FALL 22 ECEN5823
PRINCIPLES OF EMBEDDED SOFTWARE

FINAL PROJECT
DIGITAL ANGLE GAUGE

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1.1 DIGITAL ANGLE GAUGE:

A digital angle gauge measures and determines the angle of a given object. This application uses the inbuilt accelerometer MMA8451Q embedded on the FRDM KL25Z. The MMA8415Q is a 3 axis, low power, 14 bit resolution sensor, which ensures accurate results. The gauge references respective angles from the pre-calibrated 0 degrees.The GPIOs and the User Interface are configured to display the real time outputs of the gauge.

The digital angle gauge finds its application in calibrating angles by men to cut trees, carpenters to build furniture, plumbers to measure floor angels and cut pipes, and so on and so forth

1.2 OBJECTIVE:

+ Interface the 3 axis MMA8351Q accelerometer on the KL25Z using I2C protocol to measure the movement across all 3 vector coordinates and using interrupts, calibrate zero degrees on receiving interrupt from the pushbutton.

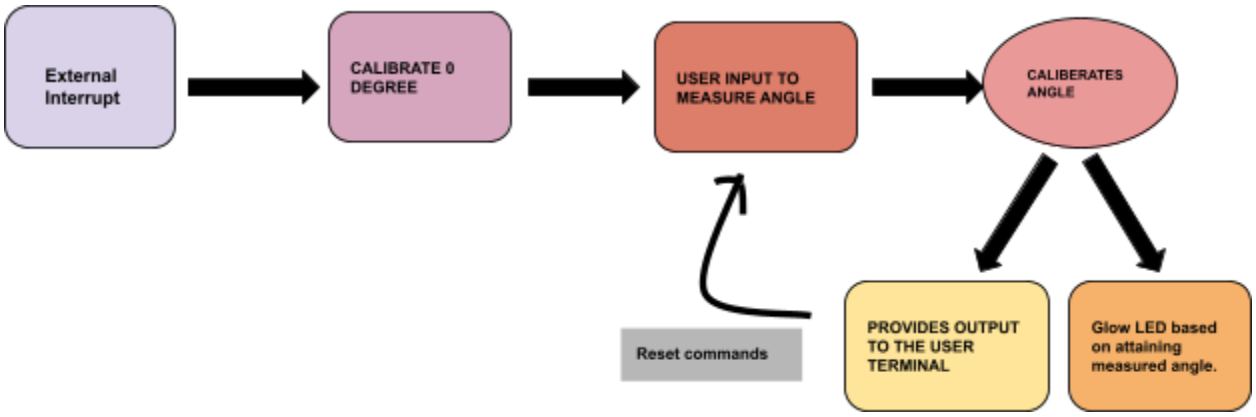
+ Using circular buffers, enable UART communication that allows transmitting user inputs to the FRDM KL25Z and display the gauge outputs to the user through a command processor.

+ Enable GPIO lines to set visual display of the angles through configuring the LEDs using PWM and controlling the brightness through respective angles measured.

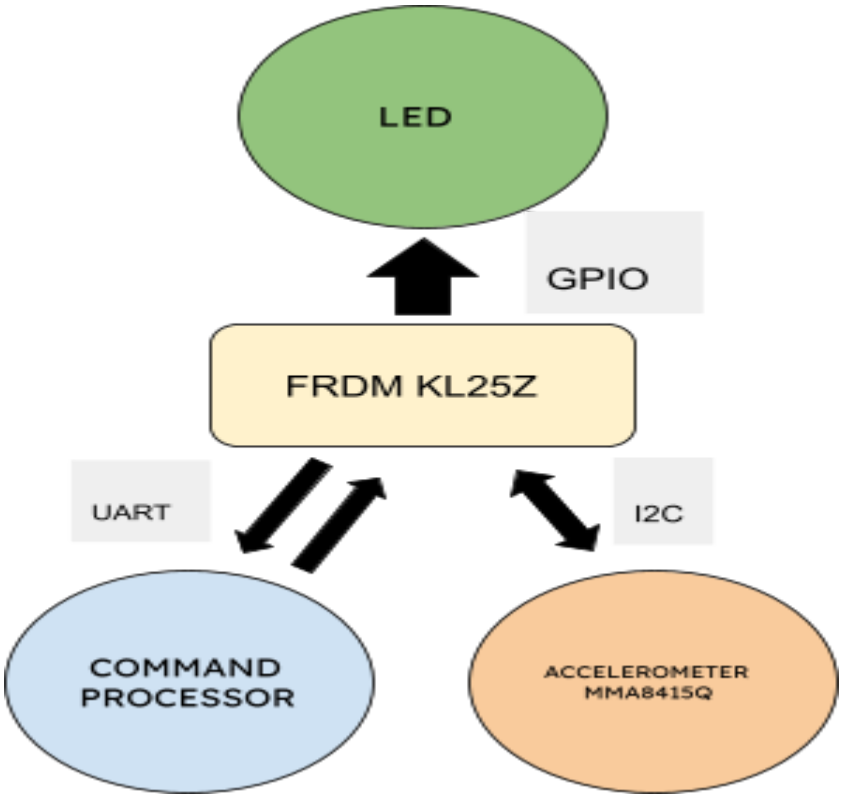
1.3 FUNCTIONALITY:

Through the UI terminal , the user will provide the angle needed to be measured and the LEDs will blink gradually through attaining the respective angle. Without resetting the system, the system can be configured to measure the next angle by providing commands through the interface. The real time measured angles and the current process information is fed to the user interface terminal.

1.4 FUNCTIONALITY DIAGRAM:



1.5 BLOCK DIAGRAM:



1.6 TECHNOLOGIES UTILIZED:

Circular buffers - Enables UART transmission and reception.

GPIO lines - Configure the LEDs to visual display the angles attained.

Interrupts - Calibrate the accelerometer to zero degrees before angle measurement and to reset to measuring the next angle.

I2C - Enable the communication of the inbuilt accelerometer MMA8514Q.

UART - To enable communication between the command processor and the FRDM KL25Z that allows transmission and reception of data to and from the user.

Command Processing - A user interface that gets the inputs from the user and displays live functionality of the program as showing the measured angle and the current state of the program.

PWM - Tunes the LED brightness according to the measured angle.

1.7 HARDWARE ELEMENTS:

+ FRDM KL25Z
+ MMA8451Q Accelerometer
+ LED

1.8 TESTING STRATEGY:

Manual Testing:
Through manual testing, the following functionalities will be tested for various cases:

Accelerometer (Tilt functionality)
LED (PWM functionality)
UART(UI functionality)
Command Processor (Valid and Invalid functionality)

Automated Testing:
Through manual testing, the following functionalities will be tested for various cases:

Circular buffers (Test cases provided will test UART functionality)
Command Processor (Echoes back user inputs to ensure the user interface functionality)
LED (Led blinking and PWM functionality)
Debug feature (Error Functionality)

1.9 ANTICIPATED LEARNING OUTCOME:

+ Deeper understanding of I2C functionality.

+ Analyzing datasheets to refer for accelerometers functionality and how to evaluate data from them, i.e, converting raw values to readable format.

+ Interrupt handling.

+ Testing strategies to ensure and cover the corner cases possible.

1.10 REFERENCES:

+ https://www.mouser.com/pdfdocs/FRDM-KL25Z.pdf
+ https://www.nxp.com/docs/en/data-sheet/MMA8451Q.pdf
+ https://learn.adafruit.com/calibrating-sensors?view=all
+ https://www.vernier.com/til/418
+ https://github.com/alexander-g-dean/ESF