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Project Proposal

Drone Stabilizer

Objective:

To build a device that helps balance the drone using the MMA8451Q digital accelerometer present on the MKL25z4 device.
The device works on the basic principle of detecting the tilt angles of the accelerometer concerning a particular calibrated value and generating the respective signals to compensate for the tilt.
The tilt angles measured with the help of the roll and pitch axis of the accelerometer helps in controlling the strengths of the PWM signals, which regulate the speed of the drone's rotors which in turn helps in balancing the drone.

Technologies to be implemented:

- UART
- I2C
- PWM
- System clock
- Circular buffers
- State machines
- MMA8451Q sensor

The project requires UART, I2C protocols, and circular buffers to communicate between the sensors and display the sensor data on the UART terminal. It also requires an MMA8451Q sensor set up along with the PWM module and systick clock configured.
All the technologies mentioned are discussed in the class and are reused in the project, except I2c and onboard accelerometer.

Design and implementation:

The project is similar to the idea of a digital angle gauge shared in the instructions. In addition, the sensor data and PWM signal strengths are logged on the UART terminal.

MMA8451Q is an innovative, low-power three-axis capacitive micromachined accelerometer with 14 bits of 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.

Initialization of the MMA8451Q sensor properly allows to precisely derive the gravity and the acceleration values at a particular time. Based on these values, roll and pitch values calculations help drive the PWM signal used to control the speed of rotors, which is represented on the LED by changing the brightness of the LED.

A state machine model represents switching between different states. The PWM module will control the LED's brightness according to the sensor values read over the I2c, and the sensor data will be logged on the screen using the UART and circular buffer concepts. A push-button will be configured to one of the GPIO ports to give the user the calibration option.

Learnings required in developing the project:

Mainly configuration of MMA8451Q accelerometer over the I2c and how to log the data over the UART channel.
Reference:

- https://community.nxp.com/t5/Sensors-Knowledge-Base/MMA8451Q-Bare-metal-example-project/ta-p/1127268 .
- https://mcuoneclipse.com/2012/09/21/tutorial-accelerating-the-kl25z-freedom-board/
- Chapter 8: Serial Communications from Embedded Systems Fundamentals with Arm Cortex-M based Microcontrollers: A Practical Approach.
- Getting Roll, Pitch and Yaw from MPU-6050 (samselectronicsprojects.blogspot.com)

Hardware requirements:

Only a push-button interface connected to any of the GPIO ports helps in the calibration of the accelerometer. The onboard digital accelerometer sensor on the KL25Z4 board is used.

Testing strategies:

Manual tests will be done on the system, observing the change in the PWM signal strength varying the brightness of the LED for changing tilt angles about a particular calibrated position. For example, check the LED color and brightness while changing the device's position across the pitch and its roll axis. Furthermore, confirm back on the calibrated color while placing back on a flat surface.

- Calibrate the sensor by placing the device at a solid reference position.
- Check for tilt across roll.
- Check for tilt across pitch.
- Place back on the position used for calibration and verify the initial color of LED.