

Lab 3: MEMS Accelerometer, Timer and Interrupts

ECSE 426 – Microprocessor Systems



McGill University

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# 1. Abstract

# 2. Problem Statement

The goal of this experiment is to create a system that detects the orientation of the STM32F4 discovery board.

# 3. Theory and Hypothesis

## 3.1. Accelerometer

### 3.1.1. Orientation

--- Relationship between 3 axis and 3 angles (one of them cannot be detected)

--- Figure showing the axis and angles

### 3.1.2. Acceleration

--- How the angle is quantified

## 3.2. Data Calibration and Filtering

### 3.2.1. Data Calibration

--- 6 positions expected (not normalized?) acceleration (0 0 1, 0 0 -1, 0 1 0, 0 -1 0, 1 0 0, -1 0 0)

--- Show calibration data in **Appendix A**

--- Calibration operation (need equation)

### 3.2.2. Data Filtering

--- Kalman filter (what’s the purpose of filtering?)

--- Kalman parameters, show Matlab simulation results in **Appendix B**

### 3.2.3. Data Interpretation

--- Normalize acceleration

--- Convert from acceleration to angle in radian (need equation)

## 3.3. External Keypad

## 3.3.1. Circuit Layout

--- Determine connections (experimental)

--- Figure showing the layout

## 3.3.2. Data Acquisition

--- Set, detect, reverse, detect

## 3.4. External 7-Segment Display

### 3.4.1. Circuit Layout

--- Resistors and transistors to protect the circuit against possible high current flow

--- Figure showing the layout

### 3.4.2. Data Display

--- Select digit, display, next digit

## 3.5. Timing

### 3.5.1. Timing Based on Sample Rate

--- Interrupt when sample is ready

### 3.5.2. Timing Based on Hardware Timer

--- Clock frequency, Prescaler and Period 🡪 Interrupt (show equation)

--- Figure to show the relationship

# 4. Implementation

# 5. Testing and Observation

# 6. Conclusion

# Reference

# Appendix A – Calibration Data