Wireless Leak Detector and Inhibitor System

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Presentation Outline

1. Motivation and Background
2. System Overview
3. Project Management
4. System Design
5. System Implementation and Testing
6. Future Work and Business Considerations
7. Individual Contributions
8. Closing
9. Questions

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Team Roles

Petar Arnaut:

CEO, Hardware Engineer

Olivier Thomas:

COO, Firmware Engineer

Chris Fontaine:

CTO, Hardware Engineer

Barry Zou:

CFO, Software Engineer

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Motivation and Background

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Motivation and Background

- Canadians on average pay $840 annually for home insurance. [1]
- Approximately 40% of all home insurance claims are from water related damages. [2]
- Average cost of water related damage rose from $7192 in 2002 to more than $15500 in 2012. [2]

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Motivation and Background

How do we develop a system that is able to alleviate this issue and offer users a peace of mind?

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System Overview

- Based on that information, we want
  - A system that is able to detect a leak effectively with limited false positives
  - A system that is able to prevent additional water damage by stopping the water source
  - A system that is able to warn the user of a leak remotely
- 3 modules
  - Detector
  - Inhibitor
  - User management

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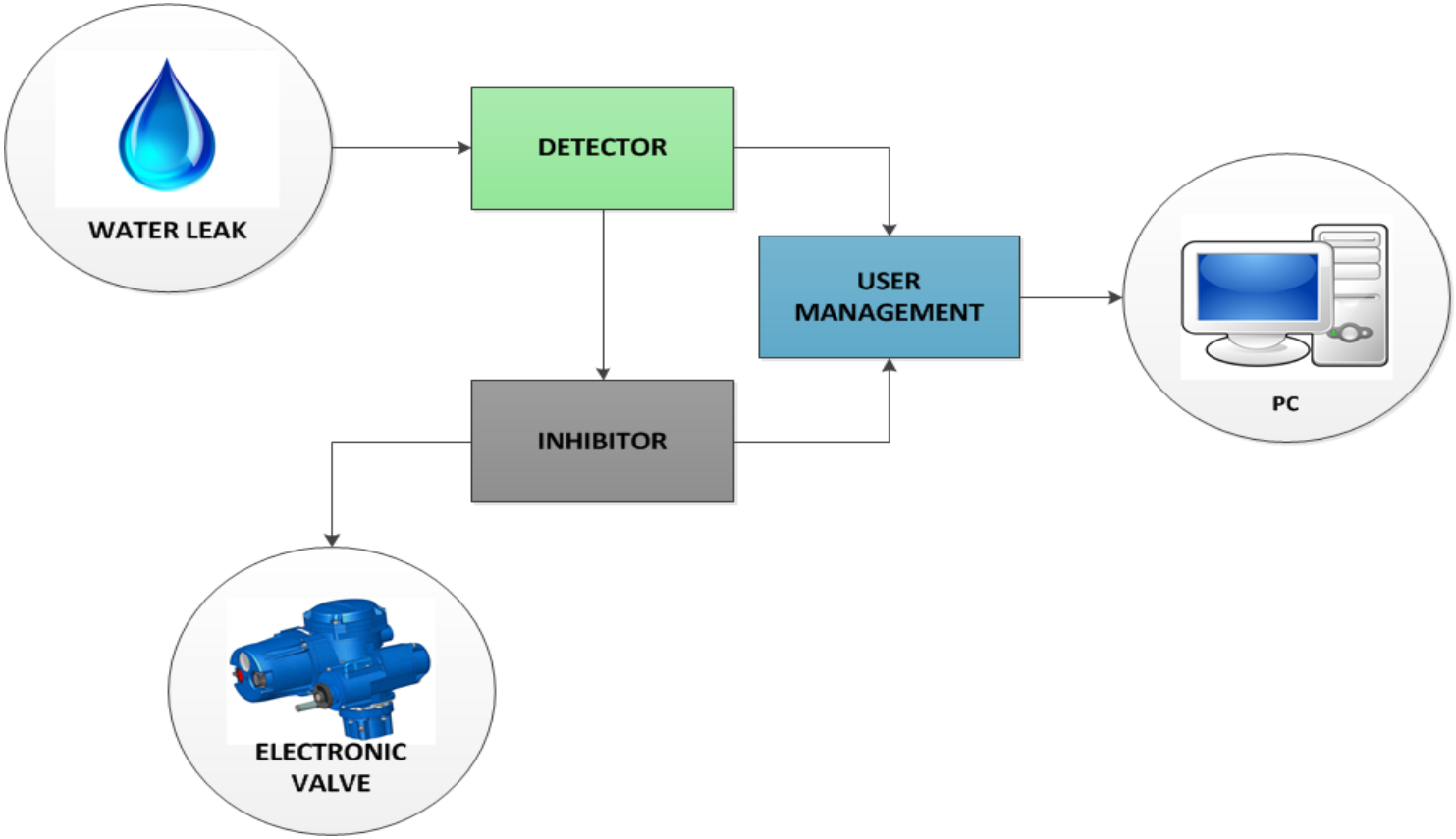
System Overview



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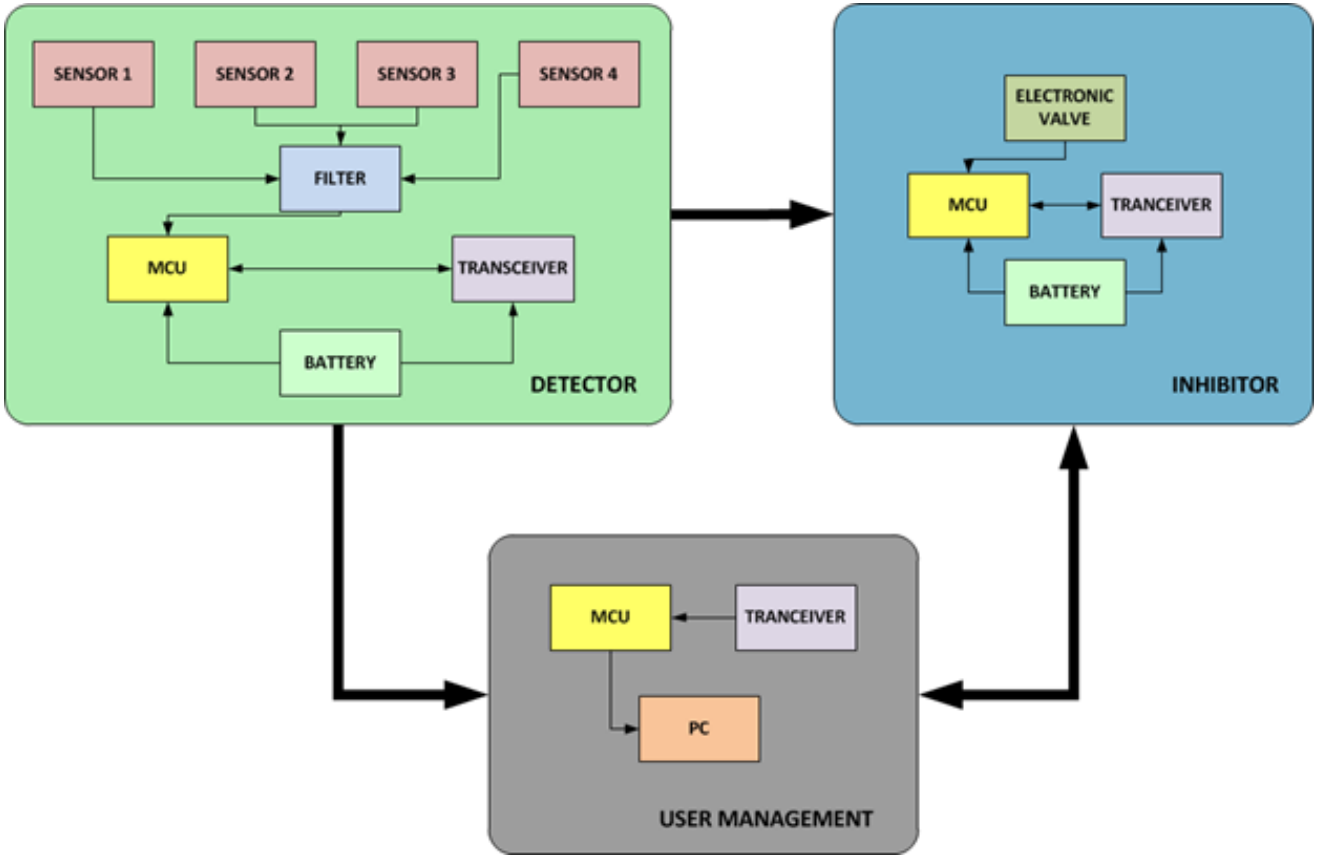
System Overview



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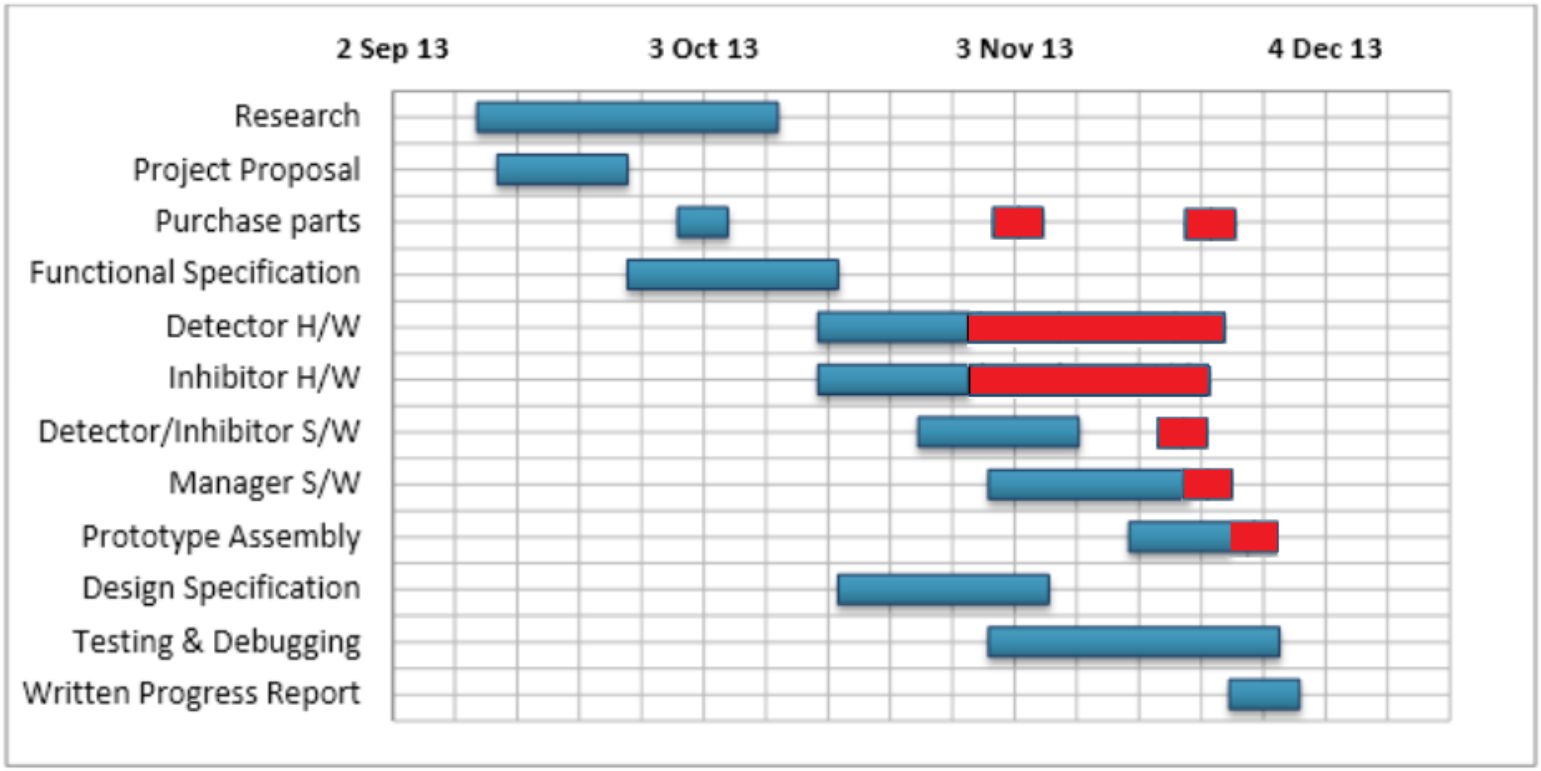
Development Schedule



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Development Cost

Equipment List	Estimated Cost	Actual Cost
Arduino Microcontrollers	$100	$94.56
Transceiver Modules	$80	$75.85
Moisture Sensors	$40	$0
Electronic Valve	$50	$24
Enclosure for Inhibitor/User management	$50	$16.26
Rubber Mat	$30	$30
Water proofing material (Seals, Covers, etc)	$20	$24.06
Miscellaneous Electronic Parts, Construction Equipment (Wires, Switches, Resistors, Screws, Wood, etc)	$80	$150.82
Internally Driven Buzzer	$ -	$11.04
RP-SMA Antenna	$ -	$31.12
Miscellaneous Tax/Shipping Costs	$ -	$91.93
Contingency	$70	
Total Cost	**$520**	**$549.64**

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Prototype Unit Cost

Detector Rubber Mat, Cover, Arduino, Transceiver, Electronic parts, Misc	Module Cost $165.50
Inhibitor Electronic Valve, Arduino MCU, Transceiver, RP-SMA Antenna, Enclosure, Cable Gland	Module Cost $90.00
User management nRF24LU1+ Transceiver, RP-SMA Antenna, Enclosure	Module Total Cost $60.25
Total Cost	**$315.75**

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Market Demand

- Not all water related damages will be covered by insurance
- Hassle and nuisance to deal with claims and repairs
- Provides benefit of peace of mind while users are away from the property
- Suitable for both home and business owners

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Competitive Advantage

Alternative Similar Systems On The Market	The Signatus Wireless Leak Detection System
Have basic functionality	Customizable through software
Cannot have remote alerts	Remote alerts
High Cost	Cost-Efficient
	Scalability
	Ease of installation
	Sensors are appealing and easy to move

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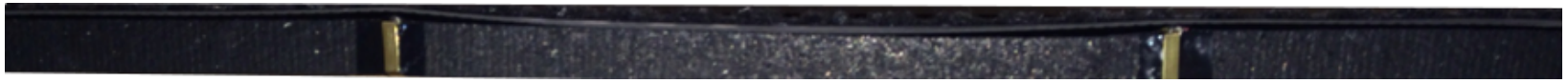
Detector Hardware Design



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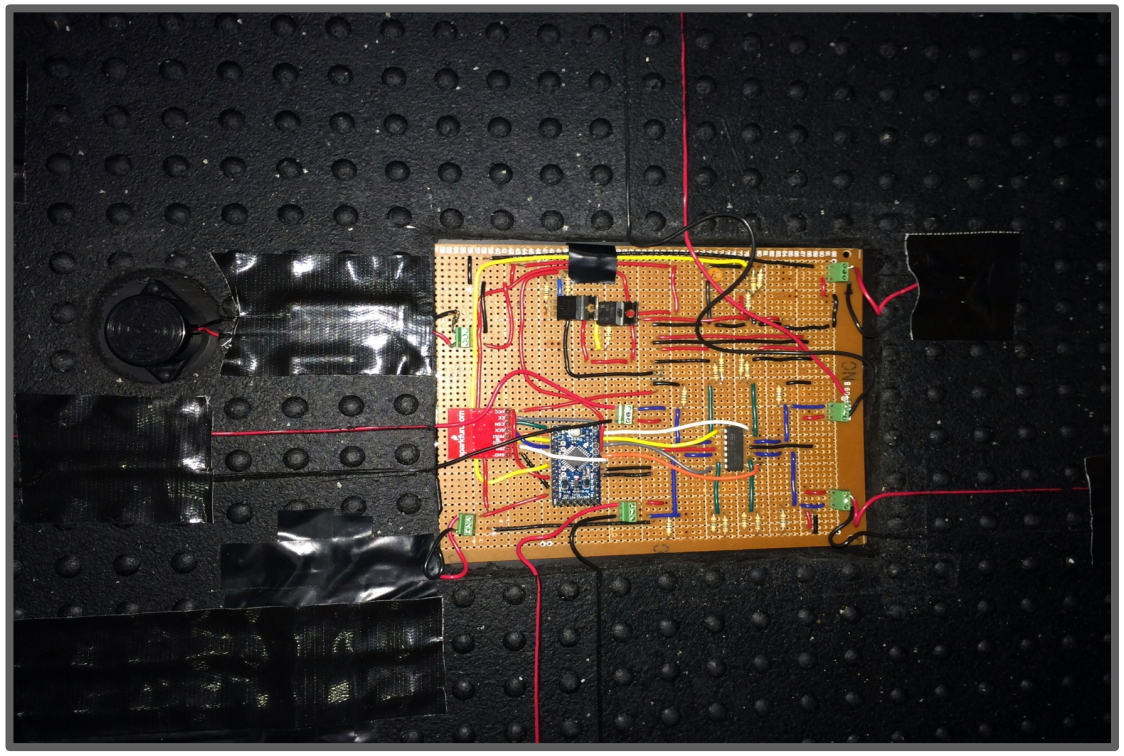
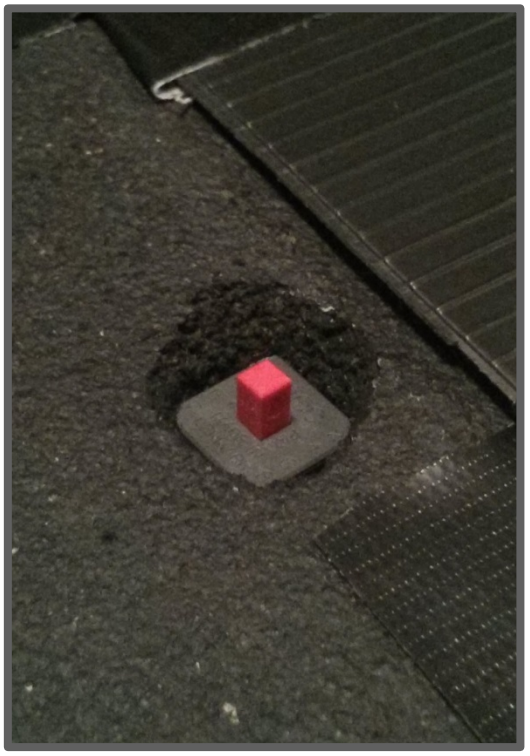
Detector Hardware Design





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Detector H/W Iterative Design

1. NMOS switch circuit
2. Simple comparator circuit
3. Wheatstone bridge with instrumentation amplifier

Final Design Choice

4. Wheatstone bridge with a comparator

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Inhibitor Hardware Design

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Inhibitor H/W Iterative Design

1. Original design for a normally open valve
   - Simple NMOS switch
2. New design for either valve type with software control

<u>Final Design Choice</u>

4. PMOS to switch power for valve with NMOS to act as software switch

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MCU + Transceiver Selection

- MCU
  - Size
  - H/W Interrupt
  - SPI
  - I/O and Analog Pins
- Transceiver
  - 2.4 GHz
  - Includes low level packet wrapper
  - Range

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Embedded Design

Leak Detection

Valve Control

Battery Monitor

RF Communication

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RF Communication

Unique ID	Reserved	Type ID	Conn Status	Data	
				Leak	Battery
8 Bits	4 Bits	2 Bits	2 Bits	1 Bit	7 Bits
23	15	11	9	7	6 0

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Application Software Design

- After receiving the data is then passed into the USB ram on the MCU
- The GUI application requests data asynchronously, when the MCU has data in the USB RAM it clears the request and passes the data. After receiving the data the GUI application sends a new request

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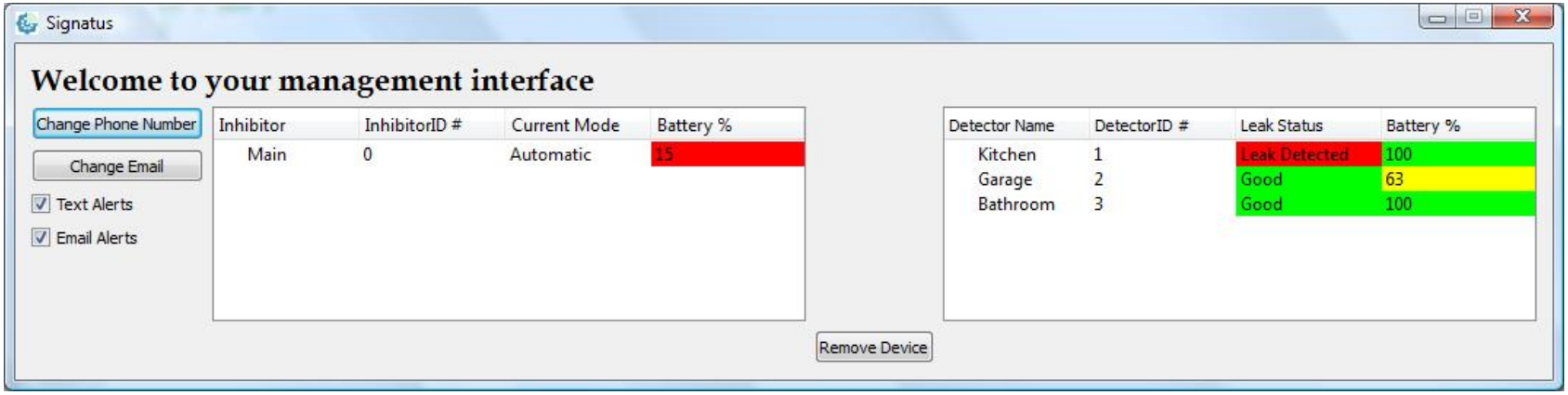
GUI Application

- Implemented using Qt Creator and Qt 5.1.1 Framework
- Designed for simple and intuitive, along with ease of use, reliability



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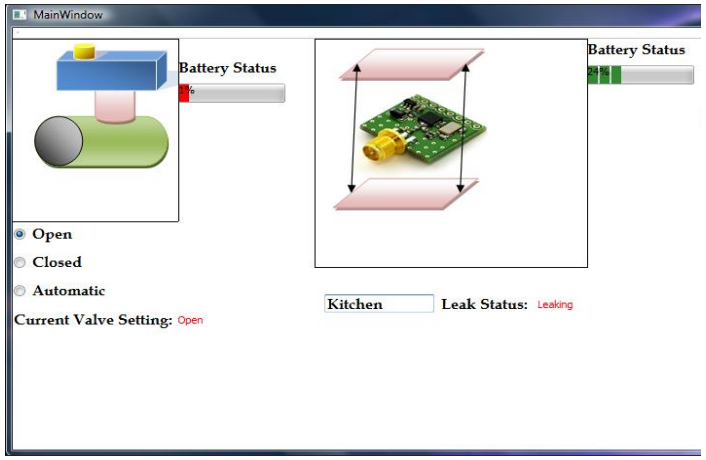
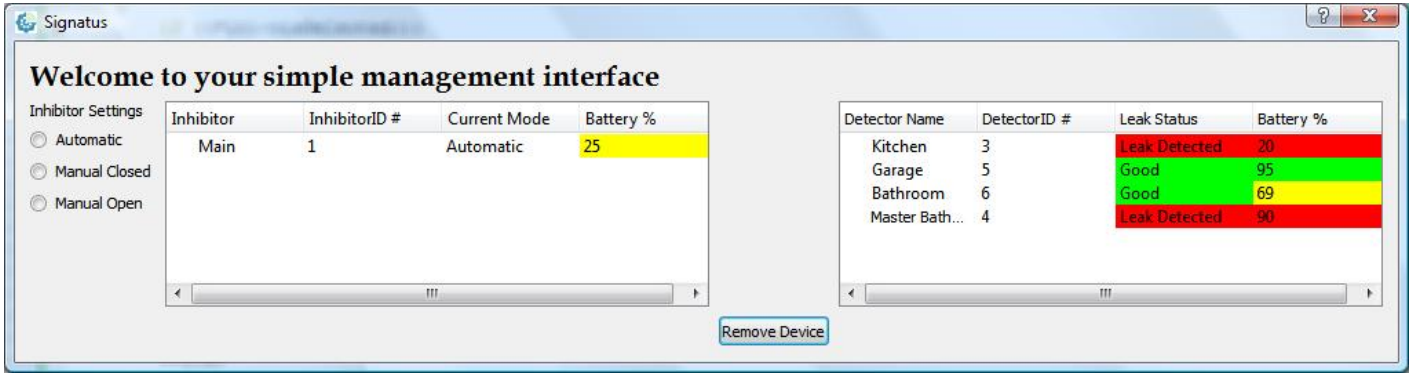
GUI Iterative Design





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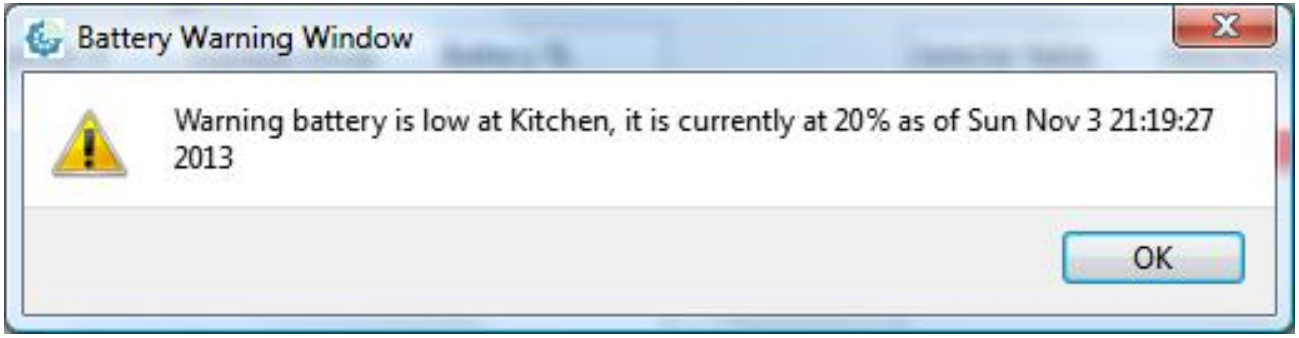
Battery Status and Leak Detection



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Email and SMS Alerts

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System Implementation

- Divided tasks according to expertise
- Subdivided each device into the smallest subcomponents possible
- Unit tests after each subcomponent complete
- Integration
- Testing of integrated device
- Repeat

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Unit Testing

- Water Detector
- Valve Inhibitor / Pump
- Transceivers / Receivers
- GUI Interface
- Integration

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Product Capabilities

- Detectors can be placed within 90 feet of inhibitor
- Battery life on detector estimated at minimum one week
- Able to detect any conducting type of liquid
- Can withstand a person walking across the detector
- Software is capable of sending notifications
- Detector and inhibitor will automatically connect with each other, when in range

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Design and Scope Changes

- No battery status for Inhibitor
- No software control over the Inhibitor

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Future Improvements - Detector

- 95th Percentile male can step on Detector without harm
- Batteries able to last for 6 months before replacement
- Manufacture the electronic circuit + MCU + Transceiver into a PCB design
- Different type of rubber mat material

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Future Improvements - Inhibitor

- Supplied by AC power through property electrical panel
- Offer a variety of sizes for the electronic valve
- Use a valve that is normally open, power to close
- Improve the strength of the receiver

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Future Improvements – User Management

- User management MCU + Transceiver built into 1 ASIC
- Proper GUI elements and support
- Additional GUI features such as
  - Proper Text messaging using a paid service
  - Manual Inhibitor controls
  - Buzzer disable option

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Contributions – Petar Arnaut

- Arranged meetings between team members, divided tasks among members
- Documentation of all meeting minutes and submissions
- Design and implemented detector buzzer, sensor, battery status circuit
- ENSC 220, 225, 325, 425

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Contributions – Olivier Thomas

- Initial system design
- Functional specification, Design specification for embedded software
- Researched parts for overall system
- Designed and implemented embedded software for Detector, Inhibitor and RF communication
- ENSC 215, 350, 351

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Contributions – Chris Fontaine

- Specifications for inhibitor, editor for final review of documentation.
- Designed the wheatstone bridge for use in the water sensor circuit
- Designed and implemented inhibitor electronic valve control circuit
- Unit testing of hardware devices and fabrication of final product
- ENSC 325, 425

Contributions – Barry Zou

- Documentation for drafts Project Proposal, Progress Report, Presentation
- Functional specification and Design specification for GUI application
- Tracked financials and purchases of main electronic parts
- Designed and implemented the GUI application
- CMPT 128

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Conclusion

- Built a prototype Wireless Leak Detector and Inhibitor System which includes
  - A water sensing electronic circuit that is able to transfer leak information wirelessly
  - An inhibitor module that is able to take appropriate actions with transmitted data and shut off water source
  - A user management module that is able to display accurate status information through a GUI, as well as remotely warn users of leaks

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Conclusion

- During the system development process we gained experience and learned about
  - Project planning and management
  - Time management and prioritizing
  - Team communication
  - Hardware and Software skills

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Thank You

Any Questions?

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