Smart Home Monitoring and Controlling System using Raspberry Pi through Android Application

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Abstract— **The home automation system is a system of operating or controlling a process by electronic devices with reducing human involvement to a minimum. This paper aims at the implementation of monitoring and controlling smart home system from an android application based on Raspberry Pi. A system uses Wi-Fi technology as a communication protocol to connect smart home system components. A system developed using two main components an android platform and Raspberry Pi. An android application that can give orders to units that one wishes to control and a second part is Raspberry Pi that has an appropriate interface to sensors and appliances of a home automation system and communicates with an android application through wireless technology. Implemented smart home application is tested and it is able to perform the smart home operations such as indoor and outdoor temperature monitoring and, switching functionalities, automatic lighting etc. Experimental results show the efficient implementation of proposed smart home system.**

Index Terms— *Android application, Internet of Things, Smart home automation, Raspberry Pi, Wireless technology.*

I. INTRODUCTION

Internet of things (IOT) grant to people and things to be connected anytime, anyplace, with anyone, ideally using any network and any service [1]. Home automation is one of the important application of IoT technologies. It is used to monitoring of the energy consumption and the controlling the environment in buildings, schools, offices and museums by using different types of sensors that control lights, temperature, and humidity [2]. Home automation could be improved through developments of a communication network that uses, radio signals or an internet Protocol as standards. The home automation system includes a central controller, sensors, mode of transmission, user interface. Many smart appliances or devices became capable of communicating with one another through the Internet. For example, users can now control their smart TVs through their mobile phones. With the rapid expansion of the internet, the quality of life has been improving [1].

The Smart home is known as house automation with the use of new technology, to make the domestic activities more convenient, secure and economical [10].Different challenges faced by the home automation system were discussed [3].These barriers are high development costs, high installation costs, additional service and support costs,

consumer unfamiliarity with technology, and complex user interfaces. Raspberry Pi is a credit-card-sized single board computer developed in the UK by Raspberry Pi foundation [4]. It is used to eliminate the use of a personal desktop keeping the cost of the overall system to a Minimum.

II. RELATED WORK

Home automation refers to the monitor and control of home appliances and domestic functions by locally or remotely. Jain Sarthak et al. developed Home automation control through email where the received email is read by the developed algorithm on raspberry pi [4].A system can access and send emails to the consumer with the use of MODEM (Modulator-Demodulator). Memory space required is ejected by email based home automation system because it simply uses the already existing web server service provided by G-mail and this technique is better than DTMF (dual tone multi-frequency) based home automation system. Rozita Teymourzadeh et al. AT-commands has been applied and homeowners will be able to send and receive SMS and control home appliances from user's mobile phones [5]. Disadvantages of home automation using SMS are costs for the SMS and SMS depends on the networks. R.Pivare et al.An interaction between Arduino BT board and cell phone has been done through Bluetooth [6]. Bluetooth is password protected to make that the system is secure from any intruders. The Bluetooth has a range of 10 to 100 but access is limited to within the Bluetooth range. WI-FI technology as a communication protocol to connecting system components [7]. Components are a web server to control users home using LAN (Local Area Network) or the internet and Second part is Arduino board. IDE (integrated development environment) comes with the Arduino microcontroller itself. Arduino software track status from connected sensors, then apply an action to actuators [7] [8].Wi-Fi technology has a capable solution by controlling remotely .WI-FI based system has security and effectiveness as compared to Bluetooth and DTMF. The application has been developed based on the android system. Java programming language using the android Software Development Kit (SDK) has been used for the development and implementation of the smart home application [8] [9]. The application has been installed on an android Smartphone, a web server, and a raspberry pi card to control the shutter of windows. Android application on a smartphone apply command to Raspberry Pi card. A Recent development of the Raspberry Pi minicomputer has applied in a vast number of areas e.g. home automation.

Raspberry Pi system has unique advantages, this technology holds great promise for providing solutions within

the developing world. Use of GPIO (General Purpose Input/Output) which allows automated data acquisition and producing simple digital control systems [9]. Shih-Pang Tseng et al. [10] proposed Smart home system based on the ZigBee, all sensors and actuators are connected by a ZigBee wireless network. Simple smart socket designed, which can remote control via ZigBee. PC host has used as a data collector and all sensing data are transferred to the VM (virtual machine) in the cloud.

III. SYSTEM DESIGN

This paper proposed a smart home monitoring and controlling system based on Raspberry Pi and an android device using a wireless router. The objective of the smart home system is to provide comfortable, a convenient user interface by sensing and controlling home environment and to improve the energy efficiency by monitoring and controlling the appliances.
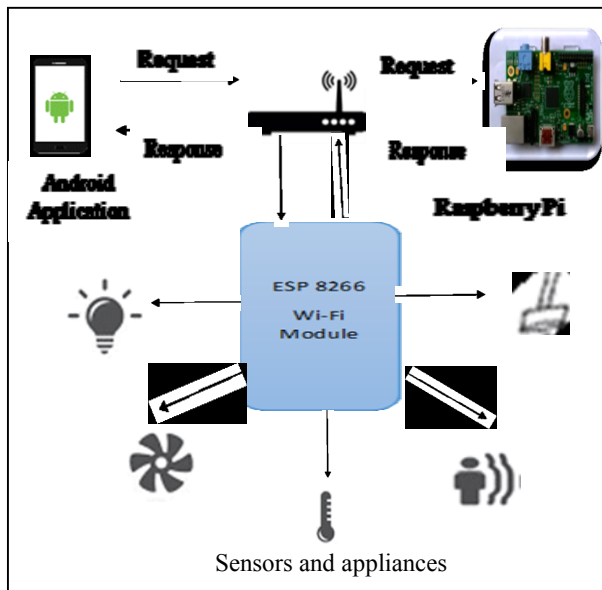

Figure 1. Architecture of Smart Home Monitoring and Controlling System

Figure 1 illustrates the architecture of proposed smart home Smart Home Monitoring and Controlling System. In essence, all sensors and relays are connected by an ESP-8226 wireless module. In a proposed system designed a PCB (Printed Circuit Board), which can have control via Wi-Fi module. Therefore, all appliances, connected to the PCB and it can be controlled by an android application. In the smart home automation system, Raspberry Pi is used to control flow between android device and PCB. Communication between the Raspberry Pi and home appliances is done over Wi-Fi network. The user can use android phone to monitor or control the smart home environment.

IV. IMPLEMENTATION

The flow of smart home automation system is shown in Figure 2 Initially Raspberry Pi, wireless router, PCB is

initialized by switching on and then initialization of ESP WI-FI module and sensors is done. Once the hardware is ready, a user can access present environment of a home by providing authentication information and the sensors start sensing present in the environment and displaying on an android application of user smartphone. Basically, an all sensing data are transferred to the Raspberry Pi. The Raspberry Pi can issue the control command to an android application.
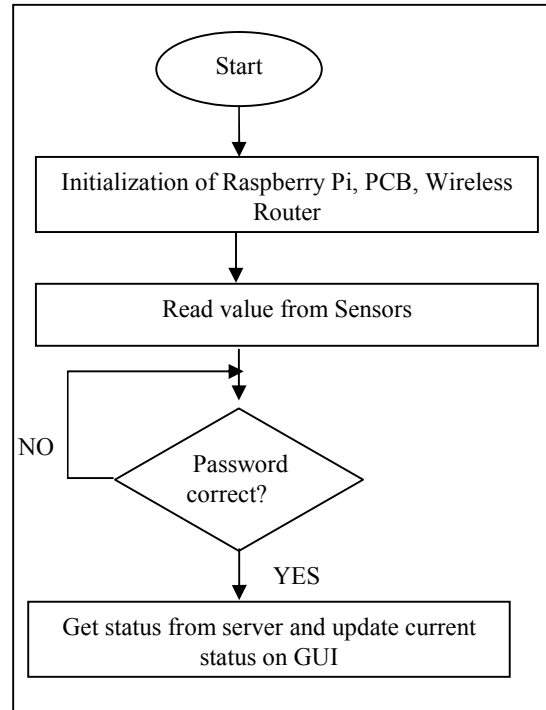

Figure 2. Flow chart of proposed system

In proposed system the android platform application is developed as most of the phones support android operating system. Java programming language using the android Software Development Kit (SDK) has been used for the development and implementation of the smart home application. The screenshots of developed smart home application is shown in Figure 4. The main controller Raspberry Pi is hosting the server acts as the one important part of the smart home automation system consisting of the server application. An HTTPConnection instance represents one transaction with an HTTP server. The output messages sent to the smart home application is in JavaScript Object Notation (JSON) format.

The LM35 temperature sensor has been used to monitor the indoor and outdoor environment of a smart home. For Auto lightning mode, the HC-SR501 Infrared PIR Motion Sensor and light-dependent resistor (LDR) sensor has been utilized. Relays have been used to operate switch within smart home from android application

### V. RESULTS

Figure 3 shows Setup of Smart home system,

Figure 3.Setup of proposed syste

Proposed smart home system has been developed and tested to demonstrate its effectiveness. The screenshots of the smart home application developed has been presented in Figure 4. As mentioned, authentication is required to access the smart home system and displaying the wrong password entered shown in Figure 4(a). If the authentication information is correct then proceeds to show the smart home controls page with a message notifying success of login. Home user can create dynamic button to control home function according to their feasibility.
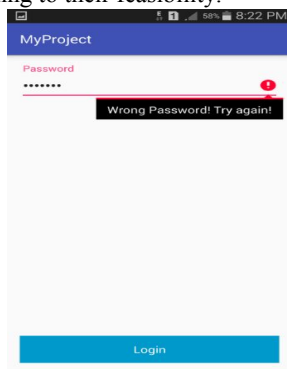
(a)
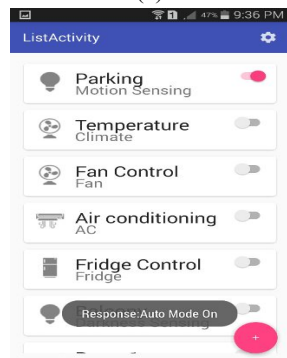
(b)

Figure 4. Smart home android application

The designed android application for the smart home system provides the following functionalities to the user:
- User authentication by providing password verification.
- Activity management facility i.e. add, remove device or change sequence of a device.
- Device control and monitoring
- Automatic lighting control according to the current environment of a smart home.
- Current temperature monitoring of smart home environment
- Password change option

The user authentication function provided in order to successfully connection and access the smart home system, the user has to enter the correct password of android application. A server on Raspberry Pi has to run and it grants access to the smart home system. After password authentication application will switch to the main GUI and it contains a list of activities. If the password is incorrect then displayed an error message. The activity management function is used to add device by including all device information such as room name, device name, sensor name, device MAC address and device icon etc. A user can remove and change device sequence as per user feasibility. Appliances monitoring and controlling for improving the energy efficiency of the smart home. And can show the status of each device which connected by the developed socket means a device on or off. Auto mode function used to automatic lighting control of the smart home environment by motion sensing and light intensity sensing respectively. Temperature monitoring function monitor status of home environment like temperature inside and outside of a home.

CONCLUSION

IoT-based smart home systems will bring more convenience and comfort to people's lives. Any android supported device can be used to install the smart home application. Using android application user can control and monitor the smart home environment within a range from Wireless router. Raspberry Pi provide an economic and efficient platform to implement the smart home automation system. It can be used for monitoring and the controlling the environment in buildings, schools, offices and museums by using respective sensors that control lights, temperature, and other appliances. It will use to minimize wastage of electricity. It is less time consuming and helps to old and handicapped people .A system can be used to control to home devices and smart environments with the use of a user-friendly interface. It would be extended to the large-scale environment such as colleges, offices, and factories etc. with the number of functionality.

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