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Innovative Project

A LOW COST FLEXIBLE AND RELIABLE HOME AUTOMATION SYSTEM WITH IP CONNECTIVITY THROUGH LOCAL Wi- Fi

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SYNOPSIS

This work presents a low cost flexible and reliable home automation system with additional security using Arduino microcontroller, with IP connectivity through local Wi- Fi for accessing and controlling devices by authorized user remotely using Smart phone application. The proposed system is server independent and uses Internet of things to control human desired appliances starting from industrial machine to consumer goods. The user can also use different devices for controlling by the help of web-browser, smart phone or IR remote module.

To demonstrate the effectiveness and feasibility of this system, in this paper we present a home automation system using Arduino UNO microcontroller and esp8266-01 as a connectivity module. It helps the user to control various appliances such as light, fan, TV and can take decision based on the feedback of sensors remotely. We have to test our system through conducted experiment on various environmental conditions.

Key Words and Phrases: Arduino Uno Controller; Internet of things (Iot); Esp8266-01; Wi-Fi network; Home automation system.

Introduction

As rapid change in technology always aims to serve the mankind, the expectation for living a simple yet advance life keeps on increasing [1].

Internet has become an important part of human's social life and educational life without which they are just helpless. The Internet of things (Iot) devices not only controls but also monitors the electronic, electrical and various mechanical systems which are used in various types of infrastructures. These devices which are connected to the cloud server are controlled by a single user (also known as admin) which are again transmitted or notified to all the authorized user connected to that network[2-5]. Various electronics and electrical devices are connected and controlled remotely through different network infrastructures. Web browser present in laptop or smart phone or any other smart technique through which we can operate switches, simply removes the hassle of manually operating a switch. Now a day's although smart switches are available they proves to be very costly, also for their working we required additional devices such as hub or switch [3,6].As there is rapid change

in wireless technology several connectivity devices are available in the market which solves the purpose of communicating medium with the device and the micro-controller. Starting from Bluetooth to Wi-Fi, from ZigBee to Z-wave and NFC all solve the purpose of communicating medium. RF and ZigBee are used to used in most wireless networks [4,7]. In this project we have taken ESP8266-01 Wi-Fi module which is programmed through Arduino UNO to control various devices.

The rest of sections in this paper is organized as follows: Section II provides a system overview of the system. The hardware design is explained in Section III, Section IV discusses about the software design and experimental results are discussed in Section V. At the end the paper concludes by looking at the future research and recommendations which are required to make the system more effective.

Available technology	**IEEE Standard**	**Network Topology**	**Maximum Power Consumption (in mW)**	**Data Rate**	**Maximum Range (in meter)**	**Cost**
Bluetooth	802.15.1	One to Many	100	1 to 3 Mbps	10	medium
Zigbee	802.14.5	Star, cluster, mesh	3	20 to 250kbps	100	high
Esp8266-01	802.11	Star, mesh	100	1 to 11Mbps	150	Low

Table-1 Comparison of Different communication module

From table 1, it is observed that Esp8266-01 works on 802.11 b/g/n protocol whereas Zigbee uses 802.14.5 protocol. Zigbee consumes least power as 3mW whereas Wi-Fi and Bluetooth consumes nearly 100mW. But if we compare speed of Esp8266 has maximum speed up to 11mbps but Zigbee has only 250kbps. Clearly esp8266 defeat Zigbee and Bluetooth not only in cost but also in speed [8,9]. Fig.1 is giving a brief idea about the interconnection of microcontroller , peripheral devices as well as sensors and what is the architecture behind it [10-12].

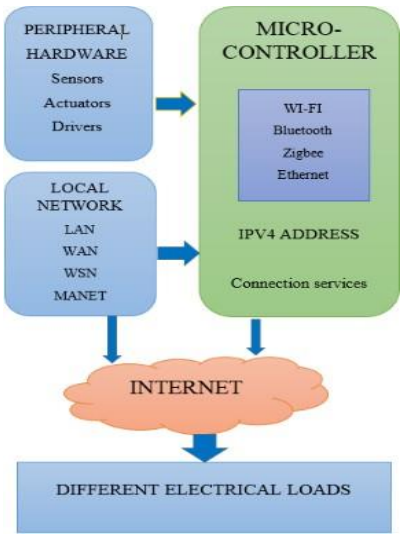

Figure. 1. Network Architecture of IoT devices

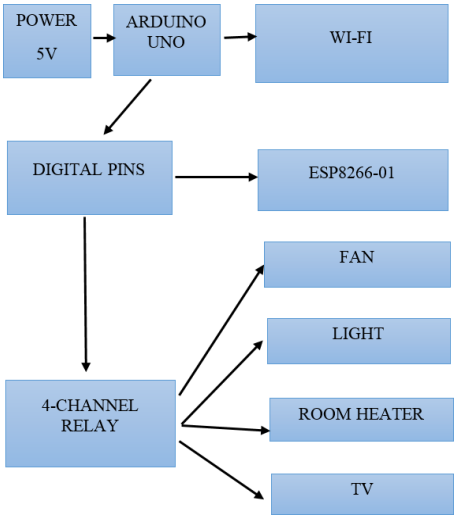

Figure . 2. Home automation system

1. System Design

Figure.1 and 2.Gives an idea about the operation of home automation system. The four different appliances such as fan, light, room heater and TV are operated remotely using Wi-Fi and through an application installed on android or iPhone. These appliances are connected through Arduino Uno with its digital input/output pins. These devices are connected with local Wi-Fi using a communicating module called esp8266-01.

2. Hardware Description

This hardware implementation contains 4 different parts. (i)A 16X2 LCD display for displaying status of the system and IP address of the local Wi-Fi network (ii) Relay for switching the load automatically, (iii) Arduino as decision maker and (iv) esp8266 version 1 for connecting to local Wi-Fi.

A. Arduino UNO

The UNO proves to be Arduino's flagship board for beginner and also for advanced users. The system needs a micro-controller to process data and connects different modules for control. This purpose was solved by Arduino Uno which has ATMEGA328p processor. It has 6 analog input pins and 14 digital input/output pins[13]. It can operate with either 5V from USB plug or 12V from external power supply. In Arduino Uno pin 1 and 0 are used as default transmission and receiving pin (Figure.3).

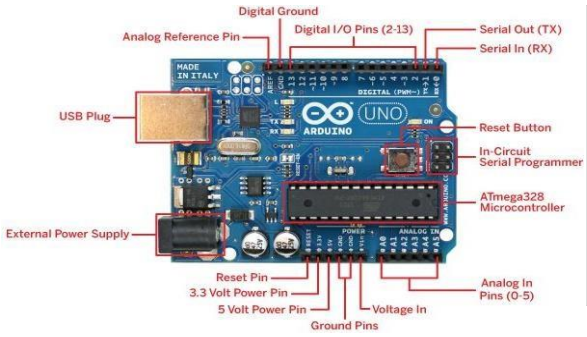

Figure.3 Arduino Uno

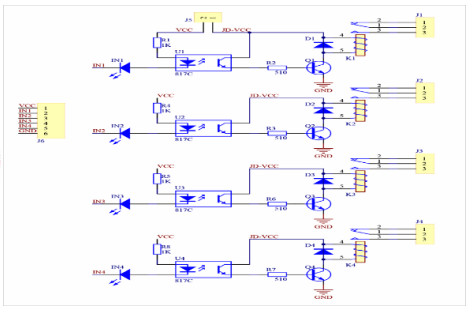

Figure. 4: 4-Channel relay module

B. 4-Channel Relay

4-Channel relay is connected to the Arduino Uno and its output is connected to the home appliances in a sequence as (i) fan (ii) light (iii) room-heater and (iv) TV set. Relay takes low current and voltage and triggers the switch which is connected to a high voltage. 4 input pins of relay are connected to Arduino which takes5V supply from it and can trigger up to 10A, 250V supply (Figure.4).

C. ESP8266-01

The ESP8266-01 is a highly compact board, used as a peripheral for any board through serial (RX/TX) and also as a standalone board. The board requires 3.3 V and

can be programmed with any FTDI operating at 3.3 V. The pins include power (+3.3 V and GROUND), RX / TX, CH_PD to enable the chip and 2 General Purpose Input Output (GPIO) [14].

D. WIFI

Wi-Fi(wireless fidelity) is a wireless communication technology which is used here to provide a hotspot through which ESP8266-01 module can connect. The router will assign a unique IP address to the module for establishing a connection between smart phone and ESP8266-01.

E. Gas Sensor

Gas sensor module detects various types of gas in an area. Here the change in value of resistance is used to calculate the gas concentration. Gases like Methane, Propane, i- butane, Alcohol, Smoke, LPG and also hydrogen can be detected using this module. There are 2 output pins (digital one and analog one).

F. Temperature Sensor

It can measure temperature as well as humidity present in a room. Its range is less than 20 meters. It has a negative temperature coefficient (NTC) element and a humidity-sensitive element which is used to measure temperature between 0-50 degree Celsius.

3. Software Design And Implementation

A. Software Design

We have used three different Software for programming and controlling. IDE is an open-source software which is not only used for writing programme but also for uploading code to Arduino. Android application for ESP8266-01 is available in the play store(Android smart phone) provides a platform to control different loads. This will only work if it is connected to the IP address and the port which is provided by the ESP8266-01 module as shown in Fig.5.User can customize the application like load name, number of loads, its ON duration etc. For controlling ESP8266-01 through web browser or computer for real time notification ESPlorer is used (Figure.5 and 6).

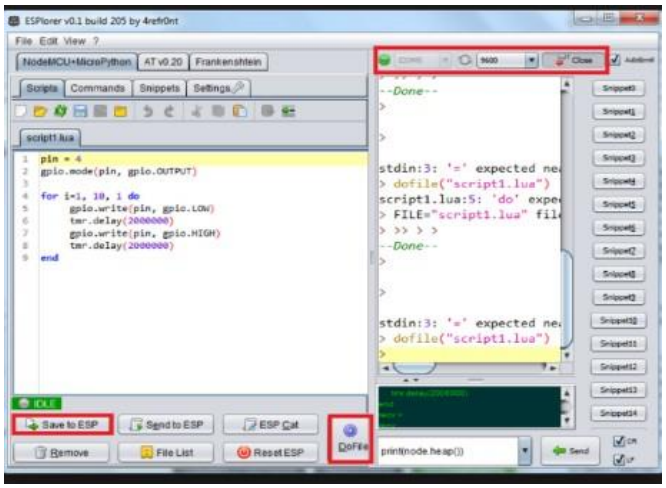

Figure.6: ESPlorer in windows

Figure.5: IP address and port for connection

B. Implementation

Figure-7 is providing idea of overall operation of the system. Initially through Arduino programming, the system checks the modules as well as their connections. If any kind of error is detected by the system then it will indicate the ERROR status. If no error is found then the system will indicate the status OK and proceed for establishing the connection with the local Wi-Fi. Here the system will again check whether the ESP8266- 01 module is connected to the internet. If there is no connection then the system will indicate the ERROR status or else the display will show status SYSTEM ONLINE and show the IP address. The system will wait for the signal and switch the load accordingly after receiving the command and update the display.

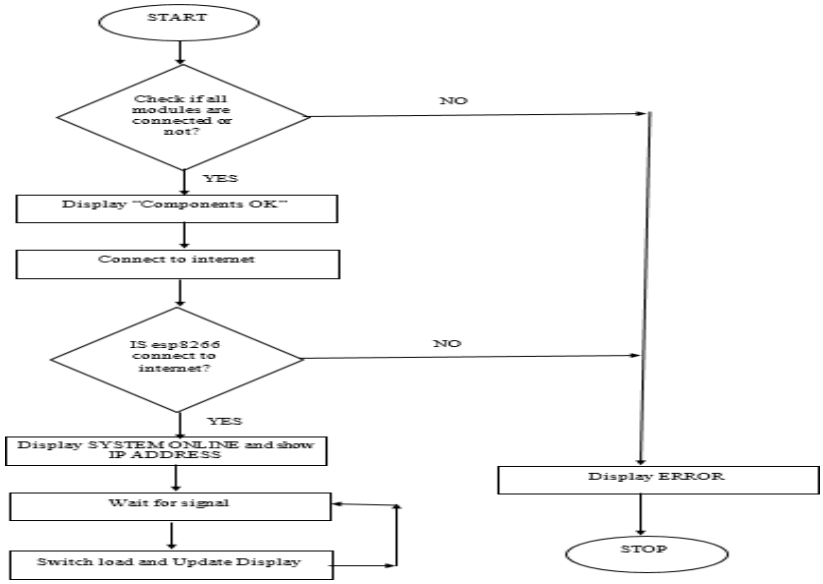

Figure.7: Flow chart of programme

To implements our home automation system we have to design a experimental setup as shown in fig. [11]. Where we use Arduino Uno as a main controlling unit. And a four channel relay board to control electrical home appliance. And we have to include a Wi-Fi module in our system to connect android and local Wi-fi present in the home of user. We have to test the experimental setup on various loads.

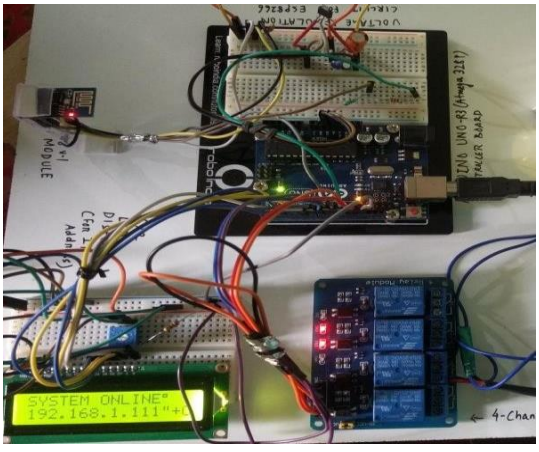

Figure.8. Experimental setup

Figure.9. GUI in android devices to control esp8266

4. Experimental Results

The IOT system we have to develop is tested in different load conditions for few houses (Figure.8). After installing the experimental setup, the user needs to install the software to his/her laptop or android phone. After proper installation of the provided software the16X2 LCD display will show the IP address. After IP address and port address are obtained user can login from the android application (Figure.5). As soon as the setup is completed, a home page will appear, from which the user could keep a track of all the electronic and electrical devices which are connected with the server as shown in figure .9.

5. Conclusion and Future Scope

In this paper we have to focus on different process of operating or controlling electrical and electronic appliances remotely with the help of Arduino. This method of controlling such applications is referred to as automation. The experimental setup which we designed has its focal point on controlling different home appliances providing 100% efficiency. Due to advancement in technology, Wi-Fi network is easily available in all places like home, Office Building and Industrial Building so proposed wireless network easily controlled using any Wi-Fi network. The wiring cost is reduced. Since less wiring is required for the switches. This also eliminates power consumption inside the building when the loads were in off conditions. This system is also platform independent allowing any web browser in any platform to connect ESP8266-01.

The system is fully functional through android application known as “ESP8266 Wifi control”. The delay to turn ON is 3 sec and turn OFF is 2 sec for any load.

For future use, the researchers would recommend as : (i)Reducing the time delay to turn on and off of an appliance. (ii) Adding speech recognition to the system.
(iii) using automatic smart phone detection through Wi-fi such that it will operate the loads automatically when it is in range.
(iv) Expansion of range of Wi-Fi such that one can operate in permissible long distance through smart phone.