CEng 491 Proposal:

SMARTHOME – An autonomous and energy-efficient electronic device management system for houses.

tranquillum

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1. Motivation

Nowadays, we are away from our houses many hours a day, even when we are not -when we're in our homes- we have hard times controlling home appliances in a smart and efficient way. Handling many things in our homes matter because, home is a special place. In our daily lives, many people face certain problems at work or at school. When we return home, we look for a peaceful place to relax and feel protected. Therefore it is important for a house to be suitable for its residents - its location, physical condition, inner structure etc. A successful home automation system blends into the house and becomes invisible just like the physical properties of the house itself. As long as things go well no one notices it.

But when things start to go wrong, it's much worse than when you have a problem with your computer. It is problematic for two reasons: First, as mentioned, instead of coming home to relax, you come home and start trying to fix it. Secondly, since the whole house might be connected to the smart home controller, things could get rough - water sprinklers going off, very low or very high temperatures, a locked front door and worse. To deal with such possibilities, smart home ideas emerge.

A smart home can be identified with following properties:

- warmer, drier, more comfortable with more natural light
- cheaper to run, with lower fuel, power and water bills (energy efficiency)
- healthier for the owners
- safer

A smart home makes the most of the sun, using it for warmth, water heating, even to generate electricity. You can also save power with energy efficient heating, appliance and lighting. Smart homes

also use less water, which means you can save on water charges if you are metered. Smart homes are dry year round, decreasing moisture and mould damage.

As an example of efficiency; we can build up strategies regarding utility pricing based on hours of day. Power distributors offer different pricing based on time of the day. Observing and optimizing the working hours of electronic devices is an essential issue especially in smart grids and environment friendly houses. Predicting advantageous hours/days for efficiency in various utilities, a huge difference can be achieved.

Moreover, smart homes provide protection to their residents both from strangers and from accidents. The psychological benefit of security and safety is quite obvious. By the use of burglar alarms, electric door locks and security cameras you know that you and your family are safe from harm, and this gives you peace you search in your safe zone.

2. Background

Home automation systems technology has been existing for many years, but it has just recently started to enter to the main scope. If we look at the existing home automation systems in the market, we face with the same basic ideas but slightly different technologies. The top five brands contributing to the home automation technology are mControl, HomeSeer, PowerHome, Control4, Vivint. All of these brands provide their customers high-tech solutions bringing the "Home of the Future" to customers' own home by letting every appliance and device in their home be at their command. In the rest of the section the technologies used by these systems are explained.

With the help of these systems, users can learn how much energy is being consumed in real time and make adjustments by manipulating the devices within their home. Moreover, the mControl products can provide the energy efficiency, even automatically. Any special macro(a series of commands executed at the same time or at assigned intervals) can be created by the customer to be warned by sending emails themselves. A voice recognition property is also supported by some of the systems letting the user to trigger macros by using a microphone. Some of the basic triggers like sunrise and sunset timers are also used in the market technologies. Additionally, some systems have the compatibility property with many media management programs, such as Windows Media Center and iTunes to supply programming macros including songs or videos. Mobile applications for iPhone and smartphones using the Windows mobile operating system are supported by these home automation technologies. X10, INSTEON, Z-wave and ZigBee are supported by most of the systems. These are the essential modules of home automation system technology, meaning that all appliances and devices

bought will operate with the system. Just after uploading a device module to the system, the user can start to control the device without doing anything beyond. The remote accessibility property also improves the usage quality. With the help of a computer or any other device like touchscreens, the user can easily access to control panel via an internet browser like IE. The basic working principle is like that; in order to control the device, the user should plug it into the right module, which is then placed into a wall socket. The modules accept signals sent by the base station of the system, which transmits signals via the existing wire connections in the house to the devices connected to module.

3. Proposal

In this project, a general purpose wireless controller hardware that controls the home appliances and various sensors, and a master controller software working on an embedded Linux installed board will be developed. Master controller will collect data, show data in a user friendly interface, let user send control commands to appliances, push data to web services if necessary, and also provide web based control of devices. Zigbee is possible wireless protocol to use. Master controller is developed on a Linux box – BeagleBoard.

Moreover, efficiency and usability of home automation systems will be simplified and designed in a generic manner. In order to apply "smart home" ideas to any house, certain requirements of electronic devices at home, light fixtures exist and they will probably cost much to renovate than "smart home" system devices themselves. Our system will be lowering the cost of these expenses. Network constituted of ZigBee compatible devices will serve as data medium, whereas PIC embedded devices with a collection of sensors will be responsible of collecting and reporting statistical data to master controller. Advantage of our approach from the ones in market is more general compatibility ability meaning that a more general communication protocol will be used to address much more devices to make our design more valuable. Also, master controller will possibly realize simple machine learning techniques to provide home the ability of learning efficiency strategies over time. In order to achieve this, we need to combine a more generic sensor collection, more than smart homes systems currently on the market. Additionally, we will work on a user friendly interface after finishing up the hardware part of the project.

Statistical data collected from end devices will be collected in master device and will be pushed to a web server for user friendly display and control of certain properties of those end devices. Local data storage in case of emergency and internet connection loss will be provided in Linux Box with certain limitations, as well.

References

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