Design and Implementation of IoT Based Home Automation

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Abstract-*In the olden days electrical, electronic and electromechanical devices were supporting all the day to day life activities. Some devices were fully automated and some were semi-automated. Due to the advancement in computer and communication technology, the trend is more towards the automation of most of the activities which are needed in a day to day activities with very less human intervention.*

In this project, we are proposing an automated tool which works on the concept of Internet of Things which is basically electronic and communication technology which controls the home appliances such as light, fan, water tap, geyser, air conditioner and washing machine.

Keywords—*Internet of Things (IoT), Home Automation System (HAS), Arduino UNO, ESP8266*

1. INTRODUCTION

A. *Overview*

In the olden days electrical, electronic and electromechanical devices were supporting all the day to day life activities. Some devices were fully automated and some were semi-automated. Due to the advancement in computer and communication technology, the trend is more towards the automation of most of the activities which are needed in a day to day activities with very less human intervention.

IoT is a world, where real, virtual and digital environments combine to create a smart environment which makes life easy. Due to the advancement in both hardware and software technology, now it is possible to communicate between two either homogeneous or heterogeneous devices. In today's world, internet is to be popular means of communication. From the end user's point of view, Internet based Home Automation System is very convenient, easy, flexible and cheap to handle all the devices which are used in the home and work place. These devices are monitored and controlled using a remote device such as mobile phone for sending the necessary control command.

2. LITRATURE SURVEY

Home automation or Smart Homes (also known as domestic) can be described as introduction of technology within the home environment to provide convenience, comfort, security and energy efficiency to its occupants [1]. Adding intelligence to home environment can provide increased quality of life for the elderly and disabled people who might otherwise require caregivers or institutional care. There has been a significant increase in home automation in recent years due to higher affordability and advancement in Smart phones and tablets which allows vast connectivity. With the introduction of the Internet of Things, the research and implementation of home automation are getting more popular [2]. Much of the research attention has been given in academia. Various wireless technologies that can support some form of remote data transfer, sensing and control such as Bluetooth, Wi-Fi, RFID, and cellular networks have been utilized to embed various levels of intelligence in the home [3]. The studies in have presented Bluetooth based home automation systems using Android Smart phones without the Internet controllability [4]. The devices are physically connected to a Bluetooth sub-controller which is then accessed and controlled by the Smart phone using built-in Bluetooth connectivity. However, due to limited range of operation (maximum up to 100 meter) the system is unable to cope with mobility and can only be controlled within the vicinity. Researchers have also attempted to provide network interoperability and remote access to control devices and appliances at home using home Networks. Introduced a Wi-Fi based home control system using PC based web server which manages the connected home devices [5]. Similar designs have also been presented in where a dedicated web server, database and a web page have been developed to interconnect and manage the devices with the Internet [6]. The

disadvantages of these systems are twofold. Firstly, a high end personal computer has been utilized which not only increases the cost of installation but also increases the energy consumption. Secondly, development and hosting of web pages which also add to the cost. A GSM based communication and control for home appliances has also been presented by where different AT commands are sent to the Home Mobile for controlling different appliances [7]. The drawback of this system is that users are not provided with a graphical user interface and users have to remember different AT commands to control the connected devices. Proposed mobile IP based architecture and its potential applications in Smart homes security and automation without any actual deployment and testing[8]. The drawback of using SOAP based Web a service is that it is complex and adds overhead to the client and server when parsing the message, resulting in slower operation and higher Bandwidth. REST has been presented as a Web-based interaction for controlling household appliances using Web techniques such as HTTP caching and pushes messaging [9]. Also a Web-based graphical user interface has been developed to manage the home devices. Home automation using Cloud computing has also been proposed by where users were able to control various lights and appliances within their home[10]. The above mentioned systems have made significant contributions to the design and development of home automation systems. However, the existing works were mainly focused on switching and controlling home appliances or connected devices rather than remotely monitoring of home environment.

3. PROPOSED SYSTEM AND ARCHITECTURE

3.1. *Features of the Proposed System*

In order to address the mentioned issues of flexibility and functionality in the literature survey, we designed and implemented a flexible and low cost home controlling system using Serial Wi-Fi Module. The system consists of a Web - server based on Arduino Wi-Fi, hardware interface modules and the Android compatible Smart phone app. The architecture presented in this work can be customized in different ways in order to accommodate different application scenarios with minimum recoding and design i.e. each time a new device is added to the Web-server, a new thread dedicated to the device is has to be created in the Smart phone app. This system allows authorized home owners to remotely control and monitor connected devices at home using any wired portion. The smart phone app provides a graphical user interface (GUI) for accessing and controlling the devices at home through server real IP. 3.2.

3.2 *Description of Proposed Architecture*

The architecture of the system [11] is designed using router and Arduino Ethernet shield, but in our proposed work we are appropriately modifying this architecture using Wi-Fi module and Arduino UNO to suit the requirement of the system.

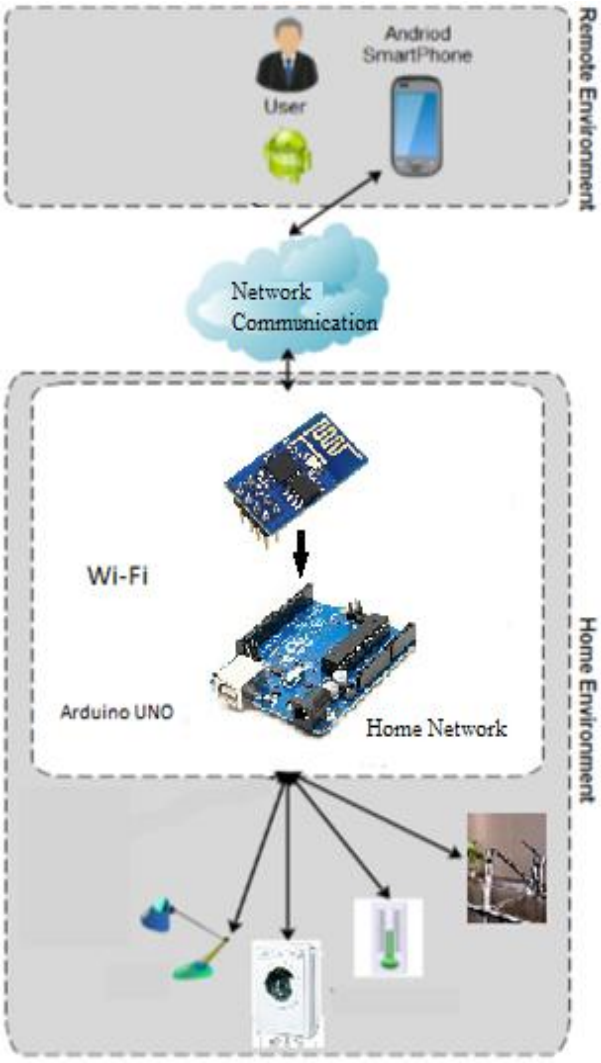

Fig 1: Overview of Architecture

The architecture is divided into three layers: Home Environment, Home Network and Remote Environment. Remote Environment represents users who can access the system on their Smart phone app using Wi-Fi. Home Environment

consists of Home Network and the devices. The primary function of the Home Network is to communicate between the user and devices. The main component of the Home Network is Arduino and Wi-Fi. The main task of the Arduino is to manage, control and monitor system components, that enables hardware interface modules to successfully execute their assigned task. Hardware interface modules are directly interfaced with sensors. It has the capabilities to control energy management systems like Lights, Fans, Water Taps and Washing Machine. For monitoring Home Environment, the system supports sensors such as temperature, light detection, motion sensor and other sensors.

4. SYSTEM IMPLEMENTATION

The proposed home control system consists of three main modules: the hardware interface module and the software module (Smart phone app). To demonstrate the effectiveness of this system, devices such as light switches, temperature sensor and motion sensor have been integrated with the proposed home control system. This section describes the system implementation details.

4.1. Software Development for Home Network

Software of the proposed home automation system is divided into two parts: application software and microcontroller firmware. The server application software is a library implementation of a server running on Arduino Uno using the Wi-Fi shield. This shield has the capability to be used both, as a client or a server. To successfully communicate between remote user and the Home Network, configuration stage and sensor/actuator control stage layers have been implemented on the Arduino Uno. The Home Network is connected to Internet over TCP/IP. Since Arduino already supports a TCP/IP stack, we have focused on implementing software to connect it to the remote user.

The flow chart of the proposed system is shown in fig.2 which enters into the configuration mode after turning it on and remains in the same until it gets response from the user. Upon successful reception of commands from the Smart phone app, it's accepted and appropriate control action is taken.

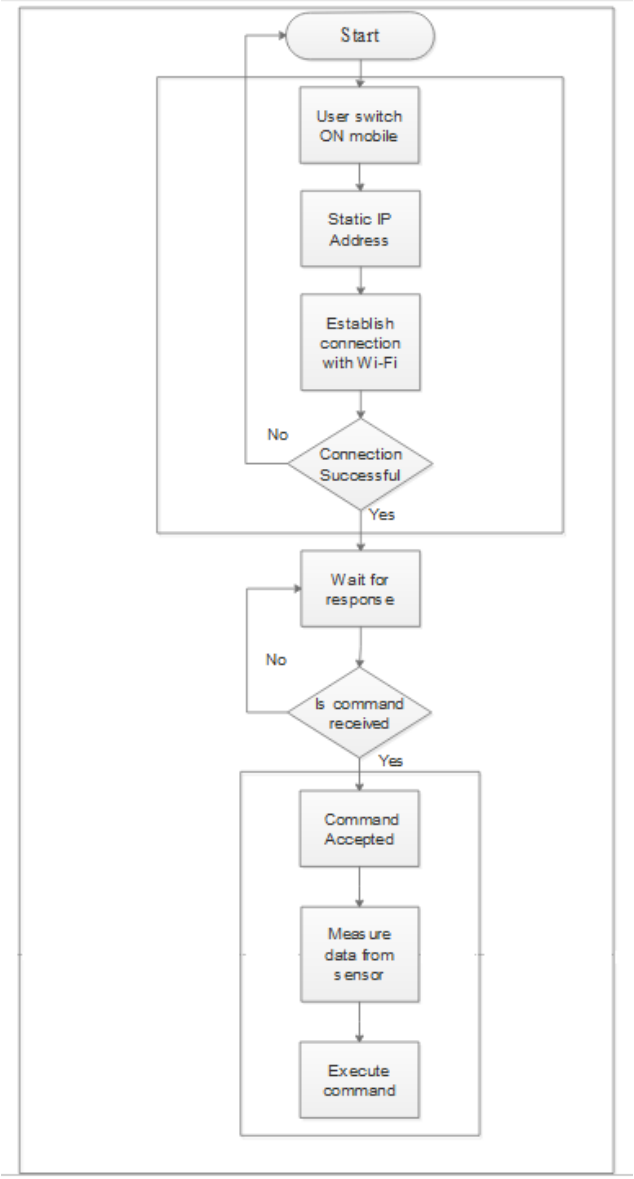

Fig 2: Flowchart for connection establishment with internet

4.2. *Smartphone Application and Features*

The most important feature of our Smartphone app is to hide several processes from the user while allowing full interaction with the application. We are using relevant generic packages to customize our smartphone for handling appliances. Smart phone app for home control and monitoring applications provides the following functionalities to the user: 1) Remote connection to the Home Network. 2) Device control. 3) Device Monitoring. To successfully connect to the Home server, the user has to configure the IP address and the Port number.

4.3. *Hardware Implementation and Home Automation Devices*

For proof of the concept, low cost and off the shelf electronics hardware is used to setup the test bench. The overall implementation diagram is illustrated in Fig.3.

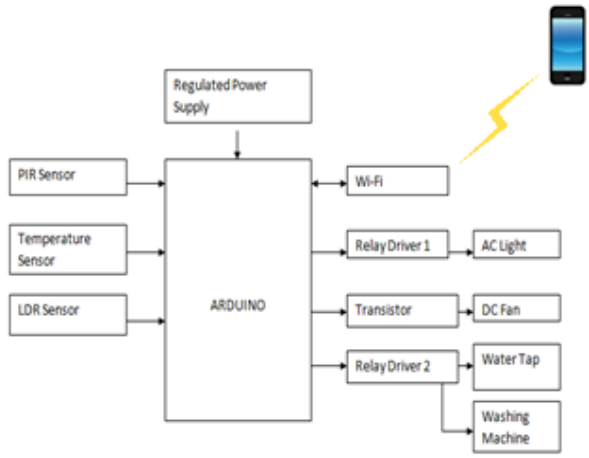

Fig.3: Hardware architecture and implementation

The Arduino Uno was used to implement the Web-server for the Home Network. Home Network connects to the Internet according to the details provided in Section 4.1. The Arduino Uno is an open-source microcontroller that uses ATMEGA 328, an Atmel AVR processor which can be programmed by the computer in C language via USB port. Arduino Uno also has on-board 5 analog pins and 13 digital pins for input and output operations, which can be used to interface with other devices. The Ethernet module acts as a bridge to connect the Home Gateway to the local proxy. A conventional light switch was integrated with the Arduino using relays to demonstrate the switching capability as illustrated in our previous work [12] and an LM35 temperature sensor was used for temperature monitoring. Details provided in [13] are used to successfully integrate the current sensor with the Arduino Uno. The hardware architecture presented is flexible and allows other home appliances and devices to be seamlessly integrated with minimal changes.

5. CONCLUSION

In this paper, we have proposed an internet based automated tool using Arduino UNO and ESP8266 (Wi-Fi model) to control the home appliances such as light, fan, water tap and washing machine. The system is tested by developing a prototype model and evaluated for its correctness and completeness.

6. REFERENCES

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