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| Lab 2: Sensor Data Acquisition, Digitizing, Filtering, and Digital I/O |
| ECSE 426 Microprocessor Systems |
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Due: February 23rd 2015

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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

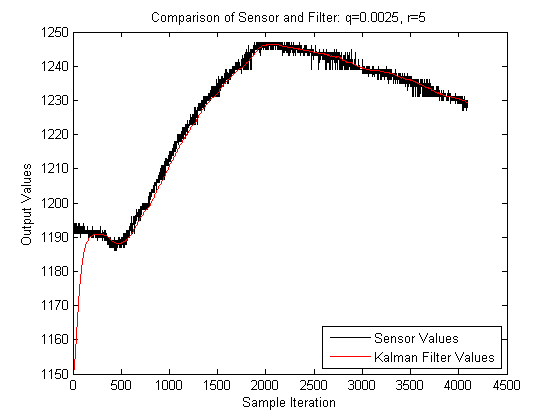
* Observe the clockwise/counter-clockwise LEDs
* Observe fade-in fade-out effect beyond threshold

# 5. Conclusion

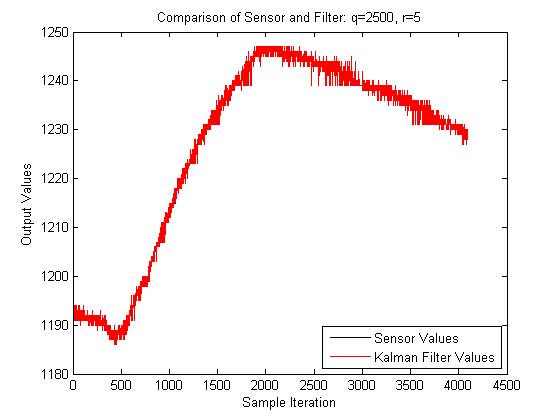
# References

# Appendix A – Matlab Simulation Results

Figure



Figure



Figure

