Experiment #4

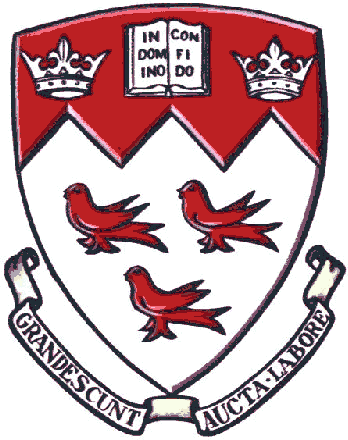
Multithreaded, interrupt-driven sensor reading and peripheral control

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# Abstract

The goal of the experiment presented in this report was to design and implement a multithreaded system using the real time operating system (RTOS) CMSIS-RTOS, capable of sensing the STM32F407 Discovery board's processor temperature and pitch angle and provide a visual display of those readings to the user. The report will show how a 4x4 alphanumeric keypad was use to provide the user a mean to select the desired mode of operation and how a 4 digits 7-segments display in combination with the on-board LEDs of the board allowed a way to provide a visual feedback to the user. To that end, the work of experiment 2 and 3 were slightly modified and successfully combined using threads in an RTOS environment on the discovery board. This report will show how the thread implementation was done such that the concurrent multithread computation operates safely.

# Problem Statement

The goal of this experiment is to design and implement a system which can concurrently sense both the current processor's temperature and either the pitch or roll angle of the STM32F407 Discovery board. To that end, the on chip temperature sensor of the discovery board's processor is to be used in order to measure the processor's temperature and the off chip tri-axial MEMS Accelerometer sensor LIS3DSH is to be used to measure the gravitational acceleration in order to compute the board's pitch or roll angle. The system needs to provide the user with a mean to input the desired mode of operation through the use of a 4x4 alphanumeric keypad. The system should also provide visual feedback using the 4 digits 7-segments display as well as the on-board LEDs of the discovery board. There are two possible modes of operation in which the system may find itself in, temperature mode or accelerometer mode. In temperature mode, the system needs to display the real time current temperature of the board's processor in degrees Celsius on the 7-segments display. If the temperature exceeds an overheating threshold, the 7-segments display should flash on and off repeatedly as long as the processor's temperature remains above the threshold to denote danger level. In accelerometer mode, the system needs to display the real time current pitch or roll angle of the board on the 7-segment display and will allow the user to select one of the four user LEDS on the board and adjust the LED brightness using pulse width modulation (PWM) according to the board's angle. The LED should be completely off when the board's angle is and gradually get brighter as the board's angle gets wider all the way up to where it should be the brightest. The alphanumeric keypad's keys 1 to 4 should allow the user to select which one of the four user LEDs is to be lit at the current time. The user also needs to be able to switch from temperature mode to accelerometer mode and the other way around by pressing preselected key(s) on the keypad. Note that while in accelerometer mode, if the board's processor temperature exceeds the overheating threshold, the 7-segments display should also be flashing on and off to denote danger level. To allow for concurrent measurement of the processor's temperature and the board's tilt angle, the system should be a multithreaded system that uses CMSIS-RTOS. The work from experiments 2 and 3 should be modified and incorporated into threads in order to achieve the desired system and therefore, the requirements regarding sampling rates of the sensors, calibration and filtering are the same as those found in those respective experiments.

# Theory and Hypothesis

# Implementation

# Testing and Observations

# Conclusion

# References

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# Appendix