

Modular Rapid Monitoring System

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Sponsor: Martin Engineering, Illinois

Advisors: Dr. Malinowski and Dr. Ahn

Bradley University Electrical and Computer Engineering

October 1, 2015

Agenda

- Problem Background
- Design Approach
- Economic Analysis
- Schedule
- Division of Labor
- Societal and Environmental Impacts

Problem Background

- Sponsored by Martin Engineering
- Modular Rapid Monitoring System
 - Logs analog and digital signals.
 - Ability to easily add additional inputs.
 - Low cost design.
- Past Project Progress
 - Team in class of 2015 worked on same project.
 - Goal: Continue development to make a “proof-of-concept” system for sponsor.

Problem Background

- System logging data within 50 ms after boot.
- Accelerometer and ADC operating at 600 Hz.
- Permanently store the first five minutes of incoming data.
- Permanently store the five minutes of data after power down.
- Keep cost under \$300.

Design: Approach

- Two subsystems
 - Sensor Interface System (SIS)
 - Acquires data from ADC and accelerometer.
 - Calculates RPM using ADC voltage/current.
 - Stores in rotary buffer.
 - Sends data via UART.
 - Gateway Interface System (GIS)
 - Receives and stores data from SIS.
 - Hosts web server that displays data to user.
 - Wireless ad-hoc network to access server.

Design: System Block Diagram

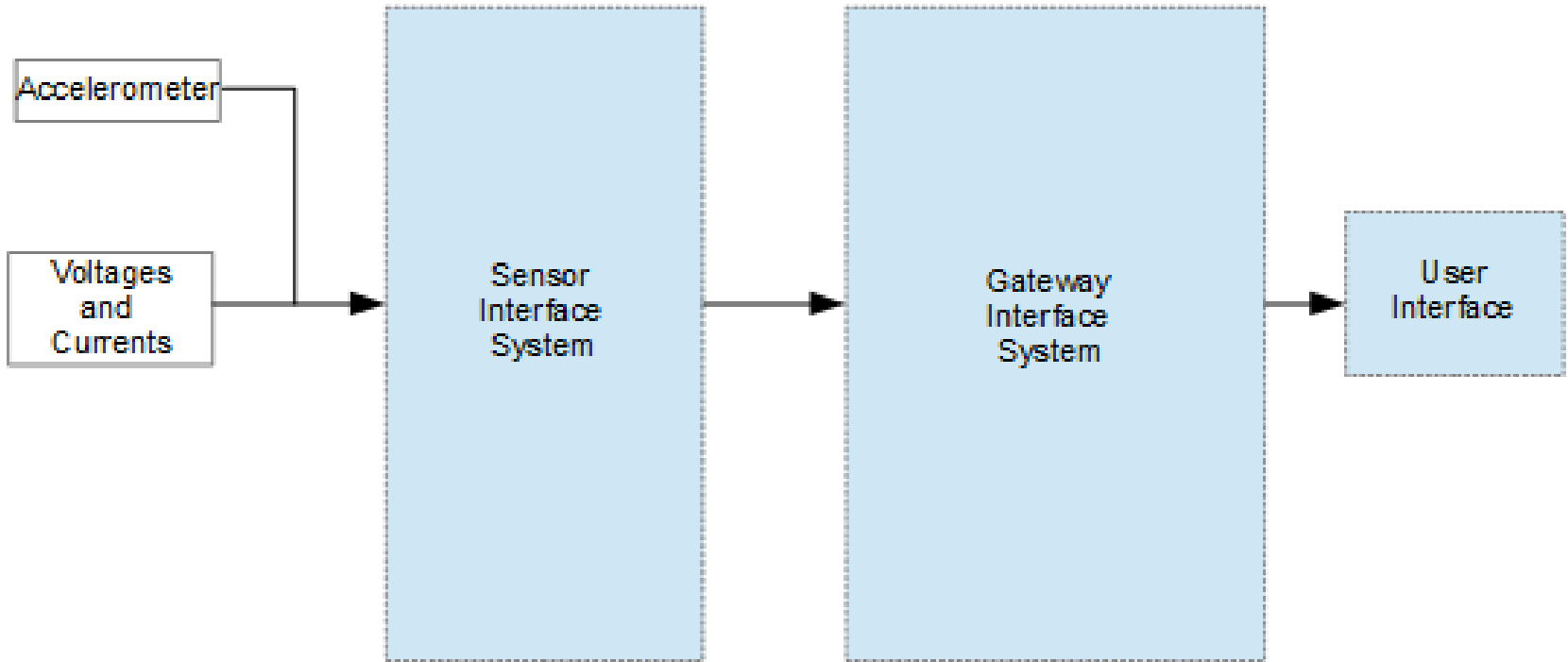
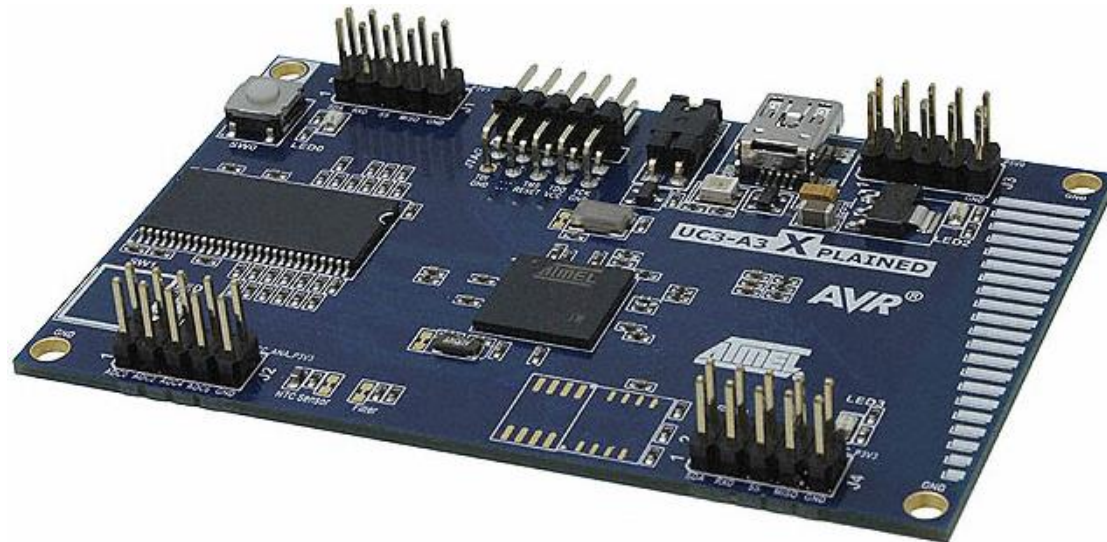


Figure 1: System Block Diagram

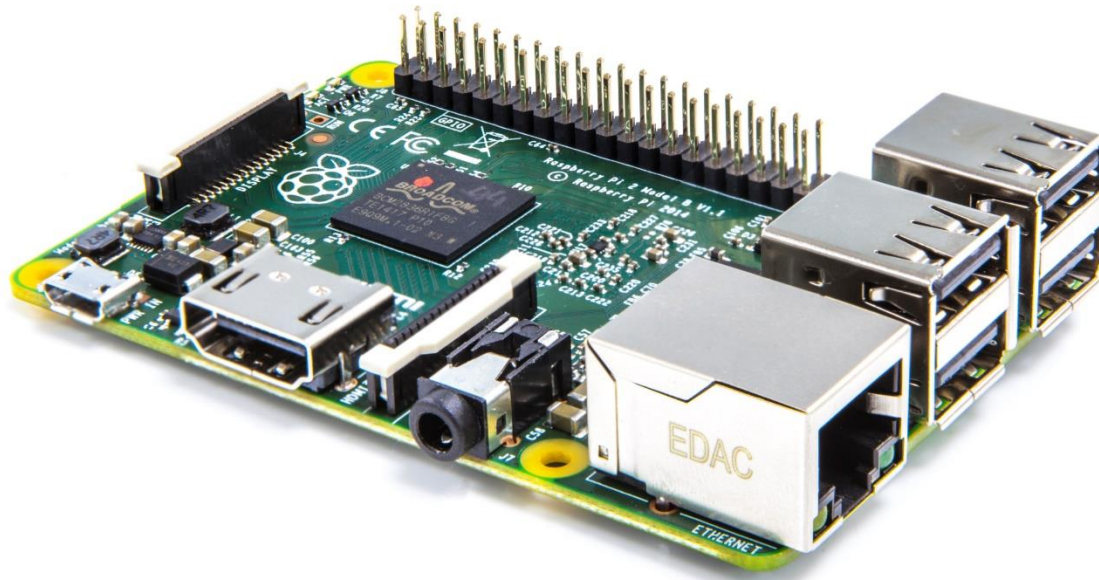
Design: Solution

- Sensor Interface System (SIS)
 - Atmel UC3-A3 Xplained.
 - ADXL335 Accelerometer.
 - UART communication.
 - Custom embedded firmware.



Design: Solution

- Gateway Interface System (GIS)
 - Raspberry Pi.
 - RT5370 USB Wi-Fi dongle.
 - UART communication.
 - Lightweight embedded Linux.



Design: Alternate Solutions

- Overall design must stay the same due to given constraints and previous work.
- Alternate Components
 - Sensor Interface System (SIS)
 - Many variations of Atmel UC3 Xplained.
 - Gateway Interface System (GIS)
 - Beaglebone Black.
 - Other ARM based boards.

Design: Key Skills and Research

- Sensor Interface System (SIS)
 - Experience with Atmel 8-bit microcontrollers and C programming from ECE 103, 205, 322, 471.
 - Analog I/O, I2C, and UART communications were covered in ECE 322.
 - Need to research different approach used in 32-bit systems.

Design: Key Skills and Research

- Gateway Interface System (GIS)
 - Experience with operating systems and microcontroller Linux from ECE 472.
 - Peripheral access covered in ECE 471.
 - Need to research driver setup and boot time optimization for embedded Linux.

Design: Facilities

- Development
 - All programming can be completed in Bradley ECE labs.
 - Any assistance can be provided from Dr. Alexander Malinowski and Dr. In Soo Ahn.
- Testing
 - Primary testing will be done in Bradley ECE labs.
 - If ahead of schedule, onsite testing at Martin Engineering will be arranged.

Design: Testing Criteria

- Sensor Interface System (SIS)
 - Boot time
 - Data acquisition
 - Amplitude and frequency
 - Rotary Buffer
 - I²C and accelerometer
 - UART communication to Gateway Interface System

Design: Testing Criteria

- Gateway Interface System (GIS)
 - Boot time
 - UART communication to Sensor Interface System
 - Web server
 - Ethernet communication first
 - Wi-Fi communication
 - Check driver works by connecting to access point
 - Create ad-hoc network and connect to web server

Design: Testing Criteria

- SIS and GIS combined
- Data acquired is displayed on web server.
 - Accelerometer and ADC.
 - Accuracy of data.
 - Speed of data update on web server.
- Boot times are synchronized with the rotary buffer.

Economic Analysis: Components

Table 1: Components Cost

Part	Cost	Store
Raspberry Pi	\$30.00	Element14 Online Store
Atmel UC3-A3 Xplained	\$31.25	Atmel Online Store
ADXL335 Accelerometer	\$15.00	Sparkfun Online Store
2x 2A Micro USB Power Adapter	\$7.99	Amazon
RT300 USB to UART Adapter	\$1.99	Amazon

Total Cost: \$96.23

Much less than a \$300 constraint

Economic Analysis: Total Cost

- All software used is either “Open Source” or provided free from developer.
- Bradley ECE Department has all equipment necessary.
- Total cost of project is only that of the



Economic Analysis: Production

- Martin Engineering has not provided any production information.
 - Quantity required and cost of installation is unknown.
- Martin Engineering will set customer price.



Schedule: Deliverables

Table 2: Deliverables Schedule

Task	Start	Finish	Duration
Proposal Presentation	9/16/2015	9/30/2015	2 weeks
Proposal Documentation	10/1/2015	10/14/2015	2 weeks
Webpage Release	10/12/2015	10/26/2015	2 weeks
Progress Presentation	10/26/2015	11/17/2015	3 weeks
Performance Review	11/17/2015	12/1/2015	2 weeks

Schedule: Technical

Table 3: Technical Schedule

	Task	Start	Finish	Duration
SIS	Develop ADC controller	9/8/2015	9/29/2015	3 weeks
	Develop Serial Communication with GIS	9/29/2015	10/20/2015	3 weeks
	Optimize Rotary Buffer for the Data Accelerometer Interfacing	10/20/2015	11/10/2015	3 weeks
	Data Storage During GIS Boot	11/10/2015	12/8/2015	4 weeks
	Correct Timings for Sending Data	12/8/2015	1/28/2016	5 weeks
		1/28/2016	2/16/2016	3 weeks
GIS	Research and decide base OS	9/8/2015	9/24/2015	3 weeks
	Interface Wifi	9/29/2015	10/8/2015	2 weeks
	Develop UART Access program	10/13/2015	11/5/2014	4 weeks
	Develop lightweight web server	11/10/2015	11/26/2015	3 weeks
	Optimize boot time	12/1/2015	1/28/2016	3 weeks
	Optimize Web server GUI	2/2/2016	2/11/2016	2 weeks
	Combined SIS/GIS Testing and debugging	2/16/2016	3/10/2016	4 weeks

Division of Labor

- Joseph Mintun
 - Sensor Interface System
 - Web Page
- Timothy Kritzler
 - Gateway Interface System
 - Web Page

Impacts

- Who is affected?
- Ethics
- Safety
- Liability
- Risks

Summary

- Problem Background
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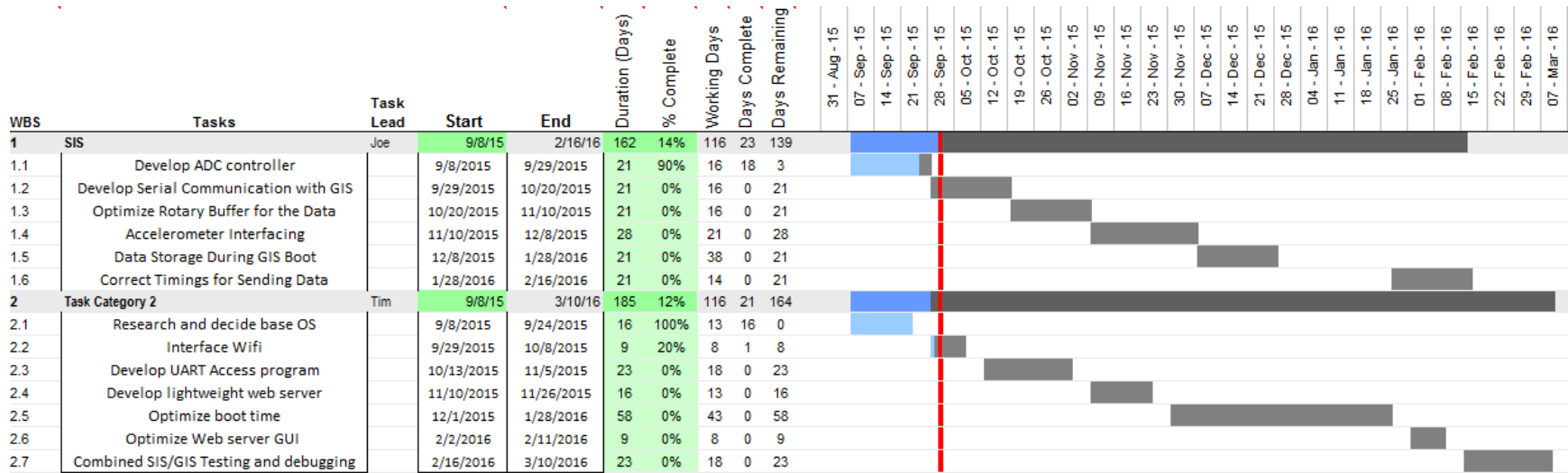
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Full Gantt Chart

Table 3: Gantt Chart



Software Flow Chart

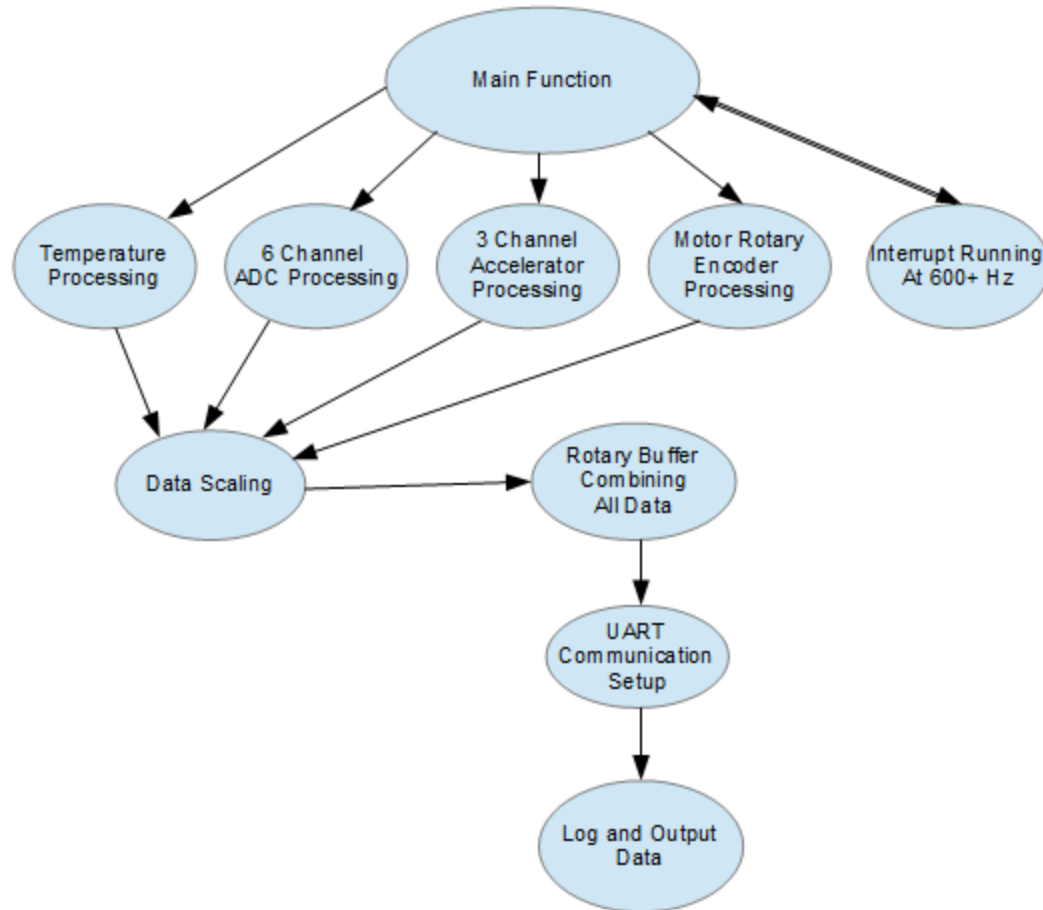


Figure 3: Software Flow Chart