PES Project Proposal

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Title - Monitoring and displaying Different Parameters of anUnmanned Aircraft

Objective:

The purpose of this project is to design a sensing system on unmanned aircraft using some sensing modules. Firstly, I will be using MMA8451Q on-board digital accelerometer to measure the roll and pitch angles which will help to regulate the speed of the motor/ brightness of the LED using PWM. Secondly, a LM35 temperature sensor will be used to measure the temperature of the battery section of the drone. Finally after gathering all the inputs such as temperature, roll and pitch angles, it will be shown on the terminal through UART and also on the LCD, for better user interfacing.

Working-

- MMA8451Q on board accelerometer works on the basic principle of detecting the tilt angles of the accelerometer depending on a calibrated value and finally compensating for the tilt. This module communicates with the help of I2C protocol. Further based on the tilt angles, speed of the motor/brightness of the LED will be regulated as needed using PWM signals which will help to balance the drone as per the requirement.

- LM35 is a three pin temperature sensor which includes a vcc pin, output voltage pin and a ground pin. The output voltage pin is the one which connects with an analog pin of the NXP microcontroller, and the temperature will be dependent on the amount of the resolution of the ADC and its corresponding reference voltage.

- A 16x2 LCD has two registers - data and command; the RS pin is mainly used to change from one register to another, if 0 then it is a command register and if 1 then it is a data register, The command register task is to clearing the display, initializing, set the cursor place, and display control whereas the data register task is to display the data on the screen. A potentiometer must be connected with pin 3 of the LCD to regulate the brightness of the screen. The enable pin should be held high to execute any read and write access. Lastly for the data part, it should be connected to 8 pins or 4 pins of the LCD as per requirement.

Technologies to be implemented:

- I2C
- PWM
- UART
- ADC
- System clock
- State machines
- MMA8451Q sensor
- LM35 sensor
- Push button
- 16*2 LCD

To communicate with the MMA8451Q sensor, I2C protocol will be used, Based on the percentage of Roll and pitch angles, motor speed/ LED brightness will be adjusted for which PWM will be used. For the LM35 sensor, only ADC is required to be implemented to get the values. Finally UART is used to display the data over the terminal.

Design and implementation:

- According to the Data sheet - MMA8451Q is of 14 bits resolution. This accelerometer is packed with embedded functions with flexible user-programmable options configurable to two interrupt pins. The device is configured to generate inertial wake-up interrupt signals from any configurable embedded functions allowing the MMA8451Q to monitor events.

- At first, A push-button will be used and configured to support and start the calibration features for the accelerometer from the user end. After calibration, Based on the acceleration data in X,Y,Z axis it should be converted to respective roll and pitch angles using cartesian geometry. Those roll and pitch angles will be converted to respective percentage based on which LED brightness will be changed.

- According to the LM35 data sheet, slope of the temperature sensor is specified as 10mv/C, so the slope is linear and the voltage is increased by 10mv for 1 degree rise in temperature. So the temperature can be calculated using 10 bit ADC with reference voltage of 3.0v .

T = (((3.0 * ADC_reading) /1024)/ 1000)/10

which is equivalent to; **T = (adc_reading *300)/1024**

- Finally, after integrating accelerometer and LM35 ; the values such as pitch percentage, roll percentage and temperature will be displayed on the LCD and will be updated every 1 second.

Learnings required in developing the project:

The configuration of MMA8451Q over I2C and LM35 with ADC will be the new learnings in this project. Here are the reference- :

- https://community.nxp.com/t5/Sensors-Knowledge-Base/MMA8451Q-Bare-metal-example-project/ta-p/1127268 .
- https://www.nxp.com/docs/en/data-sheet/MMA8451Q.pdf
- https://www.ti.com/lit/ds/symlink/lm35.pdf
- KL25Z reference manual chapter 28- ADC
- https://community.element14.com/products/arduino/w/documents/10989/tutorial-frdm-kl25z-adc-with-the-freescale-freedom-board
- Dean Book chapter 6 -> Analog interfacing page 164.
- Chapter 8: Serial Communications from Embedded Systems Fundamentals with Arm Cortex-M based Microcontrollers: A Practical Approach.

Hardware requirements:

A pushbutton is required for the calibration of the accelerometer. LM35 temp sensor is required to interface with ADC and get the temp values. And finally 16*2 LCD is required to display all the required parameters to the user. All the hardware elements are currently with me and will be assembled using jumper wires on a breadboard with KL25Z.

Testing strategies:

While changing the PWM signal strength and varying the brightness of the LED, manual testing will be done to check whether the LED brightness is coming correctly or not based on the pitch and roll percentage. Calibrating the sensor by placing it on a flat surface and then checking for roll and pitch angle will also be done. For the temperature part, manual testing will be done to check whether the temp coming out in a room for LM35 is the same as the current temp for the room.

For the testing part of LCD. With the help of a logic analyzer- enable pin should be tested to check whether it is only going high for read and write operation. Different timing analysis such as address setup time, hold time, read delay time, write hold time should also be tested and checked if it matching according to the data sheet.