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Developing an Automatic System for Home Appliances Controlling Based on Cloud Computing

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Abstract:
Consumers' interest in smart home concepts has been increasing due to the rapidly expanding home appliances industry that introduces Wi-Fi enabled appliances. Manufacturers provide firmware that allows users to control appliances using smartphones from anywhere. Smart appliances, firmware, and smartphones connected to a cloud server for data storage to form a simple smart home automation system (SHAS). This paper reviews how SHAS is implemented and its recent progress. The authors' observation found that there is a growing interest among researchers and developers to study software defined network, web services, and end-user development tools within 2016 and 2018. This progress caused by researchers' and developers' interest to mitigate heterogeneity issues in SHAS.

Keywords—Internet-of-Thing; smart living; intelligent living;

Introduction

The demand for automation systems both in homes and industries is on the increase because of their numerous benefits such as comfort, centralized control of appliances, cost reduction, energy saving, security, and safety. Home automation provides increased quality of life for users, especially the elderly and disabled, and enables monitoring of children activities as well as controlling their accesses to resources at home. In recent years, the Internet, especially cloud computing, is used in seemingly unlimited applications in all spheres of life. The Internet has made the interconnectivity of virtually every object possible – human social networks and even machine-to-machine (M2M) communications. The use of smart devices in daily activities is increasing exponentially, and consequently their intelligence getting enhanced, due to much higher affordability and simplicity through their connectivity [1]. The concept of the "Internet of Things" has tied in closely with the popularization of home automation [2]. The Internet of Things (IoTs) is an evolving technology which has received quite a lot of attention from researchers following the vision of a global infrastructure of networked physical objects. While this vision is enthralling, no consensus exists about its realization [3]. IoT involves integrating smart objects; embedded devices with sensors and actuators connected to the Internet. These devices are intelligently interconnected thereby necessitating new forms of communication between things and people, and between things themselves [4]. However, early smart homes suffered poor performance, high cost of ownership, complicated set-up and operation, poor management and maintenance, and in many cases, the need to rewire the home [5]. The first "wired homes" were built by American hobbyists during the 1960s but were limited by the technology at the time. The term "smart house" was first coined by the American Association of House builders in 1984 [6]. A distributed home automation system will consist of various, independent, possibly heterogeneous, computing units which are referred to as

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nodes. These nodes collaborate together in order to achieve the desired automation functionalities by exchanging data (passing messages) to synchronize their current state. These messages exchanged between thenodes of the home automation distributed system are usually terse as compared to human-to-human network data [7]. This is in addition to the input and output data operation of the individual systems and applications [8]. Recently, novel home automation is fast evolving and consequently there have been different procedures with vast of them based on the wireless and Internet technologies relating to the concept of "Internet of Things". In this work, the problems with complexity, multiple incompatible standards and the resulting expenses in these recent systems by providing a simplified design protocol and developing a robust distributed home automation system are addressed.

IMPLEMENTATION OF SMART HOME AUTOMATION

Developments in both ICT and electrical hardware industry have made smart homes easier to be implemented as compared to the past two decades. Today, various electrical appliances have been designed with the capability of connecting to wireless network, Wi-Fi. It makes the electrical appliances smarter as it can be controlled remotely using a smartphone. As compared to the past two decades, some of the home electrical appliances like TV, fan and air-conditioning units can only be controlled using the remote control units provided remote control units. However, they come with the additional firmware that allows consumers to control the appliances through mobile applications on their smartphones. This situation supports the implementation of the smart home system easily.

There are various definitions of smart home given according to their respective areas; covering from construction, engineering, energy, to ICT. In terms of construction and engineering, smart home is more likely to be defined through the use of modern materials to produce energy-efficient homes. On the other hand, the use of software and hardware for controlling home appliances is the major focus of ICT for the smart home. Horálek et al. [8] defined a smart home as a home built using modern materials with low-energy consumption, and it uses hardware and software tools for general task automation which enhances the comfort of living and provides a cost-effective operation to the residents.

In this paper, smart home refers to a home or living environment that uses technology to allow electrical appliances and systems to be controlled automatically [9, 10]. In particular, it uses ICT to control homes including the electrical appliances and home automation such as windows and lights [11]. Mittal et al. [4] proposed a SHAS, a residential space that provides comfort to residents, facilitates the operation of electrical appliances all the time regardless of whether they are at home or away. Appliances can be controlled remotely using applications on smartphones that are connected via Wi-Fi and the Internet. Communication to SHAS is simple and affordable using the existing network infrastructure. Smartphones affordability has been significantly increasing the demand for home automation. Also, the emerging of Internet of Thing (IoT) where electronic appliances, sensors, and software are connected to home network [1] has catalyzed the SHAS.

Home automation has undergone a revolution by witnessing a wide range of electrical appliances that can be controlled remotely. In the beginning, only fans, TVs, and airconditioning units can be controlled using remote controllers. Then the gate and garage can also be controlled remotely. Infrared (IR), radio frequency (RF) or Bluetooth technology have been used extensively for the wireless communication between the electrical appliances and the remote controllers [12]. However, today, various electrical appliances can be controlled remotely using Wi-Fi technology, including refrigerators, washers, lamps, rice cookers, ovens, and dishwashers. Consequently, the word "smart" has always been used together for marketing of these appliances to differentiate them with the old technology. For example, smart TVs, smart refrigerators, and smart lights, to name a few. Fig. 1 shows four common remote controllers for

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wireless technology used by the manufacturers on their electrical appliances. The description of the wireless technology as defined by Techopedia [13] is presented in Table I.

Fig. 1. Common wireless communication technology for home appliances

TABLE I. WIRELESS COMMUNICATION TECHNOLOGY FOR REMOTELY CONTROLLED HOME APPLIANCES

Wireless communication technology	Description
Infrared (IR)	A wireless communication technology used for device communication over short ranges. line-of-sight, unable to penetrate walls
Radio frequency (RF)	A wireless communication technology that uses radio waves in the range of 3 kHz to 300 GHz
Bluetooth	A wireless technology standard that is used to exchange data over short distances (less than 30 feet).
Wi-Fi	A wireless network technology used for connecting mobile devices to the Internet using the microwaves frequencies of 2.4Ghz or 5Ghz.

Smart electrical appliances can be controlled using both the remote controllers and smartphones. The manufacturers provide a firmware to allow users to control the electrical appliances from the smartphones when both devices are connected within the same Wi-Fi Service Set Identifier (SSID). In other words, both smartphones and electrical appliances should be connected to the same Wi-Fi network to allow pairing process to be successfully completed. Then only users can control the appliances from the smartphones. Apart from Wi-Fi enabled appliances, the manufacturers provide additional features for the smart electrical appliances. Recently, those appliances have been integrated with cloudbased services to provide value-added services, operations, and management [2].

Cloud enables users to control and monitor smart electrical appliances remotely using the Internet connections. For example, LG's Cloud Center provides an application that allows users to check and view the contents of the refrigerator from home or remotely. This method avoids loss of cold air when the door of the refrigerator is open, resulting in more energy to keep the cold temperature [13-14]. Hence, energy can be saved. Additionally, users can plan a meal using the existing ingredients in the refrigerator or buy grocery items that are running out of stock. Another example is the lighting system supplied by Philips Lighting. It uses Google Cloud Platform to enable users to change home lighting styles to various modes for more comfort than the ordinary lights. It also works with Nest security system that is capable of detecting human movements through surveillance cameras installed outside the house and activating the lights in the home as if the movement has been heard or known by the residents. These are just a few examples of the cloud services of smart electrical appliances that manufacturers provided to the consumers.

In this paper, we survey smart electrical appliances available in the market to understand the functionalities of cloud-based SHAS that the manufacturers could offer. We used the term “smart” and “Wi-Fi-enabled” electrical appliances on Google search engine for the searching. We also classified the smart home into rooms where the smart appliances could be needed such as the living room, bedroom, kitchen, entrance, and laundry as well general-purpose appliances.

CLOUD SERVICES

Cloud computing is a phrase used to describe a variety of computing concepts that involve a large number of computers connected through a real-time communication network such as the Internet. In science, cloud

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computing is a synonym for distributed computing over a network, and means the ability to run a program or application on many connected computers at the same time [15]. The major models of cloud computing service are known as software as a service, platform as a service, and of infrastructure as a service.

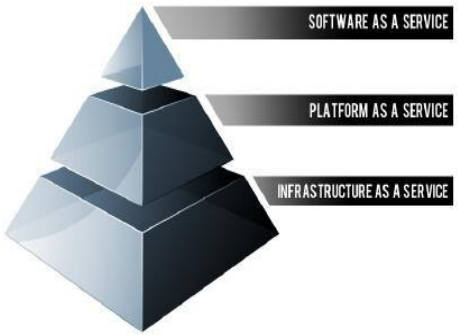

Fig 2: Cloud services stack

Communication via the network

In this mechanism communication is done via the network with the use of network cables and a switch. This medium is accurate since equipments can be distinguished with unique ip addresses assigned to them and also it does not impose any limitation on the number of equipments that can be connected. Though this mechanism requires wiring of equipments to the home computer this can be avoided with the use of Ethernet over power (EOP) mechanism. Power line Ethernet runs over residential power lines using a Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) protocol to arbitrate the shared medium; a Physical layer designed for transmission over electrical wiring. Hence with the use of this mechanism it is possible to avoid wiring of equipment's to the home system.

SYSTEM IMPLEMENTATION

Hardware Construction

Most of the hardware components are modules by the virtue of the integrated design and development adopted for the project. Therefore, standards data bus and jumper wires are used in routing all the network paths for the embedded hardware except the ATmega16L which was placed on an IC socket soldered on a Vero board and the integrated sensors as the LM35 and the LDR which were also soldered and mounted carefully on the casing. Each of the hardware modules were tested as they were acquired and all were confirmed to be good and usable for the project. Also, during each of the stages of construction, the modules were tested and each was confirmed to work as required independently as well as conjointly. Figure 3 shows the coupled CPE in a transparent casing revealing the embedded hardware system.

Fig.3. Hardware system

Software as a Service

Software as a Service (SaaS) is defined as the software that is deployed over the internet.With SaaS, a provider licenses an application to customers either as a service on demand, through a subscription, in a "pay-as-yougo" model, or (increasingly) at no charge when there is opportunity to generate revenue from streams other than the user, such as from advertisement or user list sales .SaaS is a rapidly growing market as indicated in recent reports that predict ongoing double digit growth. This rapid growth indicates that SaaS will soon become commonplace within every organization and hence it is important that buyers and users of technology understand what SaaS is and where it is suitable [16].

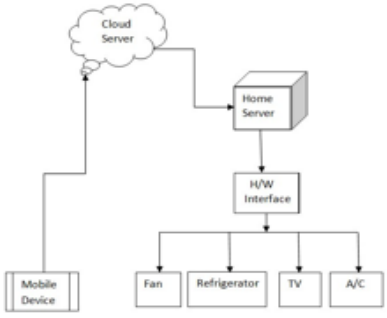

Fig 4: Architecture of HAS

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Proposed system

As mentioned the proposed home automation system consists of three main modules, the server, the hardware interface module, and the software package. Serial port is used by server and hardware interface module to communicate with each other. User may use the Internet to login to the server web based application, so that remote users can access server web based application through the internet using compatible web browser. The proposed system is implemented using JSP, HTML and CSS. The server application is implemented in JSP & Java whereas the embedded hardware interfaces application shall be implemented using C Programming Language.

System Implementation Plan

The system is comprised of different client modules for different platforms.

Cloud server

It is a central server focused on providing services to the other sub modules. Central server acts as the brain and data respiratory system. It provides three interfaces to the three sub modules viz mobile, web configuration tool and home system. The server analyzes the data it receives from home, send updates to the mobile and vice versa. A database is maintained by the server and it is updated according to the changes done at home end.

- Embedded Program for Microcontroller, and Hardware Circuit.
- Internet Client for any mobile phones or desktop.

CONCLUSION

In this work, the state-of-the-art web technologies were utilized and structured to render the whole home automation system a distributed type with the processes as services. The cloud portion of the distributed system involves the web applications integrated with data management and repositories as well as communication interfaces.The concept of the smart home received high attention from consumers lately due to fast-growing development of smart electrical appliances in the market. Various Wi-Fi enabled appliances are available to enable consumers to build a SHAS at lower costs. The use of Wi-Fi enabled appliances has introduced the cloud-based SHAS where control of these appliances is made over an Internet connection and data is stored on a cloud server. It causes heterogeneity issue, in which each manufacturer uses their custom firmware, and communication protocols. This study found that researchers and developers pay attention to SDN, web services and EUD tools for SHAS. These three areas are expected to gain a high level of attention from researchers, developers, and users, in particular, to provide interoperability functions for SHAS.

REFERENCES

[1]. M. Alaa, A. Zaidan, B. Zaidan, M. Talal, and M. Kiah, "A review of smart home applications based on Internet of Things," Journal of Network and Computer Applications, vol. 97, pp. 48-65, 2017.

[2]. Y.-T. Lee, W.-H. Hsiao, C.-M. Huang, and T. C. Seng-cho, "An integrated cloud-based smart home management system with community hierarchy," IEEE Transactions on Consumer Electronics, vol. 62, pp. 1- 9, 2016.

[3]. J. Koetsier, "1.5B Smartphones, Triple-Digit Growth In SmartHome Tech: Top Trends For 2018," in Forbes, ed, 2018.

[4]. Y. Mittal, P. Toshniwal, S. Sharma, D. Singhal, R. Gupta, and V. K. Mittal, "A voice-controlled multi-functional Smart Home Automation System," in 2015 Annual IEEE India Conference (INDICON), 2015, pp. 1-6.

[5]. H. Hassan, M. Nasir, M. Herry, N. Khairudin, and I. Adon, "Factors influencing cloud computing adoption in small and medium enterprises," Journal of Information and Communication Technology, vol. 16, pp. 21- 41, 2017.

[6]. M. Firdhous, O. Ghazali, and S. Hassan, "Statistically Controlled Robust Trust Computing

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Mechanism For Cloud Computing," Journal of Information & Communication Technology, vol. 13, 2014.

[7]. Zion Market Research, "Smart Home Market (Smart Kitchen, Security & Access Control, Lighting Control, Home Healthcare, HVAC Control and Others): Global Industry Perspective, Comprehensive Analysis and Forecast, 2016-2022," Zion Market Research2017.

[8]. J. Horálek, J. Matyska, J. Stepan, M. Vancl, R. Cimler, and V. Soběslav, "Lower layers of a cloud driven smart home system," in New Trends in Intelligent Information and Database Systems, ed: Springer, 2015, pp. 219-228.

[9]. G. Demiris, M. J. Rantz, M. A. Aud, K. D. Marek, H. W. Tyrer, M. Skubic, et al., "Older adults' attitudes towards and perceptions of 'smart home'technologies: a pilot study," Medical informatics and the Internet in medicine, vol. 29, pp. 87-94, 2004.

[10]. S. Solaimani, W. Keijzer-Broers, and H. Bouwman, "What we do–and don't–know about the Smart Home: an analysis of the Smart Home literature," Indoor and Built Environment, vol. 24, pp. 370-383, 2015.

[11]. B. L. R. Stojkoska and K. V. Trivodaliev, "A review of Internet of Things for smart home: Challenges and solutions," Journal of Cleaner Production, vol. 140, pp. 1454-1464, 2017.

[12]. A. Z. Alkar and U. Buhur, "An Internet based wireless home automation system for multifunctional devices," IEEE Transactions on Consumer Electronics, vol. 51, pp. 1169-1174, 2005.

[13]. A. Botta, W. De Donato, V. Persico, and A. Pescapé, "Integration of cloud computing and internet of things: a survey," Future Generation Computer Systems, vol. 56, pp. 684-700, 2016.

[14]. M. Khan, S. Din, S. Jabbar, M. Gohar, H. Ghayvat, and S. Mukhopadhyay, "Context-aware low power intelligent SmartHome based on the Internet of things," Computers & Electrical Engineering, vol. 52, pp. 208-222, 2016.

[15]. I. Horvat, N. Lukac, R. Pavlovic, and D. Starcevic, "Smart plug solution based on bluetooth low energy," in Consumer Electronics-Berlin (ICCEBerlin), 2015 IEEE 5th International Conference on, 2015, pp. 435-437.

[16]. M. Al-Amin and S. Z. Aman, "Design of an Intelligent Home Assistant," in Intelligent Systems, Modelling, and Simulation (ISMS), 2016 7th International Conference on, 2016, pp. 69-71.