AirTack

REAL-TIME AIR QUALITY MULTIMONITOR

PROJECT PRESENTATION AND DEMO BY

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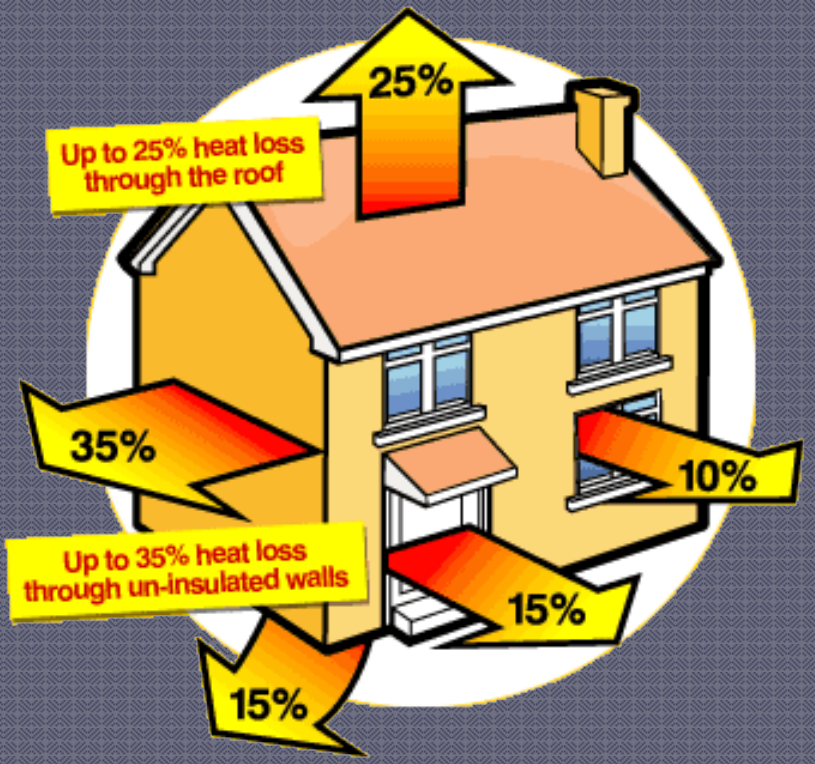
Outline

1. Motivation and Background
2. Product Design
3. High-Level Project Details
4. Future Work
5. Conclusion
6. Acknowledgements
7. Questions
8. Demo – Video and Live Presentation

Motivation – A Better Solution

Smoke and water related damage

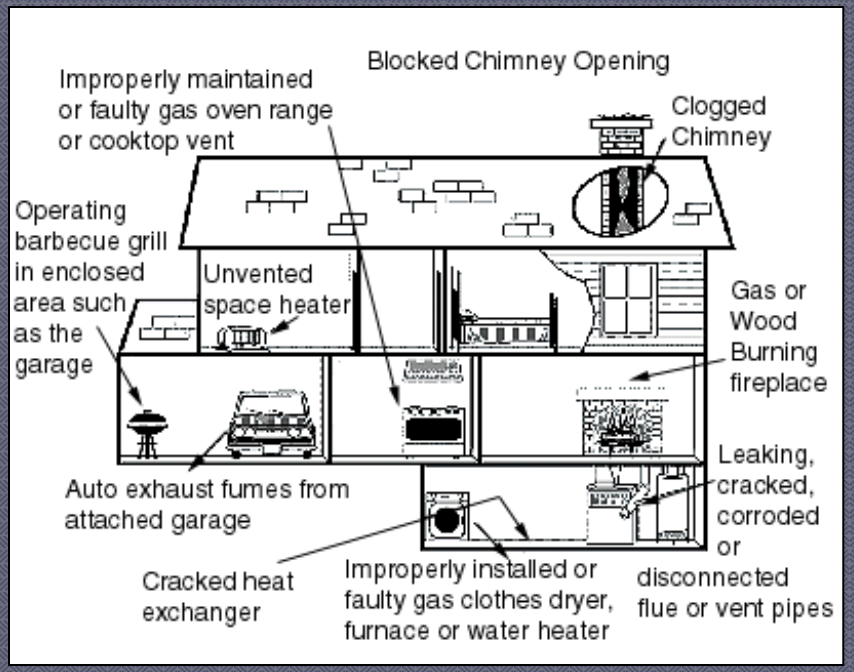


Temperature differentials and heat loss

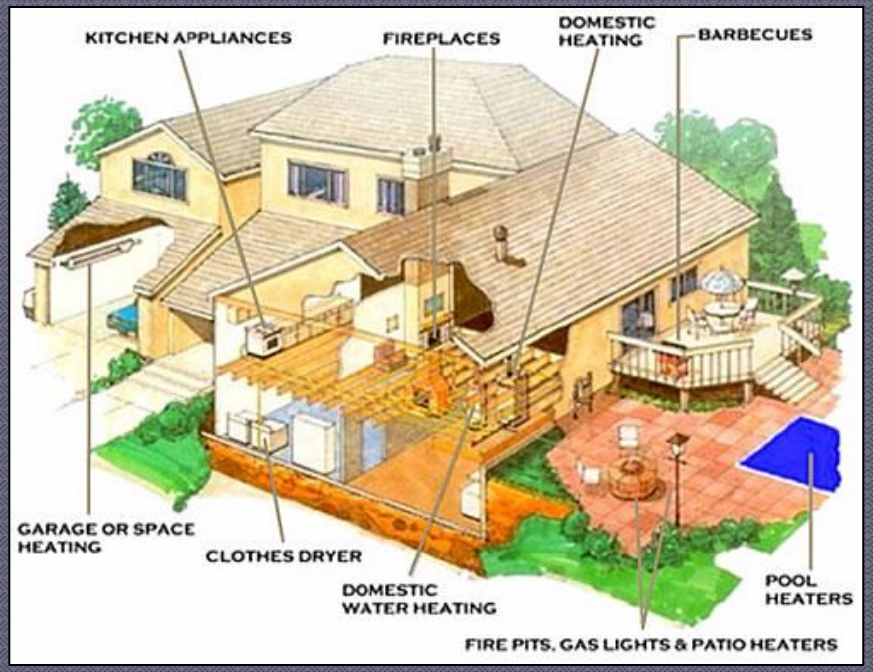
Motivation – A Better Solution

Individual monitoring systems already exist for $CO_{(g)}$, methane, smoke, humidity and temperature

Combine, Communicate and Conquer!



Sources of $CO_{(g)}$ in the home



Sources of natural gas leaks in the home

The Business - Competing Solutions

$CO_{(g)}$, Methane and Smoke monitor

$50.00

$CO_{(g)}$ and Methane dual monitor

$50.00

Temperature and Humidity dual monitor

$20.00

Competing Solutions – What's Missing?

No communication between discrete devices

No data analytics available – knowledge is power!

Several devices to train user on

Motivation - Goals and Objectives

Achieved

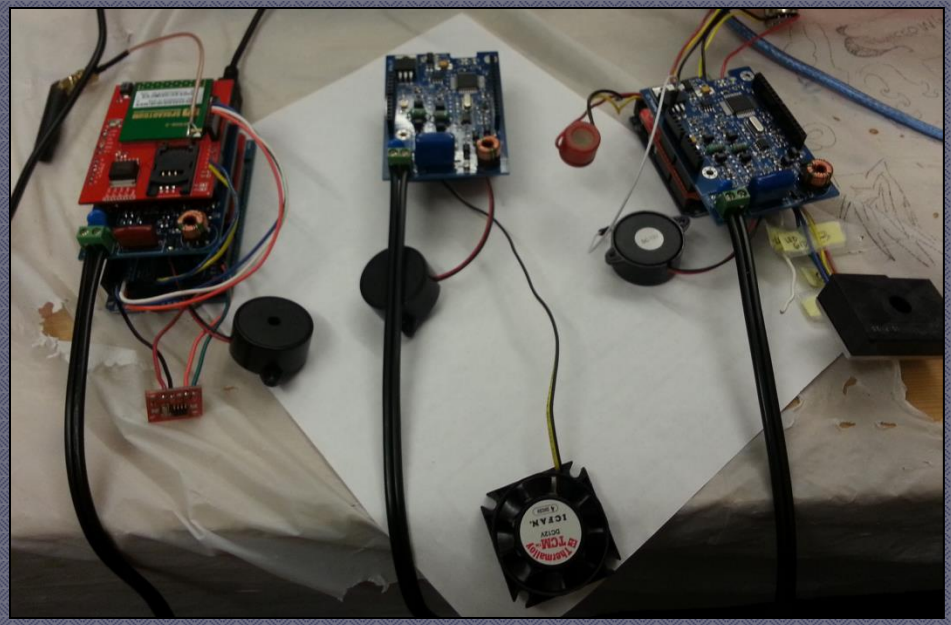
- ✓ Monitor levels of five environmental factors in real time, with user-friendly data analysis
- ✓ Response Mechanisms:
  - ✓ SMS text message, ventilation management, buzzer initiation
- ✓ Powerline Communication for universal installation
- ✓ Modularity: Easily add/remove additional modules for each room in a house

Future Development

- ✓ Full conformity to safety standards (CSA)

Product Design - Our Solution

1. High-Level Overview
2. Server Module
3. Sensor Module
4. Active Module
5. Powerline Communication
6. Data Analytics
7. Safety, Usability and Sustainability



Product Design - Our Solution

Scaleable Multimonitor

- ✓ Monitors it all:
  - ✓ Carbon Monoxide
  - ✓ Natural Gas
  - ✓ Smoke
  - ✓ Humidity
  - ✓ Temperature
- ✓ No renovation install

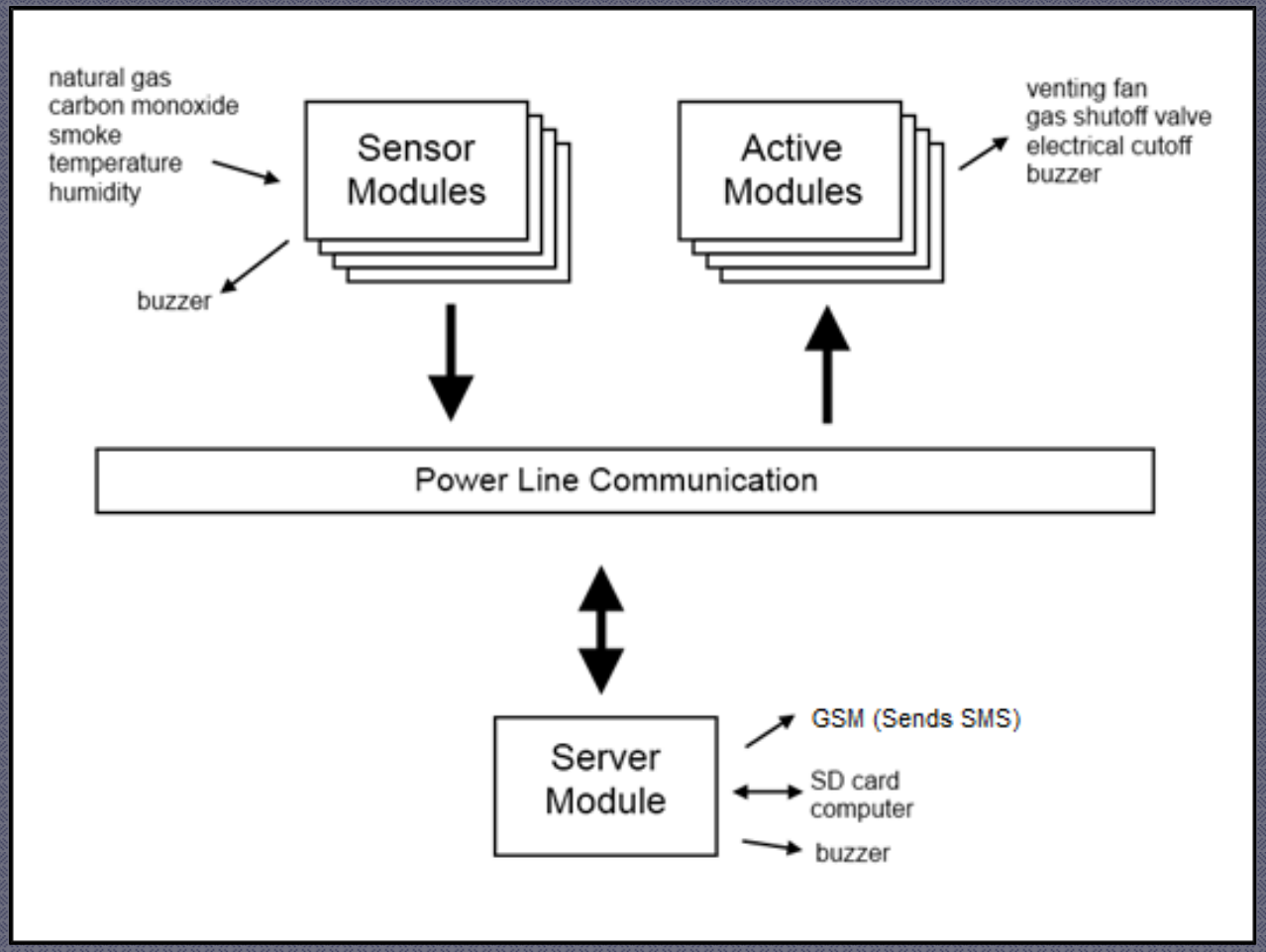
Reliable Real-Time Response

- ✓ Automated Response Systems
  - ✓ SMS Text Alert
  - ✓ Ventilation Initialization

Real-Time Data Analysis

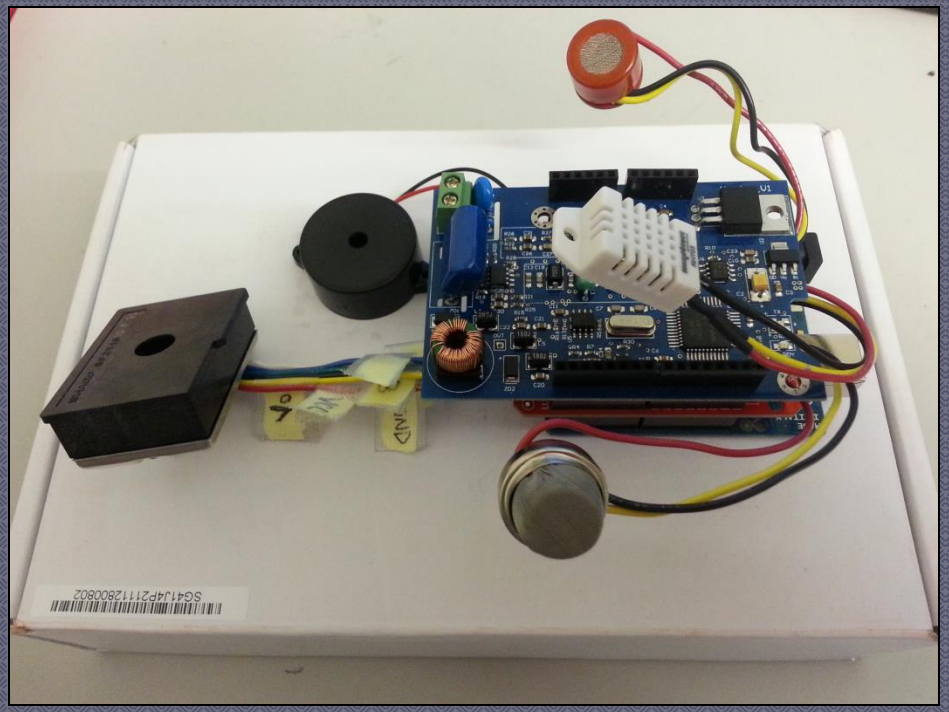
- ✓ Real-Time Data Trending
  - ✓ Trend Graphs
  - ✓ Correlation Analysis

High Level System Overview



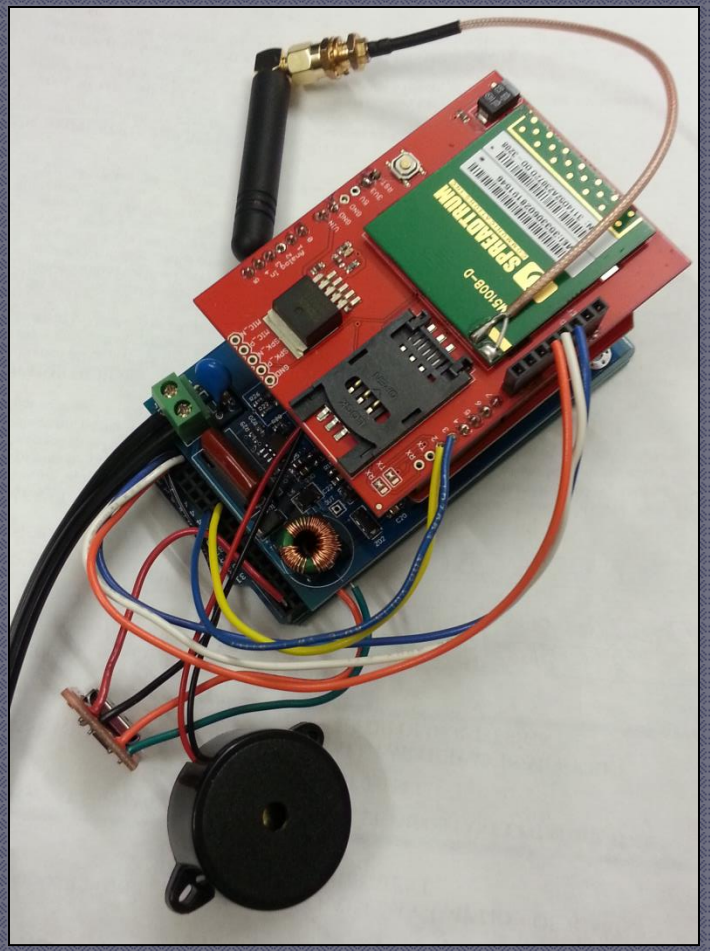
Sensor Module

- The sensory input
- Can monitor multiple environmental factors
- Minimizes latency by sending alarm signals directly to other modules



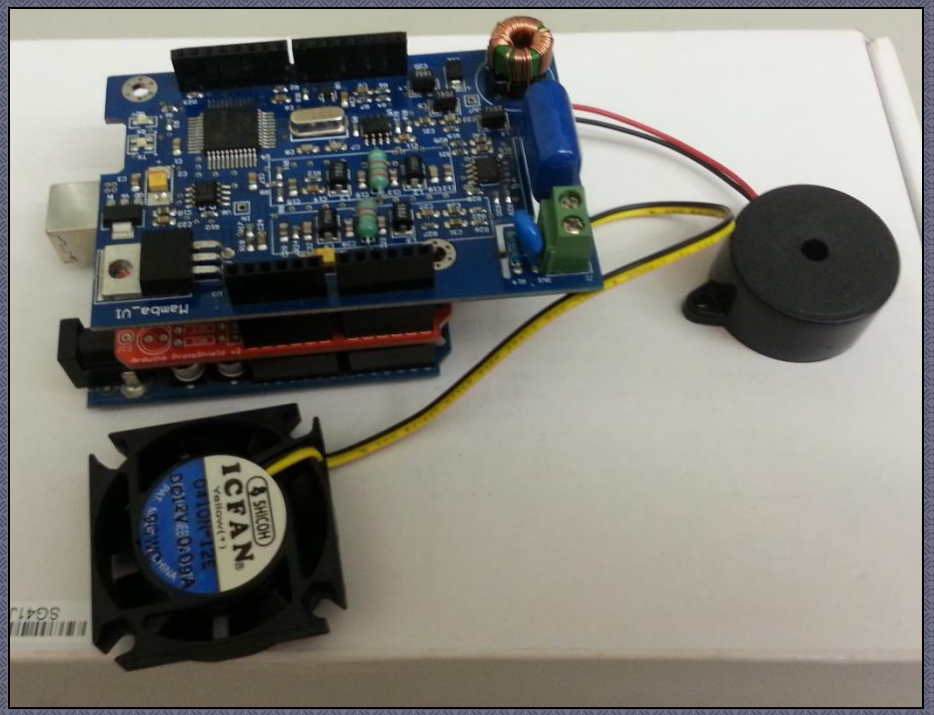
Server Module

- The brain!
- Keeps track of all the modules
- Manages incoming data and storage functionality
- Interfaces with a PC to provide data analysis and graphing capabilities



Active Module

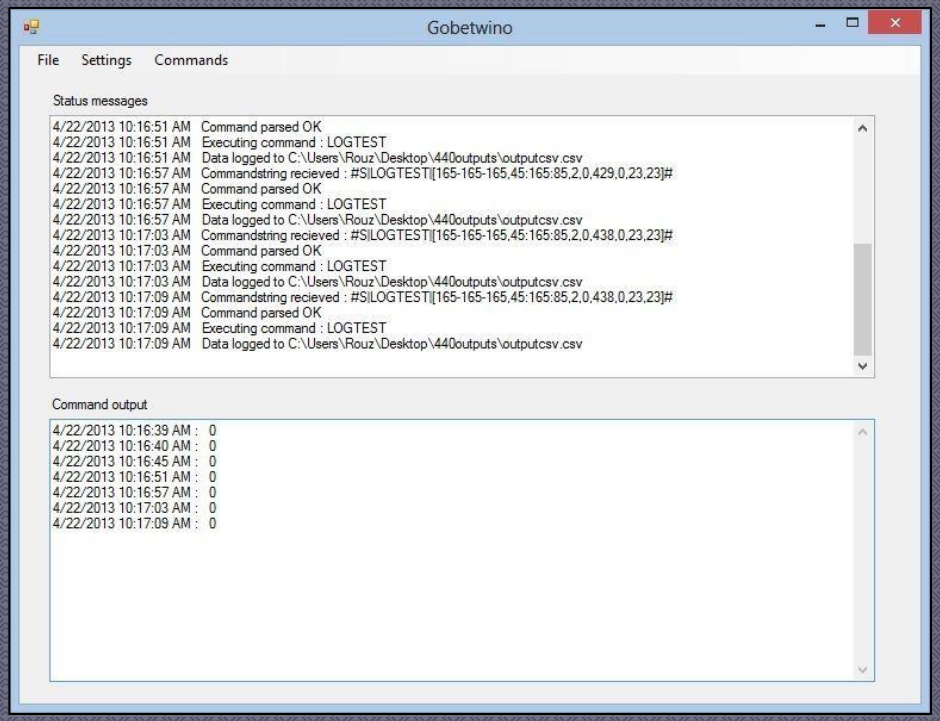
- The response mechanism
- Peripherals are used for response only (Buzzer, fan)
- Frees up pins on the sensor/server module



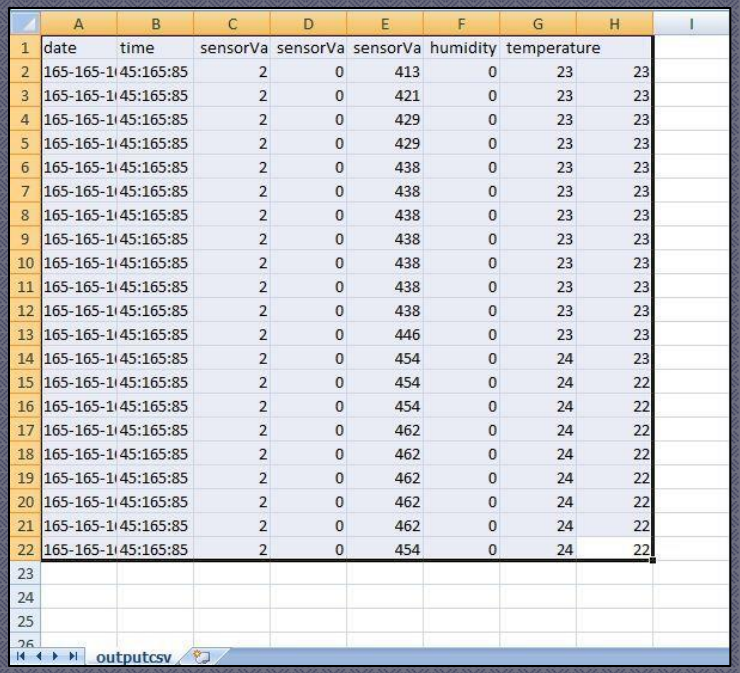
Powerline Communication

- The nervous system
- Based on the PLM-1 powerline modem
- Communicates using the existing powerlines
- Can operate during blackouts

Data Analytics – Streaming Sensor Data



Gobetwino: Serial to CSV stream



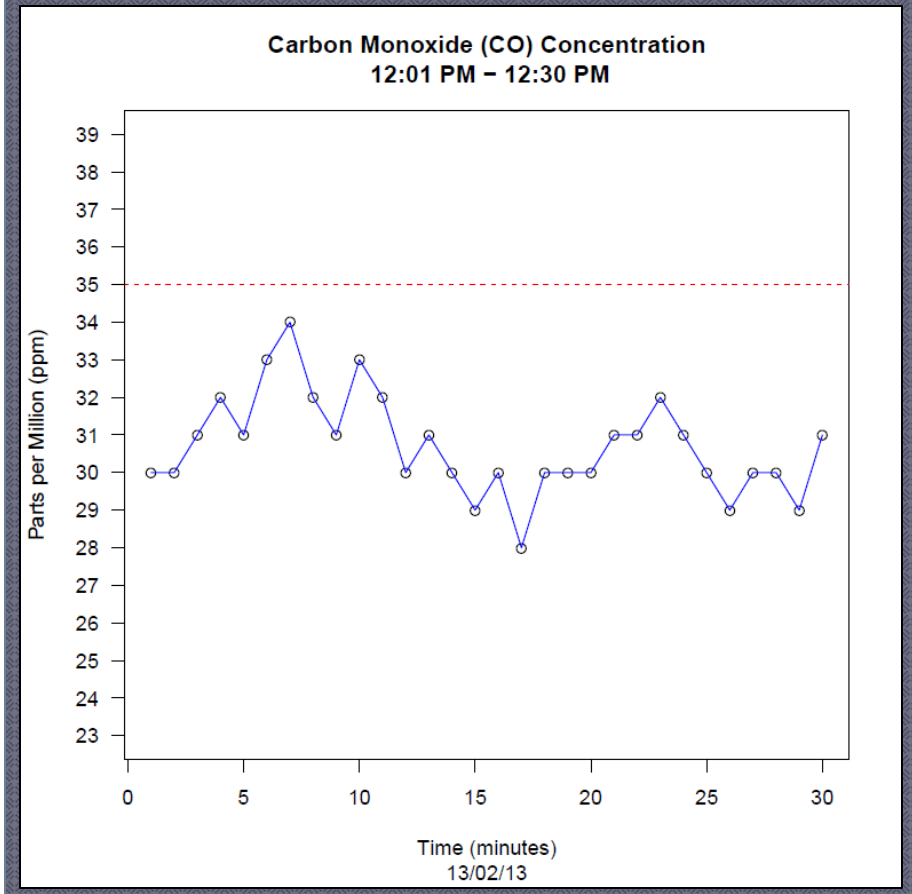
	A	B	C	D	E	F	G	H	I
1	date	time	sensorVa	sensorVa	sensorVa	humidity	temperature		
2	165-165-1	45:165:85	2	0	413	0	23	23	
3	165-165-1	45:165:85	2	0	421	0	23	23	
4	165-165-1	45:165:85	2	0	429	0	23	23	
5	165-165-1	45:165:85	2	0	429	0	23	23	
6	165-165-1	45:165:85	2	0	438	0	23	23	
7	165-165-1	45:165:85	2	0	438	0	23	23	
8	165-165-1	45:165:85	2	0	438	0	23	23	
9	165-165-1	45:165:85	2	0	438	0	23	23	
10	165-165-1	45:165:85	2	0	438	0	23	23	
11	165-165-1	45:165:85	2	0	438	0	23	23	
12	165-165-1	45:165:85	2	0	438	0	23	23	
13	165-165-1	45:165:85	2	0	446	0	23	23	
14	165-165-1	45:165:85	2	0	454	0	24	23	
15	165-165-1	45:165:85	2	0	454	0	24	22	
16	165-165-1	45:165:85	2	0	454	0	24	22	
17	165-165-1	45:165:85	2	0	462	0	24	22	
18	165-165-1	45:165:85	2	0	462	0	24	22	
19	165-165-1	45:165:85	2	0	462	0	24	22	
20	165-165-1	45:165:85	2	0	462	0	24	22	
21	165-165-1	45:165:85	2	0	462	0	24	22	
22	165-165-1	45:165:85	2	0	454	0	24	22	
23									
24									
25									

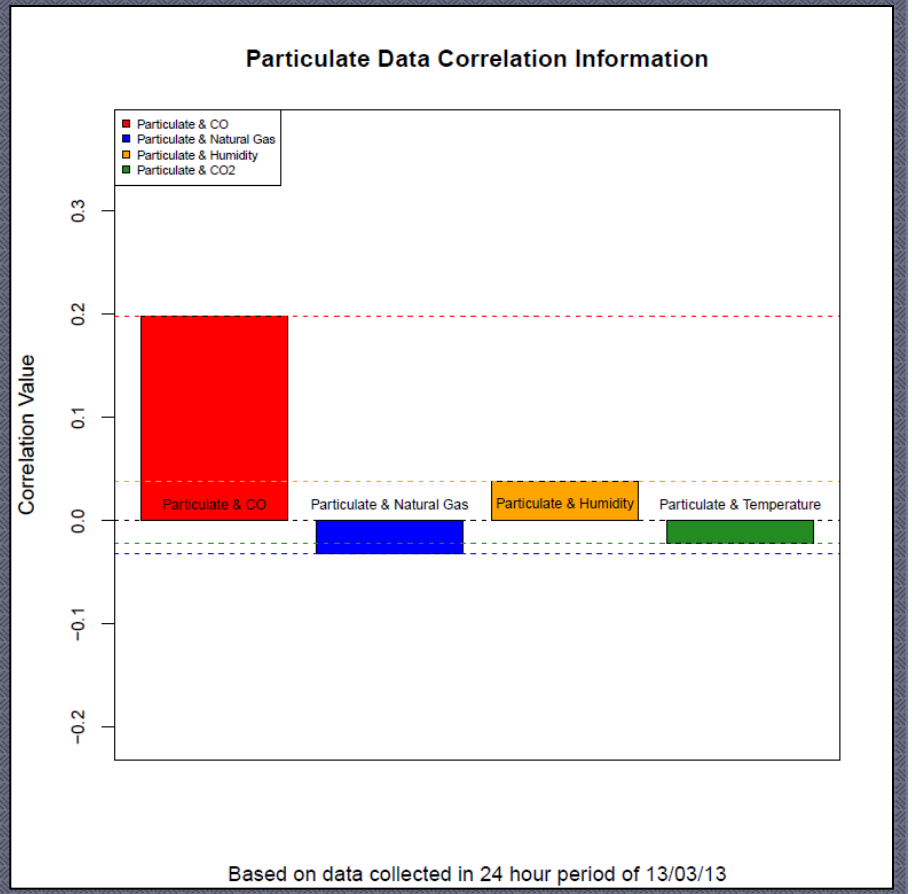
outputcsv

Output: Excel CSV screenshot

Data is also receivable via SD card

Data Analytics – Graphing





High Level Details – Project Costs

Required Materials	Estimated Cost	Actual Cost	Comments
3 Arduino Microcontrollers (Mega)	$180.00	$0.00	Did not have to purchase, had our own and borrowed from ESSEF.
MQ4 Sensor (Methane)	$5.00	$4.95	
MQ7 Sensor (Carbon Monoxide)	$8.00	$7.25	
Optical Dust Sensor - GP2 (Smoke)	$12.00	$23.90	A single replacement sensor had to be purchased.
RHT03 Sensor (Temperature and Humidity)	$10.00	$9.95	
SM5100B GSM Cellular Module	$100.00	$99.95	
Microcontroller Accessories	$75.00	$50.10	
3 Arduino Mamba Shields	$175.00	$164.85	
Test Equipment	$50.00	$67.14	AirTack was able to obtain help from professionals at AirCare to test the device with accurate equipment.
Shipping Costs and Backup Fund	$180.00	$47.20	
Total	**$795.00**	**$475.29**	**We came in pretty far under budget.**

Unit costs could be dramatically reduced in mass production

Cheaper, simpler microcontrollers

PCB and cheaper sensors

Cut out cost of most accessories

High Level Details – Safety Design

- Device is for indoors only
- Hardware is not to be modified by end user
- Installation design ensures user has minimal contact with any electrical source
- **Future Development:** Conformity to strict safety standards and own enclosure

Threshold/calibration levels set according to health advisories from reputable sources

Environmental Factor	Threshold Level
Carbon Monoxide	35 ppm
Natural Gas	1% LEL
Smoke (particulate)	150 ug/m^3
Humidity ($H_2O_{(g)}$)	30-50% RH
Temperature	Below 19 °C (66 °F) Above 22 °C (72 °F)

High Level Details –Usability Design

- **Combines** all household environmental monitoring into one simple-to-use and install device
- **Data reports** are simple to produce and read

High Level Details – Sustainability

- **Less waste –** combined devices.
- **Modular** – Use only the sensors and modules you need *(future development)*
- **Easy install –** no wasteful construction/reno or additional infrastructure needed
- **Reusable components –** arduino, shields, etc.

High Level Details – Future Plans

- Conformity to safety standards
- Use data analytics as a secondary response trigger
- Optimize design for mass production
- Redundant communication (Wi-Fi/Powerline Communication)
- Online reporting

No plans to commercialize, but will continue work as a hobby

Lessons Learned

- Gantt charts are made to be followed
- More time should have been budgeted for testing and integration
- Good idea to focus on proof-of-concept functionality in the small timeframe, especially given the learning curve
- Not enough experience with arduino before the project, bugs were harder to fix than expected and delayed integration
- Professionalism/flexibility are valuable in team projects

Project was an extremely valuable experience for all of us, and we're proud of what we've accomplished.

Acknowledgements

- ***Dr. Stephen Stewart, P.Eng*** and his team at **AirCare** for helping us calibrate and test the Sensor Module with accurate monitors and known gas concentrations.
- ***Dr. Andrew Rawics*** for helping us find industry contacts who could assist in sensor calibration
- ***The ESSS*** (for ESSEF funding allocation and parts library)
- ***Graeme Cowan*** for his advice regarding sensor accuracy and test methodologies

AirTack

QUESTIONS?

Photo Credits

- http://www.markham.ca/wps/portal/Markham/Residents/FireServices/FirePrevention/CarbonMonoxideDetectors
- http://www.png.ca/
- www.floodprofessionals.com
- http://www.dehumidifiersfor-home.com/
- http://canadiantire.ca
- http://sbchukill.blogspot.ca
- http://www.tried-and-true.com

Demo Videos

- Testing and calibrating sensors at AirCare
  - Calibrating
    https://www.youtube.com/watch?v=jMGAftUFDUM
- System operation (all 3 modules operational)

  The Setup
  https://www.youtube.com/watch?v=Bs7KQlSBV4o

  System Testing
  https://www.youtube.com/watch?v=tQ9l2DSlZKQ
- Data recording to SD card, analysis of SD data with R script
- Data streaming to computer via gobetwino