Modular Home Monitoring System (MHMS) – Group 7

1. Group Members

- Gary Leutheuser, major: Electrical Engineering
- Robert Simon, major: Computer Engineering
- Robert Short, major: Electrical Engineering

2. Project Description

Problem Statement

Many homeowners have a need for a way to monitor the status of their dwellings while they are away. A familiar example of a product that fulfills this need is a home security system. Consisting of a base station and a number of linked sensors, these notify the homeowner (and possibly the local police) of any activity that might indicate a break-in. However, there are also other applications. Consider a home that is frequently left unoccupied for long periods of time, such as a vacation home. If, for example, a water pipe were to burst, the owner would need to know about it, preferably before significant damage were to occur. There are many similar scenarios (such as a fire or a power outage, to name a few) which the owner would like to know about without having to resort to constant personal supervision.

If an integrated, modular system for monitoring various sensors and generating notifications based on the gathered data were available, the task of taking care of a property would be greatly simplified. Perhaps more importantly, being able to remotely verify the safety of a structure would do wonders for the owner's peace of mind. Ideally, such a system would have configurable alerts, and a real-time monitoring function, so that the user could both receive alerts when an abnormal and possibly dangerous condition is encountered (such as a fire) or simply view sensor readouts to ensure that everything is working properly (by checking the temperature to ensure that the air conditioner is functioning, for example).

There are many systems on the market which try to fulfill this need. Unfortunately, most of them fall far short of the ideal. Commercially available security systems will monitor motion detectors or door sensors and alert the police when tripped. However, many do not alert the homeowner (giving him or her an opportunity to interrupt what may be a false alarm). Most are also tied to a particular service provider, and will not function at all unless a significant monthly fee is paid. Almost none have any support for environmental sensors (humidity sensors, smoke detectors, etc.). Dedicated environmental sensor systems exist, but these do not support security-related sensors. At present, the best option for anyone who desires both security and environmental monitoring is to maintain and install a separate system for each. This leads to a significant increase in both complexity and cost.

Goals and Objectives

Our project's objective is to design a set of sensors that can provide both security and environmental monitoring in one system. We believe that a modular, integrated solution will solve the problems discussed in the previous section. By combining the functionality of two systems into one, we can leverage the shared functionality to save on hardware and maintenance costs. Similarly, by presenting one user interface, rather than two distinct ones, our system will be significantly easier to use. The reduced cost and effort of our system, compared to alternatives, will hopefully make a complete home monitoring system practical for the average homeowner.

Functional Description

Functionally, the system will consist of a base unit which communicates with sensors located nearby. The base unit will be capable of alerting the user through text message or e-mail if a sensor is tripped (useful in the case of security devices), if a measurement exceeds a preset range (useful for temperature or humidity), or simply deliver measurements and status updates at regular intervals. Additionally, the user should be able to remotely view real-time readouts of all sensors, if desired. The sensors will mostly be focused on providing security (motion sensors, glass break detectors, cameras, etc.) and environmental information (temperature, humidity, leak detection, etc.), but the framework should be simple to extend in order to support any other useful sensors.

For the basic sensor suite, we propose that our system should support: cameras, broken glass sensors (acoustic), carbon monoxide detectors, smoke detectors, sound sensors, and motion detectors. Together, these should cover most of the common use-cases for our system. If time permits, the basic suite could be expanded.

3. Requirements Specifications

1. Weight & Construction
    1.1. The entire system including its modules shall weigh less than 30 pounds.
2. Functionality
    2.1. Security
        2.1.1. The system shall provide a live video feed via a web interface to the user.
            2.1.1.1. The live video feed shall be encrypted according to a crypto standard.
        2.1.2. The system shall alert the user to motion during pre-determined times.
        2.1.3. The system shall alert the user if it detects broken glass.
        2.1.4. The system shall send pictures of its field of view to the user when it senses motion during unauthorized times.
        2.1.5. The camera shall provide a contrast of in a range of 50:1 and illuminance from 10 to 11,000 lux
    2.2. Smoke Detection Sensor
        2.2.1. The system shall provide smoke detection for the room it will be monitoring.

2.2.2. When a smoke is detected the system shall sound an alarm and send an alert to the user.

2.3. Carbon Monoxide (CO) Sensor

2.3.1. The sensor shall provide output indicating if it detects a CO concentration of greater than 150 ppm.

2.4. Modularity

2.4.1. The functionality of the system shall be modular: the system must function with (or without) any combination of supported sensors, within the allowable limit of 5 total sensors.

2.5. IOT Enabled

2.5.1. The system shall follow the internet-of-things paradigm.

2.5.2. Alerts will be sent over the Internet to the user.

3. Performance

3.1. Wireless Communication

3.1.1. The system shall support at least a 1Mbps wireless data transfer rate.

3.1.2. The device shall notify the user within 10 seconds of a safety threshold being surpassed.

3.2. Camera

3.2.1. The camera shall be able to take 1 megapixel still images.

3.2.2. The camera shall be able to continuously capture 640x480 resolution video at 20 frames per second.

3.3. Carbon Monoxide Sensor

3.3.1. The sensor shall detect and output carbon monoxide levels in the air with a range of 20 PPM to 2000 PPM in a minimum of 5 PPM increments.

3.4. Glass Shatter Sensor

3.4.1. The sensor shall detect the sound of glass shattering within the room it is in for up to 30 feet.

4. Energy

4.1. The system shall be powered by a standard 120 Volt, 60 Hz, grounded US power outlet.

5. Economic

5.1. Cost

5.1.1. The system shall cost no more than $600.00 USD in parts to build.

5.1.2. The system shall cost no more than $200.00 USD in software and licenses to develop.

5.1.3. The developers shall use as much open source software as possible to mitigate cost.

6. Health and Safety

6.1. The system shall not emit harmful levels of electromagnetic energy.

6.2. The system shall abide by any laws governing the use of Radio Frequencies in the home.

7. Maintainability

7.1. The system will require no regularly scheduled maintenance except for occasional cleaning/dusting of the case to maintain optimal operation.

8. Legal/Privacy
   8.1. The system shall adhere to all laws of the United States.

4. Block Diagram

A block diagram of the project is shown in Figure 1- Top Level Block Diagram.

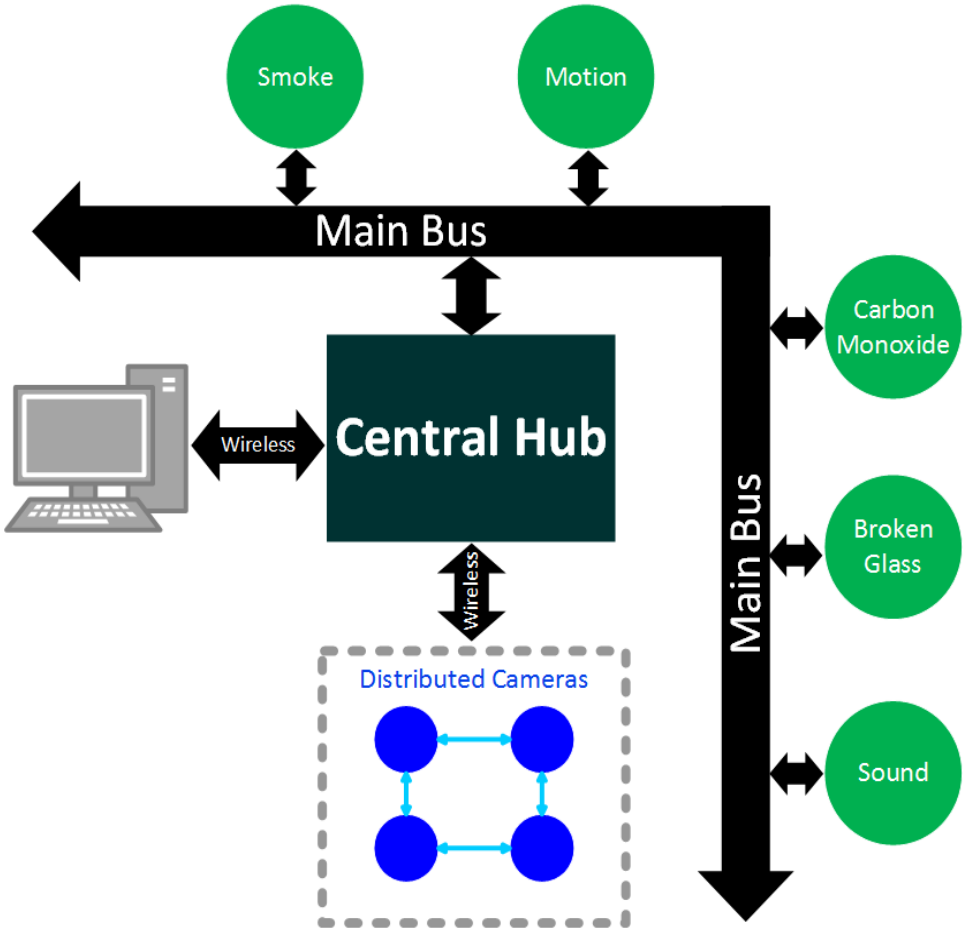

Figure 1- Top Level Block Diagram

The responsible member and status for each block is shown in Table 1 - Block Status and Assignee.

Table 1 - Block Status and Assignee

Block	**Responsible member**	**Status**
Central Hub	All	Design
Distributed Cameras	Robert Short	To be acquired
PC	Robert Simon	To be acquired
Broken Glass	Robert Short	To be acquired
Carbon Monoxide	Gary Leutheuser	To be acquired
Sound	Gary Leutheuser	Design
Motion	Robert Simon	Design
Smoke	Robert Short	Design

Further, a list of the inputs and outputs of each block is shown in Table 2 - Block Interfaces.

Table 2 - Block Interfaces

Block	**Signal**	**Input?**	**Output?**
Smoke	Smoke status		x
	Turn module on	x	
	Turn module off	x	
	Reset module	x	
Motion	Motion status		x
	Turn module on	x	
	Turn module off	x	
	Reset module	x	
Carbon Monoxide	Carbon monoxide level		x
Carbon Monoxide	Turn module on	x	
	Turn module off	x	
	Reset module	x	
Broken Glass	Glass status		x
	Turn module on	x	

Block	Signal	Input?	Output?
	Turn module off	x	
	Reset module	x	
Sound	Sound level		x
	Turn module on	x	
	Turn module off	x	
	Reset module	x	
Distributed Cameras	Video feed		x
	Camera select	x	
	Turn camera on	x	
	Turn camera off	x	
	Reset camera	x	
	Turn module on	x	
	Turn module off	x	
	Reset module	x	
Central Hub	Smoke status	x	x
	Motion status	x	x
	Carbon monoxide level	x	x
	Glass status	x	x
	Sound level	x	x
	Video feed	x	x
	Module select	x	x
	Turn module on	x	x
	Turn module off	x	x
	Reset module	x	x
	Camera select	x	x
	Turn camera on	x	x
	Turn camera off	x	x
	Reset camera	x	x
PC	Smoke status	x	
	Motion status	x	
	Carbon monoxide level	x	
	Glass status	x	
	Sound level	x	
	Video feed	x	
	Module select		x
	Turn module on		x
	Turn module off		x
PC	Reset module		x
	Camera select		x

Block	Signal	Input?	Output?
	Turn camera on		x
	Turn camera off		x
	Reset camera		x

5. Budget and Financing

As per requirement 5.1.1 the device shall not cost more than $600.00 USD in hardware to construct. This cost will be split among the various parts according to Table 1- Hardware Budget.

Table 1- Hardware Budget

Component	Cost
Wall Mounted Case	$60.00
Central Hub	$100.00
Smoke Sensor	$40.00
CO Sensor	$30.00
Camera	$80.00
Wireless Communication	$50.00
Power Supply	$40.00
Glass Shatter Detector	$80.00
Misc. Hardware	$20.00

As per requirement 5.1.2 we shall budget no more than $200.00 USD in software related costs and licensing. This cost will be split according to Table 2 - Software Budget.

Table 2 - Software Budget

Software/License	Cost
Development Tool Licensing	$100.00
Internet Of Things Service	$100.00

Our group will be totally self-funded among its three members. Each member shall contribute ⅓ of the total cost of the project. The project funds shall be equally split and if any funds remain in

any bank account that the three members decide to use for the project, the remainder will be split equally. At the end of Senior Design, since no one member has a greater claim on the system than anyone else, the project's final fate will be determined by mutual agreement.

6. Project Milestones / Schedule

An initial project schedule, through completion, is shown in Figure 2 - Project Schedule. Senior Design I and II are shown in the schedule as different colors to distinguish them, and the week of the submission of this paper is considered week 3, and is highlighted for emphasis.

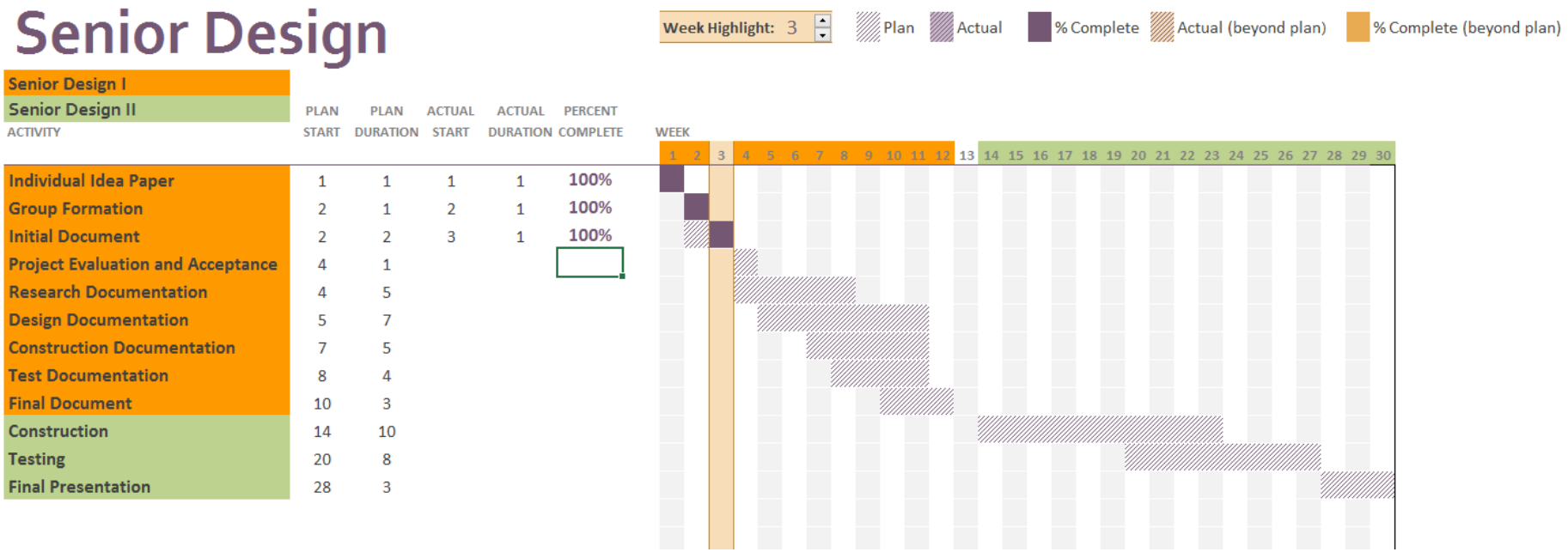

Figure 2 - Project Schedule