|  |
| --- |
|  |
| Lab 2: Sensor Data Acquisition, Digitizing, Filtering, and Digital I/O |
| ECSE 426 Microprocessor Systems |
| Group 4: Sidney Ng 260507001  Meng Yin Tao 260480207 |
|  |
|  |

Due: February 23rd 2015

|  |
| --- |
| [Type the abstract of the document here. The abstract is typically a short summary of the contents of the document. Type the abstract of the document here. The abstract is typically a short summary of the contents of the document.] |

Contents

[1. Problem Statement 2](#_Toc412123759)

[2. Theory and Hypothesis 2](#_Toc412123760)

[2.1. Analog-to-Digital Conversion 2](#_Toc412123761)

[2.2. Kalman Filter 2](#_Toc412123762)

[2.3. Data Interpretation 2](#_Toc412123763)

[2.4. Pulse Wave Modulation 2](#_Toc412123764)

[3. Implementation 3](#_Toc412123765)

[3.1. Data Processing 3](#_Toc412123766)

[3.1.1. Data Acquisition and Digitizing (ADC) 3](#_Toc412123767)

[3.1.2. Data Filtering (Kalman Filter) 3](#_Toc412123768)

[3.1.3. Data Conversion 3](#_Toc412123769)

[3.2. Visual Feedback 3](#_Toc412123770)

[3.2.1. Visual Display (GPIO) 3](#_Toc412123771)

[3.2.2. Alarm (PWM) 3](#_Toc412123772)

[4. Testing and Observations 4](#_Toc412123773)

[4.1. Terminal Window 4](#_Toc412123774)

[4.2. Visual Feedback 4](#_Toc412123775)

[5. Conclusion 4](#_Toc412123776)

[References 5](#_Toc412123777)

[Appendix A – Matlab Simulation Results 6](#_Toc412123778)

Lab 2: Sensor Data Acquisition, Digitizing, Filtering, and Digital I/O

# 1. Problem Statement

Data acquisition and signal processing are common operations performed by embedded microprocessor systems. Within the scope of this experiment, we will implement a system which collects data from a temperature sensor and displays the results using LEDs.

# 2. Theory and Hypothesis

## 2.1. Analog-to-Digital Conversion

* Resolution and step sizes
* How to interpret the output of an ADC

## 2.2. Kalman Filter

* What’s a Kalman Filter?
* Meaning of variables
* Choice of values (from Matlab simulation)

## 2.3. Data Interpretation

* Translate to understandable numbers
* Show the equations and values provided in Reference Manual (need reference!!)

## 2.4. Pulse Wave Modulation

* What’s a PWM?
* How does duty\_cycle and period influence the fade-in fade-out effect

# 3. Implementation

## 3.1. Data Processing

* Controlled by interrupt, only executes every 0.02s

### 3.1.1. Data Acquisition and Digitizing (ADC)

* Temperature sensor
* Sampling frequency – set by systick & interrupt
* ADC configuration (refer to previously mentioned theory and user manual)
* Mention that the data is passed to the Kalman Filter

### 3.1.2. Data Filtering (Kalman Filter)

* Mention that the data comes from the ADC
* Implementation of the filter using previously determined (optimal) variables
* Mention that the data is sent to conversion

### 3.1.3. Data Conversion

* Mention that the data received from the filter needs to be translated in order to be interpreted
* First get the voltage
* Second get the temperature
* Mention that the temperature changes are displayed using LEDs

## 3.2. Visual Feedback

* Independent of the interrupt, can run while data processing is waiting

### 3.2.1. Visual Display (GPIO)

* Mention that when temperature is below the threshold, we display the change
* GPIO configuration (refer to user manual?)
* How to track temperature increase and decrease

### 3.2.2. Alarm (PWM)

* Mention that when temperature is above the threshold, we use and alarm
* Increment duty\_cycle by 10% to achieve fade-in fade-out

# 4. Testing and Observations

## 4.1. Terminal Window

* Display intermediate values
  + For Kalman Filter -- Compare against Matlab results
* Know when we passed the threshold

## 4.2. Visual Feedback

* Observe the clockwise/counter-clockwise LEDs
* Observe fade-in fade-out effect beyond threshold

# 5. Conclusion

# References

# Appendix A – Matlab Simulation Results