Cost Effective Home Automation System

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Abstract
This paper presents the implementation of cost effective Home Automation using Arduino Uno and various sensor. The proposed system is able to control and monitor the temperature, light, gas, water level, humidity and other household appliances. The main body of the framework contains Arduino Uno microcontroller connected to a relay driver circuit to same a Wi-Fi network. The model is also integrated with various sensors to increase the effectiveness of proposed system. A user-friendly Android application is also developed using Android Studio which provides GUI for the users. This system works within same Wi-Fi network hence it has high speed and low connection issues. The proposed system is flexible and easy to understand. Unlike most system, the proposed system is not only used for switching functionality but also for monitoring the homeenvironment. Results of the experiments conducted are quite promising. Existing homes can be converted into thesmart home using prototype at relatively low cost with convenience.

Keywords
Arduino; ESP8266; HomeAutomation; GIU Android Application; Wifi.

I. Introduction

Smart Home is an advanced system to make ordinary house intelligent and automated. In a world which is becoming progressively automated, Home Automation is getting popularity from the households around the world. Home Automation should be more attainable since it does not require an uncommonly advanced technology and can usually be executed with off-the-shelf devices. A smart home usually consists of electrical appliances such as lighting, fans, air- conditioners, roomheaters, aircoolers and microwave oven etc.; and electronic gadgets such as television, computers, audio systems, laptops, musicsystems and mobile devices etc. All these appliances and gadgets can be connected andcontrolled remotely, over a secure channel using Wi-Fi or internet through the software application, from within or outside the house.The mainintentofour project is to construct andimplement a cost effective home automation system which should be accessible to all. We will be using in our system a nominal Android phone as the UI, and an Arduino microcontroller to offer connectivity with the home appliances and Wi-Fi network. All the devices are in wireless LAN network. The popularity of wireless LANs is proof to the agreement, cost efficiency, and ease of combination with other network components. Most of the mobile phones soldnowadays have Wi-Fi connectivity inbuilt. The advantages of using a wireless LAN are: the convenience to the user as it allows user to access network assets from any convenient location; the mobility as it allows mobile users with smart phones to be able to move from one access point to another; and the expandability and cost because it allows local area networks (LANs) to be set up with cabling that can decrease associated costs of network connection and growth [12]CISCO estimated that 50 Billion devices would be linked to the Online Network in next few years.

The modern developments in technology which allows the use of Bluetooth and Wi-Fi have enabled different devices to have proficiency of connecting with each other[13].We are using ESP 8266 microcontroller unit as a web server for the Arduino which discard the need for wired connections between the Arduino board and computer which lower cost and enables it to work as a standalone device. The ESP 8266 needs to be connected to the router or home Wi-Fi network and this would act as the gateway for the Arduino to communicate with devices. With this in mind, a Wi-Fi-based home automation system for remote control of home appliances is designed.

II. Related Work

ElShafee and Hamed [1] proposed a system that uses the Wifi technology for implementation of Home Automation. The hardware interface Module and the core system which manages the users home are two main parts of their proposed prototype. The new model which is characterized by the use of Zigbee and Radio Broadcast Data System (RBDS) is proposed by Jin[2] which supports multiple interfaces. Hamed[3] applying the concept of IRF sensor for monitoring the gas density,temperature,fire alarms,humidity for security purpose.Their proposed system has connectivity to the Internet which provides them for monitoring and controlling the various activities around the world. Their approach is merging the software and hardware progress.Wook-Sung Yoo and Sameer Sheik[4] provided with the approach of MIT App Inventor to create auser-friendly interface of theAndroidapplication.Mohd Nor Azni, M.N.H; Vellasami, L[5] provided with the approach of using Raspberry Pi for home automation system which has only switching functionality but alternatively Arduino Uno can also be used which is cheaper and can be easily implemented.Their proposed system works on the Web Application which might create issues if the connection to the server fails.

III. System Design

Following are the main components of our system:

A. Arduino UNO

Arduino is an open-source platform that can be used for prototyping any hardware and software. Arduino can be programmed to receive keyboard input or sens or data and control various electrical appliances connected to output peripherals. Our project Arduino UNO is the central controller of the system. The program is stored on Arduino boardand all the commands are executed here.

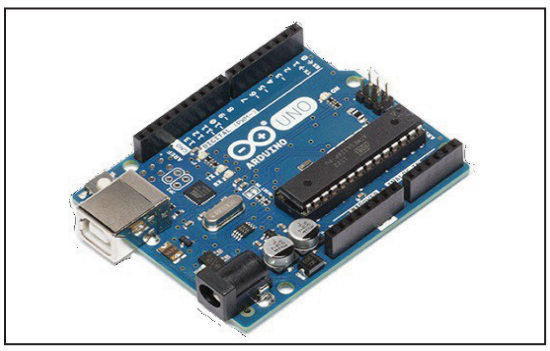

Fig. 1:Arduino UNO board

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B. ESP 8266 Wi-Fi Module

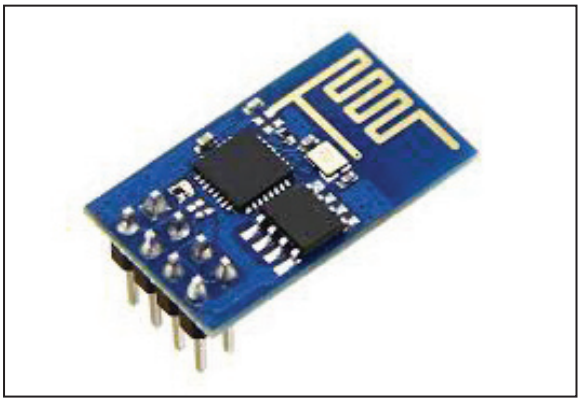

Fig. 2: ESP 8266 Wi-Fi Module

The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. In our project, we are using ESP8266 to communicate between Arduino and Wi-Fi router. It has its own IP address which can be configured by using Arduino IDE and Arduino board.

C. Light Dependent Resistor (LDR)

A simple LDR is connected to Arduino which is used to monitor daylight intensity. An LDR is a component that has a (variable) resistance that changes with the light intensity that falls upon it. This allows them to be used in light sensing circuits. This circuits can be used for automatic brightness control of the house.

D. Passive Infrared Sensor

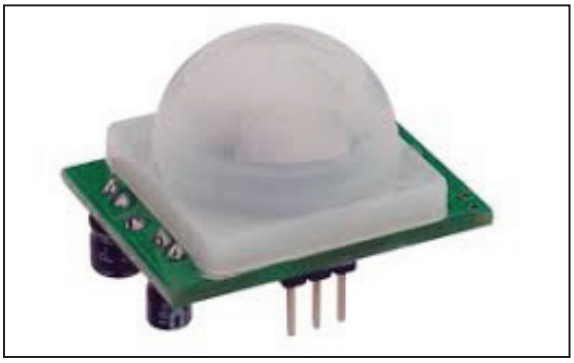

Fig. 3: Passive Infrared Sensor

A PIR sensor is a sensor detects the motion in anenvironment with the help of the energy given off by other objects. PIR sensors don't detect or measure "heat" instead they detect the infrared radiation emitted or reflected from an object.

E. Temperature and Humidity Sensor

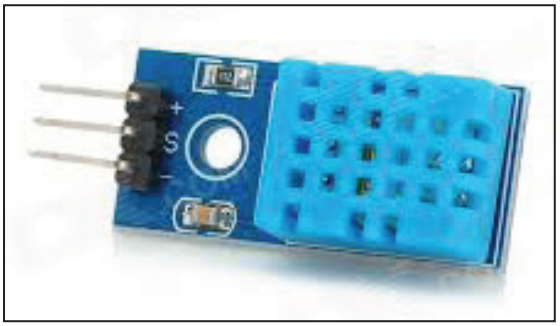

Fig. 4: Temperature and Humidity Sensor

The DHT11 sensor measures humidity as well as temperature. Humidity is detected by measuring the amount of water vapor in air vs. the saturation point of water vapor in theair. At the saturation point, water vapor starts to condense and accumulate on surfaces forming dew. The saturation point changes with air temperature. The DHT11 measures temperature with a surface mounted NTC temperature sensor (thermostat) built into the unit.

F. Water Level Indicator

Fig. 5:Water Level Indicator

Water level indicator can be integrated with Arduino to get the reading of water level in the water tank. There are different types of water level indicator available in the market. But ultrasonic sensor module is suggested as it is readily available and cheap.

G. MQ Gas Sensor

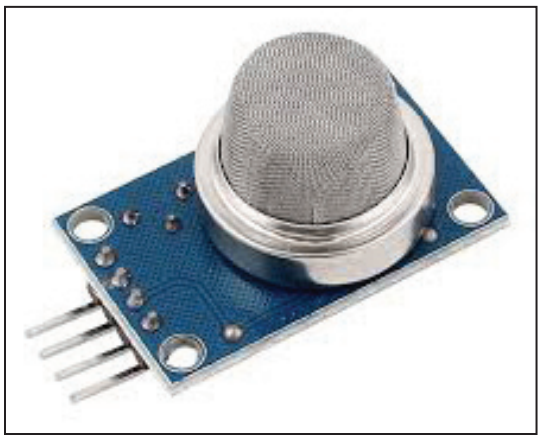

Fig. 6: MQ Gas Sensor

MQ gas sensors are smoke detecting gas sensors. These sensors are triggered if smoke is detected. The MQ series of gas sensors use a small heater inside with an electrochemical sensor. They are sensitive to a range of gasses and are used indoors at room temperature.

IV. Working of System

In this paper, the concept of home automation is realized using low-cost micro-controller based Arduino board,ESP 8266 Wi-Fi module, various sensors and an Android mobile phone. Arduino can be plan out to receive keyboard input or sensor data and control various electrical appliances connected to output devices. Since mobile phone is a wireless communication device, connectivity between Arduino and smartphone is established using ESP 8266 within Wi-Fi network. Since Arduino micro-controller unit does

not have inbuilt Wi-Fi facility thus ESP8266Wi-Fi module is used for establishing wireless connectivity. Here Wi-Fi network is used because of it fast, efficient, and reliable medium.The range of Wi-Fi depends upon the router it can vary from 36 meters to 92 meters.

The proposed home automation system does not only have switching functionality but it also offers features such as agas sensor, Light sensor, motion detector, temperature and humidity sensor. All these sensors give input to the Arduino from their environment. This data can be used to automate the functions of the smart home.

In our project, we are not using the internet so it cuts the risk of asystem failure while the internet is not working. Only the router needs to be switched on. Once home appliances are connected to Arduino board, they can be easily controlled using any Wi-Fi enabled smartphone or a web application from any browser.

V. Proposed Work

The designed system consists of two main hardware components. The first one isAndroid application or PC browser. Another one is the Arduino Uno microcontroller board which is flexible and inexpensive. The software/hardware is extremely accessible and very flexible, so it is an open source project. The architecture diagram of system is given below

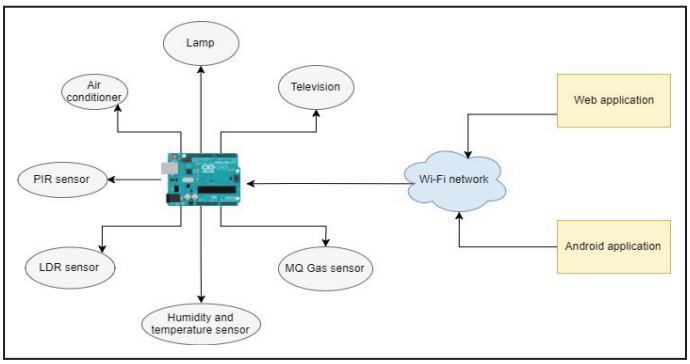

Fig. 7: Prototype of Working Model

As shown in the Figure we can clearly understand theworking of the system. When a user sends a command fromAndroid app or web application to Arduino through Wi-Fi network the command is received at Wi-Fi module which then transfers it to Arduino for further execution. Another way of giving input to Arduino is by sensors. The light dependent resistor is used to measure the brightness of the environment which can useful to automate the lighting system of thesmart home. When the sun will set then the lights will automatically turn on.PIR sensor can detect motion by studying the energy emitted by human of objects. This sensor can be useful for security purposes if a burglar enters the house motion is detected by PIR sensor then thealarm will be triggered. Temperature and humidity sensor is also integrated with Arduino whose data can be used to automate the air conditioning system of thesmart home. An ultrasonic sensor can be integrated with Arduino which will display the water level in the water tank on users Smartphone. If the water level rises above its limit then the water pump will be automatically shut off. A smoke/gas sensor can be integrated with Arduino which will trigger the alarm if smoke is detected and theuser will receive notification on his phone. A switching mechanism is integrated with Arduino using relay switch by which user can turn on/off any appliance connected to the system. Android application or web application can be used to control or monitor the system.

VI. Implementation

The flowchart for animplementation of thehome automation system is shown in Fig. 8. The first android phone needs to be linked to the same Wi-Fi to which Arduino is connected. Arduino system should be turned on i.e. should be provided with power for working. An Android app is designed using theandroid studio and a web application is made using HTML,PHP, and JavaScript. These applications are user-friendly and have avery simple user interface. Once theuser opens the application he will see alist of appliance he can control and button to control it. The user just hasclicked on the button,which is already assigned to thespecificdevice, in order to control the device. If the button is red that means thedevice is turned off. When theuser taps on thebutton, the button will turn green and the device/appliance will be turned on.

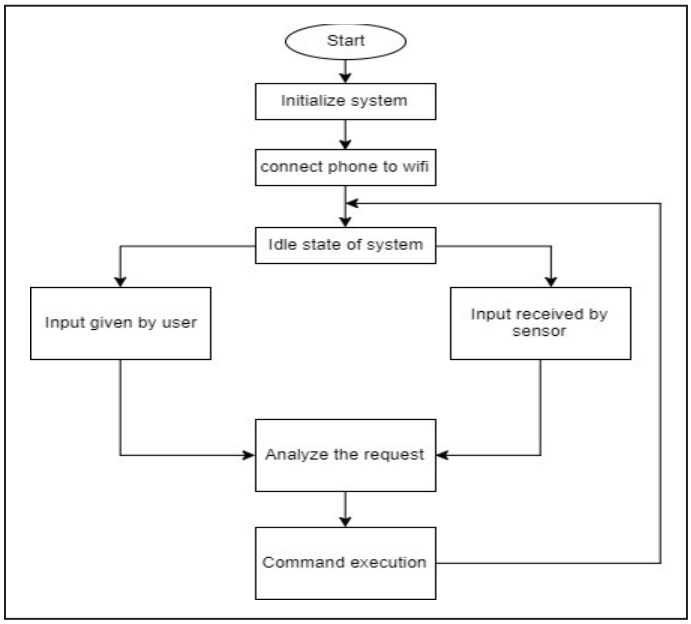

Fig. 8: Flow Chart

The application also displays thestatus of other sensor temperature of theenvironment, thewater level of the water tank. On the other side i.e. in Arduino board, data transmitted by theapplication will be received with the help of Wi-Fi module connected to the Arduino board. After receiving the instruction, data gets verified respective LED's status will be changed either to ON or OFF state For example, if user taps on the button near the LAMP icon in the Android phone, the connected lamp turns ON and if theuser again taps on the same LAMP icon lamp turns OFF. A simple model of thehome automation system is shown in fig 9 where lamp and Door are turned on.

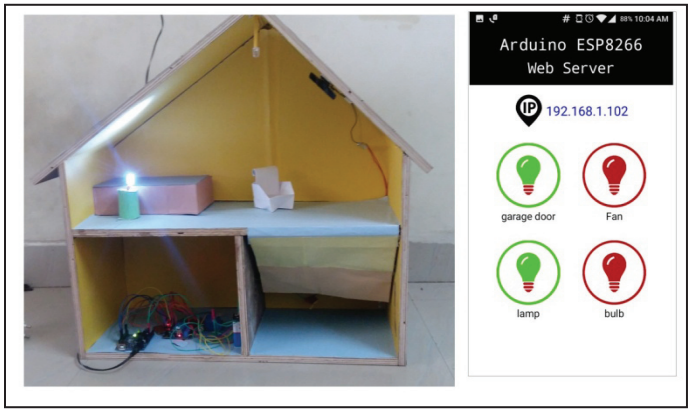

Fig. 9: Implemented Model

Advantages of proposed system

- Cost effective system than other systems available in the market
- Displays temperature, humidity, motion sensor, water tank level status.
- System does not require internet connection.
- Secure and reliable Wi-Fi network is used.

VII. Conclusion

In this paper, we propose a Smart Home Automation using Wifi network.We have created an integrated user-friendly Android application and Web application in our model. The proposed prototype is built to monitor and control different appliances in response to signal came from any sensor. A prototype model is also created to demonstrate the working of the system.Wireless sensor technologies can be used for future development.The system proposes home automation solution so that more no of people can use IOT is thesmartenvironment.

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