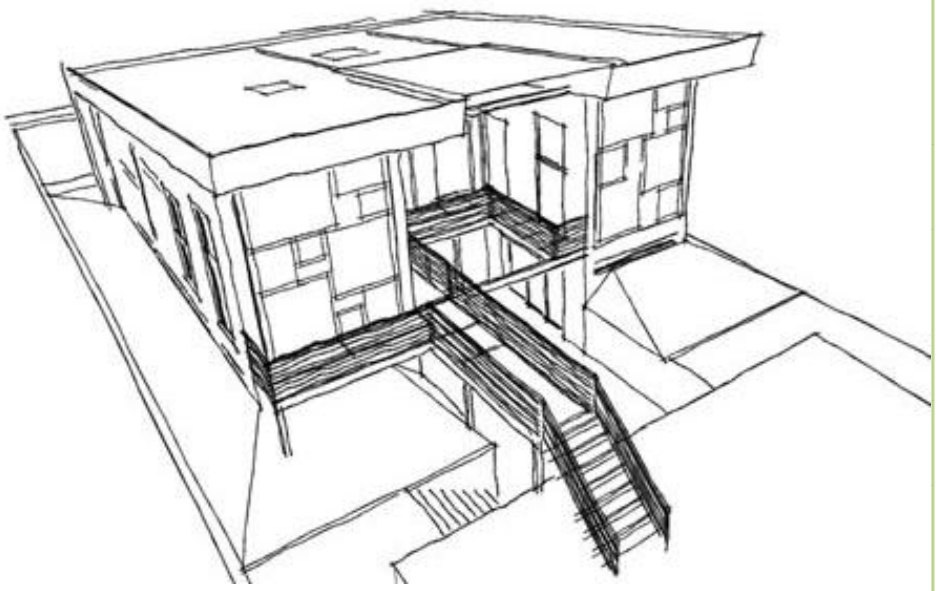
Portland State
UNIVERSITY
Maseeh College of Engineering
and Computer Science

2011

Open Source Home Energy Reduction System (OSHERS)

Product Design Specifications



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Rev 7

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Needs identification

While in the pursuit of a net-zero energy residence, it has been determined that a structure physically designed to reduce energy consumption benefits from an additional monitoring and automation system to further exploit its energy reducing potential.

- Currently available monitoring system sensors are proprietary, costly and frequently aesthetically unappealing.
- Currently available automation devices are costly if available, non-customizable and frequently aesthetically unappealing.
- Currently available systems don't allow a "hobbyist" to modify, customize or contribute to an evolving process or project.
- Currently available hardware doesn't allow a "hobbyist" to lower costs by providing "sweat-equity" in the form of assembling sensor nodes and/or output controls.
- Proprietary systems don't benefit from the ever-expanding knowledge base of an open source community.

Objectives

The purpose of this project is to design and implement an open-source home energy-reduction system. The system will be built based on open-source hardware and software to create a low cost, reproducible, network of “sensor nodes” sending information about the environment inside/outside the house to a server. Based on this information, users can manually/automatically operate/control physical outputs in the house. It will lead to a reduction in energy consumption, creating a sustainable and environment-friendly living place.

Background

Companies looking to make significant reductions in energy consumption and resource usage have turned to automation to monitor and control electricity, temperature, humidity, and water. To do this, companies have deployed numerous sensors in what is called a sensor network. Within this sensor network, sensors are linked via wireless and/or hardwires to a central sever where various parameters are defined to control lighting within offices and open spaces, timing of water sprinklers, temperatures for week days versus for weekends, and so on. It is only natural to expect that these same practices would be deployed within the confines of one's home.

Homeowners are also looking for ways to not only save money, but also lower their impact on the environment. Automation of physical outputs to control temperature of the home, lower the consumption and waste of water, turn on and off the lights based on occupancy, and use a combination of natural lighting and dimming of the lights are all key components to provide a low impact environmentally friendly home.

Requirements

Objectives	*Engineering requirements*	*Justification*	*Importance (1: highest, 5: lowest)*
1,2,3,4,6	Should be a wireless network.	Using a platform capable of communicating wirelessly.	1
1-6	Should be open-source.	The program code will be available on the internet so that others can use and modify it.	1
1-6	Should be able to sense motion in rooms. The minimum range is 15 feet.	When people enter, exit, or move within a room, information should be available to server.	1
1-6	Should be able to sense the light level in rooms. An acceptable illuminance range is from 5 – 30,000 *lux.*	Whenever users want to know the light level, light information should be available to the server. The reference light level: Full Daylight ≈ 10700 lux Twilight ≈ 10 lux	1
1-6	Should be able to sense the temperature in rooms. An acceptable temperature range is from -13 – 122^{o}F.	Whenever users want to know the temperature, temperature information should be sent to server. The reference temperature in Portland is: -2^{o}F (lowest ever) 108^{o}F (highest ever)	1
1-6	Should be able to sense humidity in rooms. An acceptable RH range is from 0 – 100% with a resolution of 1% RH.	Whenever users want to know the humidity, humidity information should be available to the server.	3
1-6	Should be able to dim the lights.	When receiving commands from the server, the system will dim the lights based on these commands.	1
1-6	Should be able to monitor water level in the cistern. Measurable range should	Water level in the tank will change depending on usage and rainfall. This level indicates how much water is in the cistern.	1

	be from 1.2 – 120 inches with accuracy of 1 inch.		
1-6	Should select and provide an appropriate motor for the blinds. It should be controlled wirelessly.	Users can control the blinds to cover the window to control internal temperature.	1
1-6	Should be able to turn outlets on/off.	To save energy, the system should be able to turn outlets on/off.	3
1-6	Should be able to monitor power consumption.	To know how much energy we have used in a specific period of time, we want to measure the power use of the house as measured from the panel.	3
1-6	Should be able to water the plants.	The plants could be watered automatically by a watering system.	5*
1-6	Should be able to monitor soil moisture level.	The soil moisture level could be monitored to avoid over-watering and conserve water.	5*
1,4	Should be done within budget. ($50 - $150/room; prototyping and testing $500).	The number of sensors, motors, wireless modules, etc will be limited by the budget.	1

Objectives

1) The system should be functional and accurate.

2) The system should be durable.

3) The system should be power-saving.

4) The system should have a low cost.

5) The system should be flexible with a variety of options.

6) The system should be easy to install and use.

Note: * Time permitting.

Documentation

At the end of this project, our team will provide the sponsor with the following documentation:

- Code
- References
- Parts / Vendor / Price
- User guide
- Reproducibility by Hobbyist

For “Code”, our team will share all of our final source-code we develop during this project. We will write clear comments for the source-code.

For “References”, we will share all useful articles, web links we used to research and develop this project.

For “Parts/Vendor/price”, we will share all information about components we used, what vendor we purchased from, and typical price of these components.

For “User guide”, we will make a manual on how to specifically install as well as use our system.

Finally, in “Reproducibility by Hobbyist”, we will discuss alternative solutions, how to install this system at another location, how to change a specific component in our system and rewrite the code for it, etc...

Contact Information

Any questions or concerns, please contact the capstone team:

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Revision History

1. Rev 1 (Jan – 12 – 2011): Initial rev released by team
2. Rev2 (Jan - 18 - 2011): Updated by team.
3. Rev3 (Jan - 19 - 2011): Added more specific information into “requirements” by Hieu Nguyen and Hai Nguyen.
4. Rev4 (Jan - 20- 2011): Updated Hieu Nguyen.
5. Rev5 (Jan - 24- 2011): Updated by team.
6. Rev6 (Jan-26-2011): Updated by Michael White
7. Rev7(5/25/2011): Updated by Michael White