Project.git