ISSN 2348-1196 (print)
International Journal of Computer Science and Information Technology Research ISSN 2348-120X (online)
Vol. 5, Issue 3, pp: (26-30), Month: July - September 2017, Available at: www.researchpublish.com

Android based Automation and Security System for Smart Homes

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Abstract: **The concept of smart homes and researches based on it are not much novel in western society. However, in South Asian region, the use and practice have not gained wide popularity. Through, a thorough review of literature it has been found that the fully fledged smart home automation system based on current technologies has not been developed yet. This particular paper has presented a smart home automation system named "H@USE" comprising the necessary features using the state of the art technologies which is highly feasible in Sri Lankan context.**

This paper put forwards the design and implementation of home automation and security system by using Arduino Uno microcontroller. Home appliances are connected to the Arduino and a standard communication between appliances and the mobile device are established using Wi-Fi connectivity. The user credentials are provided in order to ensure maximum security. The prototypical system built is highly reliable, user friendly and flexible.

Keyword: **Home Automation System, Arduino Uno microcontroller, Android, Wi-Fi connectivity.**

I. INTRODUCTION

Human life has become extremely tight in the recent days and automation has gained wide acceptance in turn. In that ground, the concept of smart homes have captured the attention of people from all walks of life as a mean to direct forward and to overcome certain issues that arise in maintenance and control of homes in absence of its owners. In times, there is an unnecessary rise in electricity bill, if electric appliances are forgotten to be switched off after use. Also, there is a fear of theft and burglary. On the other hand, it is a burden for differently abled people and elderly people to take control over modern electric appliances. Thus, there is an immense need of an automation system that cater the needs of current workaholic society.

Despite the concept of smart homes and researches based on it are not very novel in western countries, in South Asian region, especially in Sri Lanka, it has not gained wide popularity. Through, a thorough review of literature it has been found that the fully fledged smart home automation system based on current technologies has not been developed yet. This particular paper has presented a smart home automation system named "H@USE" comprising the necessary features using the state of the art technologies which is highly feasible in Sri Lankan context.

II. LITERATURE REVIEW

Several such automation systems in the recent past have been comparatively studied in order to develop a comprehensive, affordable and flexible solution that much suits the current context, especially in the context of Sri Lanka.

Kamelia et al. has proposed and prototyped a door lock automation system that utilizes Bluetooth available in mobile devices [1]. The system is based on Android and Arduino platform. Bluetooth module has been used as the command agent whereas the Arduino Uno microcontroller has been used as controller or the data processing center. Solenoid has been used as door lock output.

In one of the research [2], Wireless Sensor Network has been utilized to monitor and control the electrical appliances in order to reduce the hazards caused by electric fault. The particular electrical hazard monitoring system also consists of an android application. However, it has not focused towards the surveillance of home.

In another research towards the smart home monitoring system [3], the researchers have been successful in developing secure, comfortable and a safe smart home monitoring system that comprises of four main fields. The fields of the system are home automation and remote monitoring, environmental monitoring that includes humidity, temperature, fault tracking and management and finally the health monitoring. The system is based on MIKRO C software, active and passive sensors coupled with wireless internet services to monitor and control different processes.

Madan and Reddy [4] proposed a light controller and a remote monitoring system based on both GSM-Bluetooth technology. The researchers have utilized Bluetooth for short-distance communication within a building while GSM is used for remote communication. The system is designed to control lights, temperature and also to detect unauthorized intrusion.

In another research [5], the design of a real-time wireless home automation system based on Arduino Uno microcontroller has been proposed. The proposed design consisted of two operational modes. First mode is a manually-automated mode where the users are allowed to monitor and control their home appliances over Wi-Fi technology. Secondly, a self-automated mode that allowed the Arduino Uno controller to monitor and control different appliances in the home automatically in response to any signals from respective sensors. However, the research has focused on the control of lights and temperature alone.

Javale et al., has proposed a design of a home automation and security system based on a standalone embedded system board of Android - Accessory Development Kit (ADK) [6]. The main functionalities of the intended system are Light controlling, Door controlling, Smoke detection and Temperature Sensing. The system is to assist the elderly people and differentially abled people to control appliances using an Android smart phone.

III. SYSTEM DESIGN

This particular system comprises of both the hardware and software implementation of the H@USE, smart home automation and security system. The key functionalities of H@USE are as follows:

- Monitor and control electric lights
- Monitor temperature and humidity
- Monitor and control baby care camera
- Monitoring through IP camera (securing home from burglary)
- Android application for monitor and control status from remote locations.

The core of the implemented smart home application is Arduino Uno microcontroller. The particular microcontroller has been chosen in particular as it is highly flexible, inexpensive and easier to program. Further, it is an open-source prototyping platform based on easy-to-use hardware and software. It could be connected to computer through USB and could communicate using standard serial protocol as well [7].

There is a standard communication between the smart phone and home appliances using Wi-Fi connectivity. A relay is used to interface the microcontroller and a driver has been used to interface the relay. Figure 1 shows the architectural design of H@USE smart home automation and security system.

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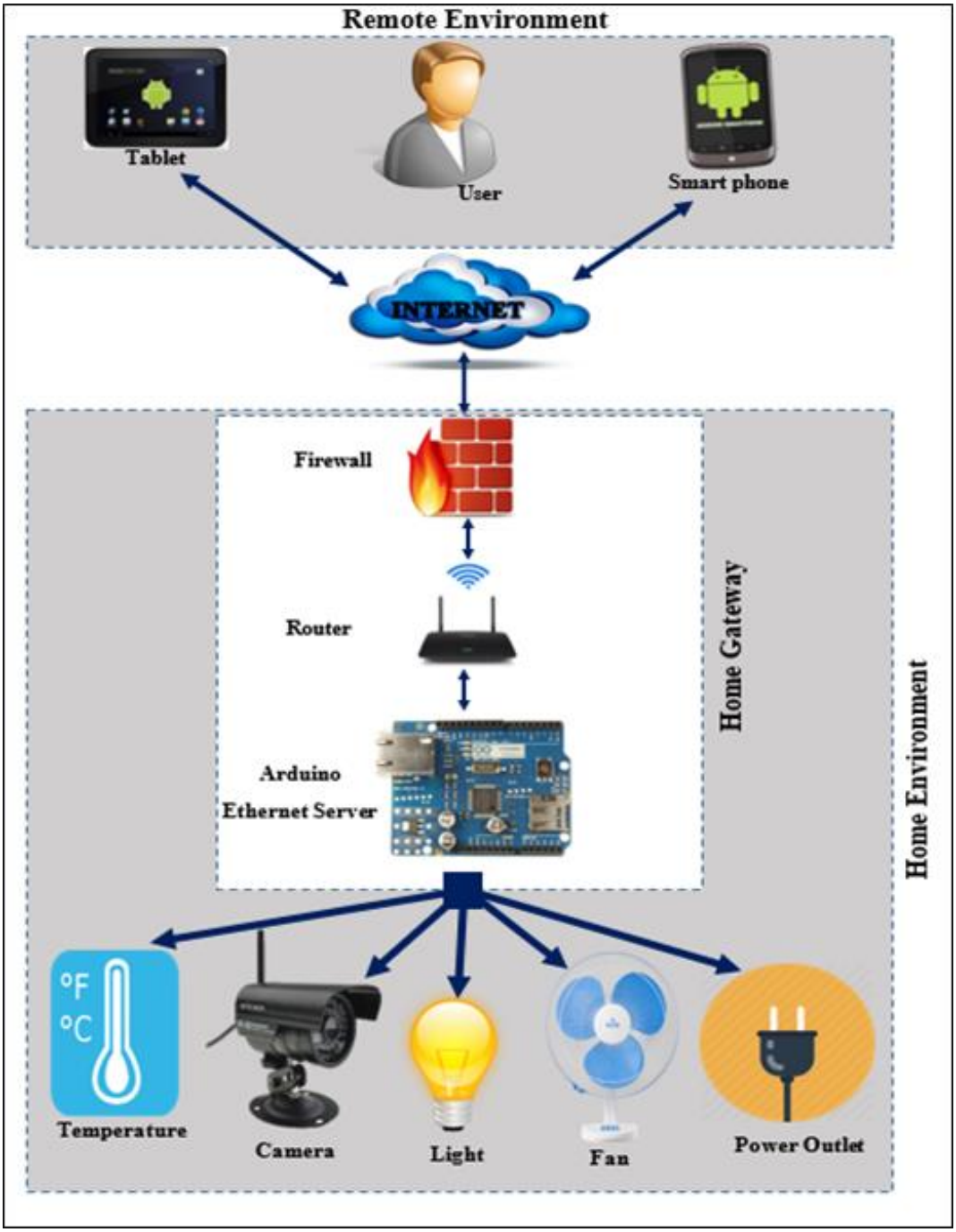

Fig 01. Architectural Design of the system

IV. H@USE ANDROID APPLICATION

Figure 2 illustrates the interface after the successful login. The system is secured from any other users or intruders through the use of passwords. The users are expected to acquire pairing password for the Arduino and the smart phone in order to access the home appliances which adds an extra shield from unauthorized users. This home interface (Figure 2) has the potential to access all the functionalities of H@USE automation system. The Home interface allows the user to access to Light Control, Temperature monitor and the monitor and control over cameras. The additional settings can also be made here.

The interface to control light, temperature are given in Figure 03 and Figure 04 respectively. The functionalities of the IP camera and its GUI are demonstrated in Figure 05.

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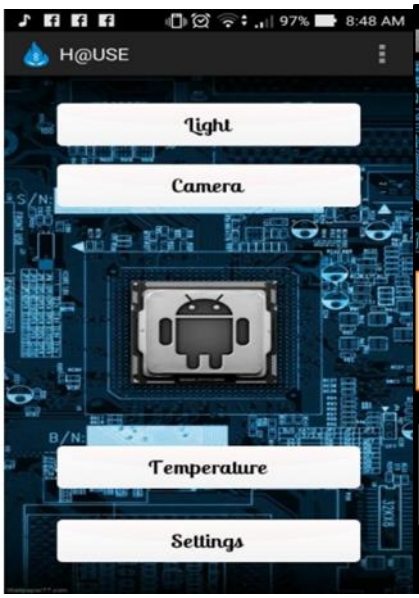

Fig 02. Home Interface

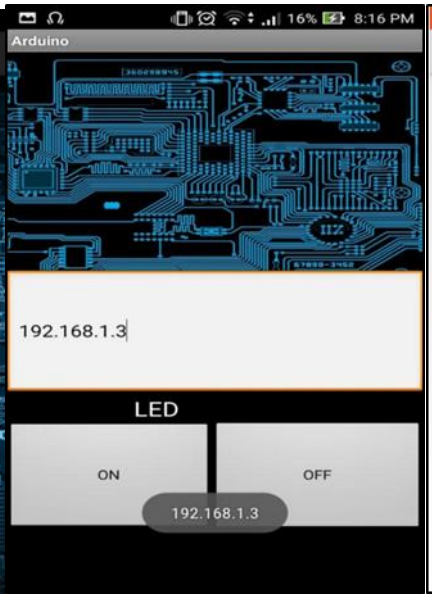

Fig 03. Light Control Interface

Fig 04. Temperature Control Interface

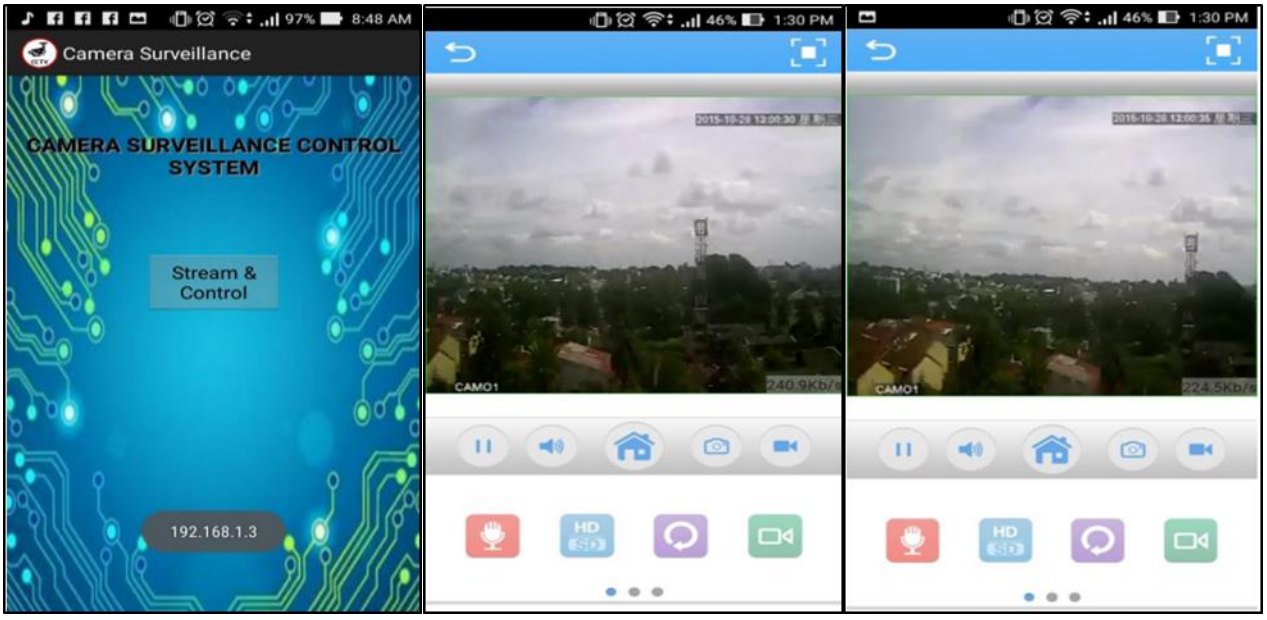

Fig 05 Interfaces of Camera control and surveillance

V. RESULTS

The modules of light control, camera control and temperature control were built separately and finally integrated as a system. The bugs, errors and interoperability were also tested and corrected. The accuracy, performance and the reliability of the resulting prototype were evaluated for every modules and it was found to be high. This system can be used as a test bed for any appliances that requires on-off switching applications without any internet connection.

The functionality of the complete home automation system prototype was tested and the wireless communication between the cell phone and Arduino was found to be limited to 50m in a concreted building and maximum of 100m range was reported to be applicable in an open range. Android platform supports to the operation of this system.

VI. DISCUSSION

In H@USE, powerful open source tools have been used such as Android, Arduino and MySQL database. Further, use of sound alerts and the use of caching in the mobile device with SQLite to avoid loss of data when offline are few other

beneficial features. The system has also made use of secure Wi-Fi connectivity for data transaction between mobile app and hardware devices in order to ensure security of the application. The following issues were identified during the development process.

- Connectivity of Arduino and database
- Low accuracy for hardware connectivity
- Loss of communication when the mobile device is offline
- Certain security issues

The following techniques have been used to overcome the issues listed above. The connectivity between Arduino and Database was established using Ethernet or Wi-Fi and web services. Further, Password oriented login has been implemented for user to ensure maximum security.

VII. CONCLUSION AND FUTURE WORK

This paper presents the basic idea of the smart home automation and security system, The H@USE. Through the literature review of several automation system in the past, this particular research has identified the potential gap existing and have designed a system to cater Sri Lankan context using the available technologies of today.

The research has utilized the Free Open Source Software such as Android and Arduino platforms thus the overall implementation cost is very cheap. The use of Android platform ensures that most people could access this system, since it is the operating system predominantly used worldwide. The implemented prototype consists of hardware implementation in conjunction with the android application. The user has the capability to control the embedded sensors and other appliances through an android based smart phone via Wi-Fi connectivity.

The system has been built only to support the android based smart phones and this could be mentioned as one of the limitation of this system. The researchers have focused to develop the system to be independent of operating systems in near future. Further, limitation to control only devices concerned are also to be removed by extending automation of all other home appliances. The scope is also expected to be scaled up without restricting to only homes.

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