

Wireless Building Automation Using ESP8266: An Energy Efficient Approach

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Abstract: With the growing security threat in the country the need of a centralized controlled security system has become necessity of time. In this project we designed a secured Wireless Building Automation System (WBAS) using *Esp8266* module (IOT: internet of things). The system is controlled through webpage which is connected to the microcontroller (Arduino) operating all loads by an *Esp8266* module (a long range Wi-Fi module). The building security webpage can be accessed by authorized people and loads can be controlled according to their requirements from anywhere in the world. This not only secures the building but also make it helpful in energy management of the building, saving much energy. In addition, this system is not only financially beneficial to the company or the owner, but also is a great initiative to reduce the energy crises in the country. In addition, it is cost efficient, due to the cheap *Esp8266* module. Our objective is to implement a low cost, reliable and scalable Wireless Building Automation System (WBAS) that can be used to remotely switch on or off any building loads, interfacing a controller and hardware simplicity. We developed a prototype mainly aimed on the lights and the locks of the buildings to elaborate the effectiveness of the proposed approach.

Keywords: ESP8266 Module, Wireless Building Automation System, Smart Building, Arduino

I. INTRODUCTION

The security crisis in our country and all over the world has made building controlled security system essential. We designed a building security system which not only wirelessly controls and protects the building but also is able to control power to the appliances and devices such as lights, locks, motors, alarms etc. Therefore, we will be able to minimize and protect the building from any kind of theft and manage emergency lightning, alarms and automatic door locking. Automated door locking system is used to ensure that only those persons (who are permissible to enter) may go through the gates. This will be highly useful in places like research, secret agencies, military premises etc. Wireless building automation as the name specifies is the automation using the internet. We are basically using an *Esp8266* module to connect the load side to the internet and then controlling the loads using the website. [1]

Wireless building automation reduces energy consumption and operating costs. Furthermore, it increases security and comfort. Wireless technology is indeed very essential to a flexible, efficient building automation at minimized installation time and system cost. There are many tasks in industry, office buildings and within the home which are done on routine basis and are manually done intensively that would benefit from the accuracy and reliability of wireless automation. The concept of smart building is an ever-increasing reality with domestic lighting and temperature. [2].

II. PROPOSED APPROACH DEVELOPMENT

The project comprises of the Load Side components and User Side development including coding of both ends. Below Fig. 1 explains the user side and load side in detail.

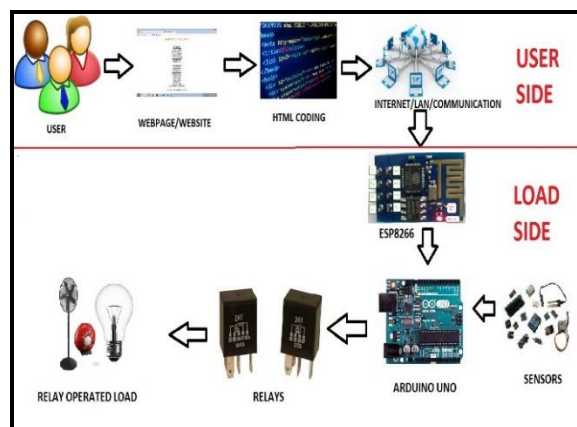


Fig. 1 Depiction of Load and User Side

A. Load Side Components

Load Side is the portion of the setup where the lights and lock motors are connected to the Arduino and further to the *Esp8266* module (IOT module) through the components specified in this part. Each component in this side has its importance, each component plays a distinct role and with any component missing, the load side would not give the required results. Load Side requires coding of the components using Arduino IDE software. The components of the load side are:

1. **Arduino** an open-source prototyping platform based on easy-to-use hardware and software.
2. **Sensor** is a device that detects and responds to some type of input from the physical environment.
3. **Relays** are electromagnetic devices which are used to isolate two circuits electrically and connect them magnetically.
4. **Buzzer** is an audio signaling device.
5. **Transistor** is a semiconductor device used to amplify or switch electronic signals and electrical power.
6. **Esp8266** is an impressive, low cost Wi-Fi module.

(i) Esp8266 Module (IOT)

Esp-8266 Wi-Fi Module Esp8266 is an impressive, low cost Wi-Fi module. It is highly integrated chip designed to provide full internet connectivity in a small package. Esp8266 can be used as an external Wi-Fi module. It uses the standard AT Command set by connecting it to any microcontroller. The module accepts commands via a simple serial interface. It then responds back with the operation's outcome (assuming everything is running correctly). Also, once the device is connected and is set to accept connections, it will send unsolicited messages whenever a new connection or a new request is issued [3].

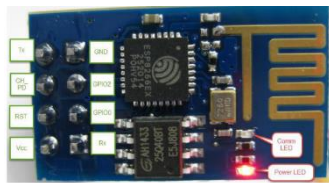


Fig. 2 Esp8266 Module

B. User Side Development

The User Side comprises of web development and no components are required for user interfacing. The web development in our project is very easy. The webpage is written in a normal notepad, anyone using a computer can build it without any difficulty. The major role is played by the 'jquery' which is the working part of the web site (this part actually works behind the webpage) [4]. We have included modes in the website which includes emergency mode, night mode, peak mode, holiday mode and morning mode which monitors the system loads accordingly, making the system energy efficient. For showing the energy management and feedback on the website, it can be done with more efficient html coding.

C. Work Flow through User to the Load Side

In our project the work flow starts when the user uses the website or clicks on any button on the website the signal through the internet using the internet protocol (IP) given in the web html coding communicates with esp8266 module. The blue light blinks on the esp8266 when it receives a signal from the webpage. The Arduino reads the signal and the coding decides the pin to be high or low. Thus, the load connected to the specified pin is operated accordingly.

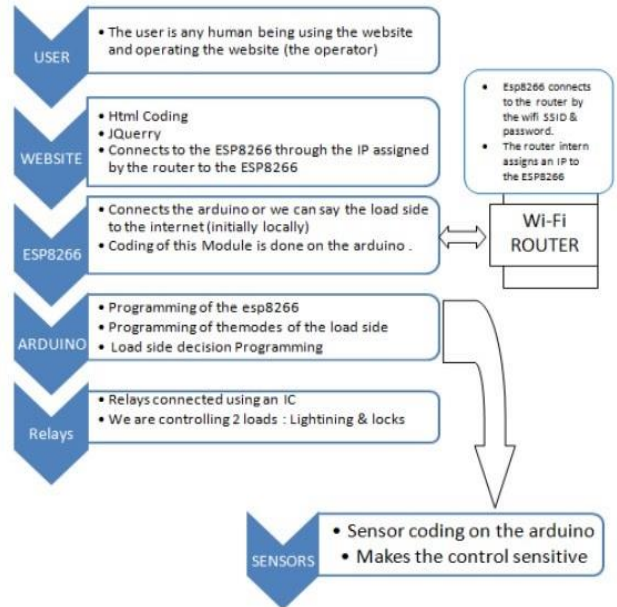


Fig. 3 Work Flow Chart of Project Working

III. PROJECT PROTOTYPE AND INTERFACING

A. Interfacing between Esp8266 Module (IOT) and Arduino UNO

The interfacing of Esp8266 and Arduino UNO requires a voltage divider of 10k by 10k, LF33 and LF7805 IC. Transmission (TX) of Esp8266 is connected to Receiver (RX) of Arduino (Pin 6). Receiver (RX) of Esp8266 by a voltage divider of 10k by 10k is connected to Arduino's TX (Pin 7), voltage divider is used for voltage adjustment or else they do not communicate showing garbage on serial monitor. The Ground (GND) is connected to Arduino's ground. Through 5 volts' power supply, LF33 and LF7805 we gave VCC of Esp8266 3.3V (LF33 is a very low drop voltage regulator which inhibit 3.3V 1A and LF7805 is a voltage regulator for 5V, 1.5A). CH_PD is connected to 3.3 V by using the two IC's. Other pins of Esp8266 are not connected in our project.

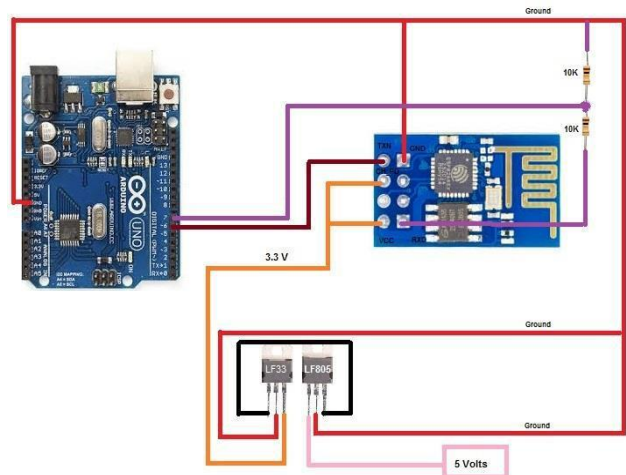


Fig. 4 Interfacing between Arduino and Esp8266 Circuit

B. Interfacing of User Side with Load Side

The interfacing of user side with load side is very important because if they are not interfaced, signal sent by a webpage will never be received by the load side. The Esp8266 is basically a module which connects the Arduino or we can say the load side to the internet. The load side is assigned an IP (Internet Protocol) using which the webpage communicates with the load side. A part in the Arduino coding specifies the SSID & Password, configures as access point, connects to the internet and gets an IP from the router. The code is as follows:

```
sendCommand("AT+RST\r\n", 2000,DEBUG);
// reset module
sendCommand("AT+CWMODE=1\r\n",1000,DEBUG);
// configure as access point
sendCommand("AT+CWJAP=\"SSID\",\"Password\"\r\n",3000,DEBUG); // SSID & Password
sendCommand("AT+CIFSR\r\n", 1000,DEBUG);
// get IP address
```

The IP which is assigned to the Esp8266 or the load side is shown on the serial monitor of the Arduino IDE software. The IP address of the Esp8266 makes webpage communication with the load side easier. IP assigned to the load side is placed in this line of the webpage code as:

```
$.get("http://172.20.10.3:80/", {pin:p}); // execute get
```

To execute the *get* request we require the IP so we placed the IP here. Whenever a button is pressed on the webpage, first the "var p" checks the pin number and the get request executes using the IP and then the Esp8266 receives a signal with the pin number from the webpage. After the data is received through Esp8266 the Arduino checks the pin and switches on/off the loads according to the button pressed.

C. Prototype Development

Initially we controlled one AC bulb as the interior lighting and one led panel as the exterior lighting using the Esp8266. The initial approach was the control of AC loads. The load side circuit and load modeling was different as shown below.

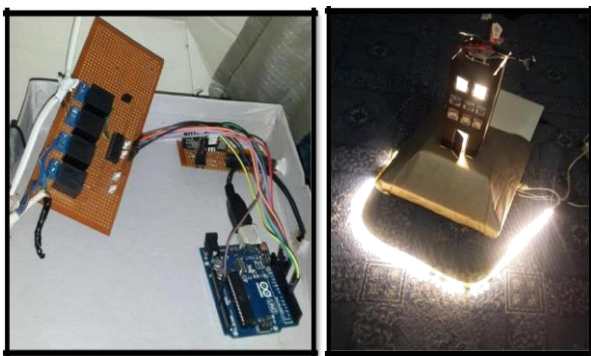


Fig. 5 Initial Circuit and Model of Load Side

In the final prototype we presented one floor of an office building which needs high security. We have placed doors without handles as they are only controlled by the website as it is the floor which needs most security and we placed DC lights to light up all the areas. The figure below shows the working prototype and AutoCAD 2D plan of the prototype.



Fig. 6 Final Prototype View

IV. DISCUSSIONS

New mobile devices provide built in microcontrollers for controlling and monitoring appliances. There are built in smart remotes found in the new smart phones. Indeed, it is a great success. After few years' internet of things will be the only field of research, development and implementation. It would be more like things connected to different things using the Internet. The society will shift to this comforting era very soon. Therefore, we choose one of the IOT modules Esp8266 for our project and research. Troubleshooting was required on regular bases as Esp8266 is internet dependent so there were times when router was unable to assign IP to the Esp8266 causing loss of communication between the load side and the user. Difficulties were faced while powering the Esp8266 module as it was a new module; the problem was solved by using the voltage divider and IC's. Uploading the code at times can test your patience. To make the project more efficient and avoiding any circumstance of switching off the loads in the presence of authorized people we can install internet based cameras viewed by authorized people using the website.

IV. CONCLUSION

The idea of WBAS is a great step in the world of *internet of things* for security issues and energy management. Above all, the proposal of WBAS is a cost efficient approach (due to Esp8266 Module) along with security and control. In this project there will be visible saving in energy consumption of the building making it beneficial for the company it belongs. The system is highly secured that cannot be operated without the permission of trusted person. The website is not published and specifically owned by the user so it is free from cyber-crime, only the owner has all the files on his/her computer or laptop. We worked on local network

therefore no security measures are required. The website will be coded accordingly to enter username and password if the website requires to be published. In future, certain advancements are required which will make it more effective, efficient, smarter and more systematic. This is the extension of the idea of Smart Home which can be further extended to make it Wireless Smartest Building Automation System. The extension will have the same setup with more sensors, feedback on the webpage, updated status of the loads on the webpage and more reliable internet (special purpose for the load side). This extension of the WBAS can be done by more research, prototype build up and testing of real system installations.

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