PLANT HEALTH MONITORING SYSTEM

FINAL PROJECT PROPOSAL

COURSE – PRINCIPLES OF EMBEDDED SOFTWARE (ECEN-5813)
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OBJECTIVE

The aim of this project is to continuously monitor the health of plants in the greenhouse by monitoring the light intensity and temperature inside the greenhouse. And alert the workers for any anomalous reading of the data that is not suitable for the plants to survive or grow in a healthy manner. This will be done using RGB LED and displaying the text messages on the terminal window.

FUNCTIONALITY OF THE PROJECT

This project is based on Bare-Metal Programming in which two sensors: ambient light sensor (MAX44009) and temperature sensor (MLX90614 or SHT21) will be used. These sensors will be interfaced with FRDM-KL25Z using the I^2C (Inter-Integrated Circuit) communication protocol.

After reading the data from both the sensors, the RGB LED will glow according to the data read by the light sensor and temperature sensor using PWM (Pulse Width Modulation) indicating the situation of the environment inside greenhouse (light intensity and temperature).
In addition to this, an alert message will be displayed over the UART (Universal Asynchronous Receiver-Transmitter) on terminal window along with the data read by both the sensors.

For instance – if the light getting inside the greenhouse is too dim and there is increase in temperature, then this condition is not favorable for the plants to grow in a healthy manner. Instead, the light and temperature should be sufficient enough for the plants to grow. In this case the specific color LED will glow in order to show the conditions are not favorable.

TECHNOLOGY USED

The idea behind picking up this project is to extensively work with I^2C, UART and PWM especially working with I^2C because this concept was taught in the class but not included in any of the assignments. Moreover, interfacing two peripherals over I^2C can be challenging.

Implementation of UART and PWM will provide deeper understanding of these concepts as the related tasks were assigned during the biweekly assignments.

UART will be used to display the alert messages on the terminal (command interpreter) if any anomalous data is read by the sensors that can be harmful for the plants.

PWM is used to control the RGB LED to indicate various situations (favorable or non-favorable) based on the data read by the sensors.

THINGS TO LEARN IN ORDER TO DEVELOP THE PROJECT

This project requires the implementation of I^2C communication protocol to interface the external peripheral with FRDM-KL25Z board, I anticipate that there will be a need to learn I^2C and its working before the execution.

Moreover, to add complexity into this project, both the external peripherals must be connected over I^2C. This will give me an exposure on how to interface and work with external multiple devices over I^2C.

Along with this, the implementation of UART and PWM will make the foundation of these two concepts strong, since these concepts have been used already, I will have the opportunity to rectify and fix the mistakes/errors made during the assignments before.

REFERENCES

The details of implementation and working with the UART, I^2C and PWM is mentioned in the textbook Embedded Systems Fundamentals with ARM Cortex-M Based Microcontrollers: A Practical Approach by Alexander G. Dean.

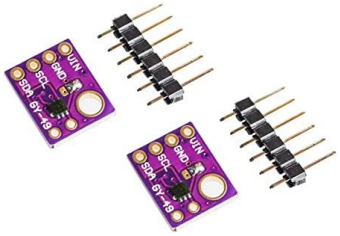
For configuring and working with the above mentioned peripherals and to get the knowledge of architecture and usage of various registers, Reference Manual of NXP FRDM-KL25Z will referred.
..\KL25P80M48SF0RM.pdf

To get the information that is hardly available in the textbook and reference manual, the forum by NXP Community will (https://community.nxp.com/) be very helpful. Along with this, the https://stackoverflow.com/ is also very important and amazing website to clarify general queries related to the technical concepts of programming.

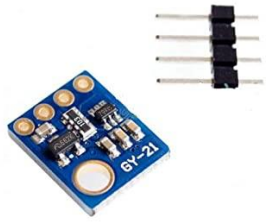
HARDWARE USED

Two external peripherals will be interfaced with the NXP FRDM-KL25Z Development Board that are ambient light sensor (MAX44009) and temperature sensor (MLX90614 or SHT21). These will be interfaced with the microcontroller over I^2C protocol.

MLX90614 Temperature Sensor



MAX44009 Ambient Light Sensor



SHT21 Temperature Sensor

MLX90614 Temperature sensor – https://www.amazon.com/MLX90614ESF-Non-Contact-Infrared-Temperature-Arduino/dp/B07YZVDWWB/ref=sr_1_3?crid=3G6SJOFETW8H4&keywords=mlx90614&qid=1637096873&sprefix=mlx90%2Caps%2C210&sr=8-3

(OR)

SHT21 Temperature sensor – https://www.amazon.com/AITRIP-Digital-Humidity-Temperature-Replace/dp/B08SHC11CP/ref=sr_1_3?keywords=sht21+temperature+sensor&qid=1637096933&sr=8-3

MAX44009 Ambient Light Sensor – https://www.amazon.com/NOYITO-MAX44009-Intensity-Interface-Development/dp/B07HFRS8XX/ref=sr_1_3?keywords=MAX44009+light+sensor&qid=1637096976&sr=8-3

TESTING STRATEGY

The mixture of both automated and manual testing will be done since this project deals with the hardware as well as the software.

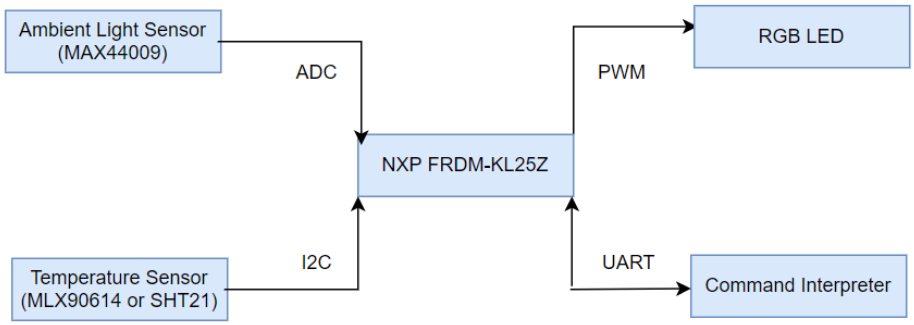
Automated Testing –

- The test for circular buffer (used for UART application) will be performed in order to make sure if it is solid.

Manual Testing –

- The value read by the sensors can be tested if they are accurate enough with respect to the actual parameters (temperature and light intensity) of the surrounding.
- Communication through I^2C can also be tested in terms of transmitting and receiving of packets correctly (do not have much idea about it right now, hence, not sure if it is going to be implemented) but will try to implement once I begin working with this communication protocol.

BLOCK DIAGRAM



Block Diagram of the Implementation