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Research paper

The Design of Promoting Building Energy Saver with Mobile Controller

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Abstract

Today, advance development of automation technology has totally changed our life that much easier in all aspects. This cause the automatic systems are more preferable over manual system. Since the increment of internet users over the past decade has made Internet as essential part of our life. With arising of Internet of Things (IoT) technology as expanding network that connect every object from manufacturing machine to user's home appliances for information sharing. This support the usage of IOT in Wireless Smart Building System to handle basic building functions automatically over internet from anywhere. Although smart building previously used to save the electric power and human energy, building with automation system differs from other system because it allows user to operate the system remotely through the internet connection. In this study, we present a design of a Smart Building System using Arduino that consist of cloud and wireless communication which allows user to control their home appliances like fans, light, air conditioner and many more in their building and storing the usage data in the cloud. The building system adjusts automatically based on sensors' data. The designed system was low cost and expandable, which accept a variety of devices to be controlled. This paper shares the architecture designs and development methodology of the system.

Keywords: *Building Energy Saver; Mobile Technology; Home Automation; Internet of Things*

1. Introduction

Normally, a building with a smart building automation system provides occupants with control over the building's electronic devices automatically [1]. For instance, the building owner who is on holiday can operate a building security system, switch appliances on and off, control lighting and perform many other tasks. Moreover, the building automation mobile became smarter when the user can perform the tasks from other places [9]. The focus of automation mobile is to control the building appliances remotely [2]. The motivation of remotely control the building appliances is to offer flexibility and save time without physically attended to the building. Besides the remote controller that uses a simple mobile phone application, it takes the added responsibility to control the smart building and can be reachable from almost everywhere people travels and lives on the earth. Internet is a good example of this type of remote communication [11].

As many articles have already explained about IoT available on the internet, we only discussed the simple term "Internet of Things – Making devices work based on connected data through internet". Kevin Ashton first used the term IoT in the supply-chain management framework in 1999 [3]. Kevin believed that the "things" aspect of the approach is how we interact and live within the physical world surrounding us, which needs serious improvements due to the enhancement in computing, Internet and data generation rate by smart devices.

In the past decade, IoT has been widely used in healthcare, utilities and transport [4]. However, as stated in [5] that IoT can be divided into four areas: (i) Individual; (ii) Business; (iii) Services; and (iv) Mobile. Figure 1 shows the personal IoT at the range of an individual home, Enterprise IoT at the range of public, Services IoT at a state range and Mobile IoT which is commonly dispensed across other areas based on the connections and level. Diversity source of data collected from multiple sensors, web servers, other devices, cell phones or any form of electronic devices that can exchange data over the internet [6]. Thus, the "Internet of Devices" + "Internet of Data" = "Internet of Things".

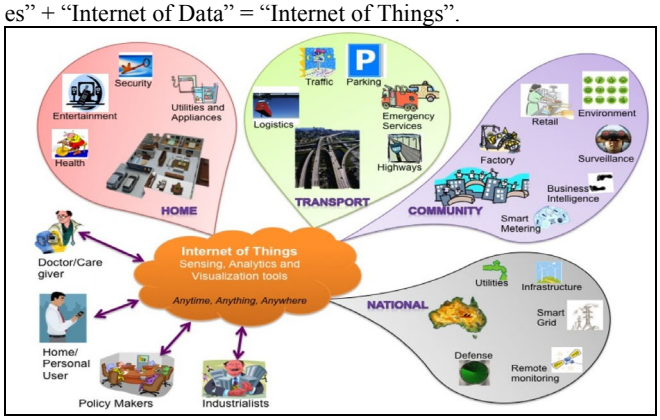


Fig. 1. IoT schematic showing the end users and the application domain adopted from [5]

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2. Related Work: Smart Building

Smart building can be constructed using building automation. Building with automation system indicates an evolving of computerization in building's equipment and functions in individual homes that let unfeasible things conducted through electronic [5]. This building can detect and identify the owner of the building. As the building can automatically adjust the lights, open doors automatically; play favourite music, watering flowers and heat water. It can also send a real time video of any situation in the house [2]. It can connects lights, entertainment devices, safety and security systems, communications tools, heating and air cooling systems into a single control central system [11]. Hence, this will allows user to create their home as an effective companion to manage their life. Today, it is difficult to get a house with no building automation. However, differences in building automation are still exists emphasizes more on comforts through ergonomics and ease of operation. Next is to clarify other terms of automation:

2.1. Automation

Automation is a combination of two fields of control systems and information technology to manage the industrial machinery and processes to reduce human involvements. As described in [7], automation is a step beyond mechanization. Mechanization as defined in [8] offers human workers with tools to help them with the physical work while automation decreased the needs of human's sensor and mental.

Automation as stated in [7] plays a vital role in the economy worldwide and in a day-to-day experience. Engineers are struggling to integrate automated devices with mathematical and organizational equipment to create fast expanding complex systems consist of applications and human activities. As claimed in [1], many responsibilities of human in the industrial are beyond the scope of automation. In fact that human pattern recognition in languages is fast than modern automated systems [8]. Duties expecting an analysis and evaluation of a complicated data, including sophisticated tasks like planning, still required human skills and knowledge [5].

Automation has significant influence in industries [8]. Indeed, telephonies have already replaced by answering machines [7]. In medical examination involved main inspection in electrocardiograph and analysis of human bodies can have fast and accurate results by computerised systems [2]. Automated teller machines provide more flexibility to do bank transactions. Generally, automation has contributed to the major economics changes from agricultural to industries and from industrial to services in the 19th and 20th centuries [5].

2.2. Office Automation

Office automation as expressed in [1] represents the various computer devices and applications used to produce, gather, manipulate, and transmit data for completing a simple job. Data repository, electronic transmission, and the administration of organisation information are the activities of an office automation system. Office automation as mentioned in [5] helps in atomizing office processes.

2.3. Building Automation

Building automation as described in [1] is the computerized functionality in controlling a building. The building is linked by smart connections of electronic devices, invented to check the performance of lights system of a building which automatically controlled by the system [2]. The Building Automation System (BAS) primarily task is to keep the temperature within a desirable level; adjusted lighting based on residence needs, and keeps aware of system functioning and device breakdowns and can notify building administrator through emails and text [11]. The BAS roles save building energy and costs compared to manually control building [1].

2.4. Power Automation

A computerized process of monitoring and observing of power plants components is called as power automation [1]. It produces consistent national electricity system normally involves remotely controlled of transformers and power subsystems units [8]. Now, it is possible to observe different power units, transfer their conditions and do error detection and adjustment without human reaction [7].

3. Methodology

The research is taking place in duration of two years in UPNM. The work begins by identifying the UPNM maintenance cost for electricity use monthly in order to get the return on investment (ROI) for the energy consumption. The software development methodology will be used for the development of this project is Rational Unified Process (RUP) Methodology. The RUP is a software engineering process developed and marketed originally by Rational Software and now IBM [10]. The RUP is a complete methodology which emphasis on an accurate documentation. This methodology highly focuses on a risk and timing. Each phase will have an iterative process. This methodology consists of four phases [10], which are (i) inception, (ii) elaboration, (iii) construction and (iv) transition. At the end of the process, the electricity consumption after the implementation of smart mobile controller for green technology will be assessed.

4. Architecture Design

An architecture design in Fig.2 shows the representation of a low cost prototype system that supports reasoning. The structure of the system comprises externally visible properties of the mobile automation system using an Android phone and a LDR Light Sensor Module. The design uses a Relay Module Board that connected to the Arduino Mega Compatible board and the prototype home appliances are connected to input/output ports of this board relays. Communication from the mobile to the system established by Ethernet (WIZnet 5100) shield router.

In the Fig.2 shows how the user accesses the application server which is located in the cloud. The client tier presents the data from the application server. The application server processes the data which is continually provided by the database server in liaison with the External Database. All of which are supported by the main servers.

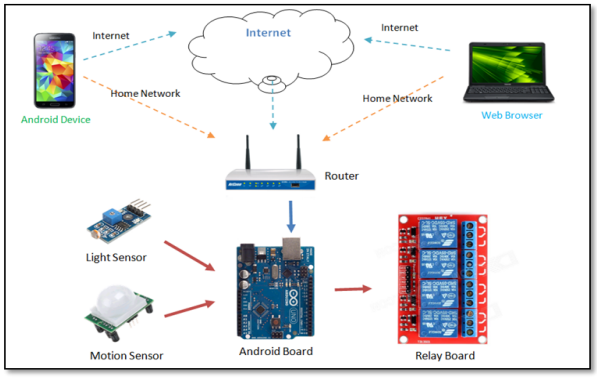


Fig. 2. Architecture Design for Smart Home Automation

5. Use Case Diagram

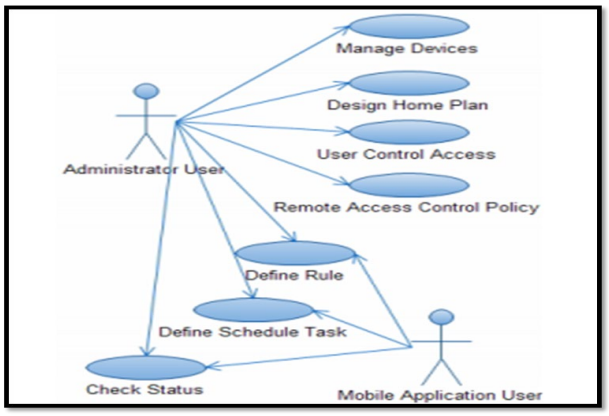


Fig. 3. Use Case diagram

The use case diagram in Fig.3 illustrates how the user will interact with the elements of the system. The use case diagram which representing the overall interaction between the user and the propose system. The system consists of seven modules: (i) Manage Devices, (ii) Design Home Plan, (iii) User Control Access, (iv) remote access control policy, (v) define rule, (vi) define schedule task and (vii) check status. Based on the use case, it shows two types of users who will be using the system which are user and administrator. The administrator has a fully access to all seven modules of the system, while the user access was limited to three modules of define rule, define schedule task and check status.

6. Interface Design

In the Fig.4 shows the Graphical User Interface (GUI) design of the Mobile Controller system. The appearance of the system refers to the functionality of the system. For example, devices 1, 2 and 6 are in the mode 'ON'. Once the connection established the control of all devices are through the system interface. While in the mode 'ON' all appliances data usage will be capture. The development and experiments of collecting and analyzing the data usage is still under progress and will be share in the next publication.

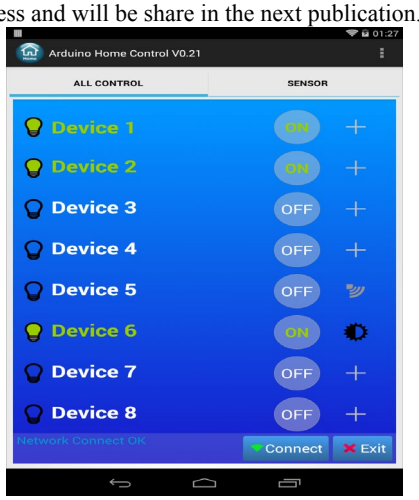


Fig. 4. Interface of Mobile Controller

7. Conclusion

A building automation has recently received a great popularity and offered an increment in quality services and comfortable life. The automation system offers a control over the building that can be remotely access from other places. Today, building automation system uses smartphone and microcontroller connected to the telecommunication network as a popular architecture to promote the services. This paper shares the architecture design, interface design and methodology of Smart Building System using Arduino microcontroller in UPNM environment.

Acknowledgement

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