Control of Home Appliances using IoT

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Abstract: Automation stays an essential primary focus in practically all fields today and most IoT advancements are centred on redesigning M2M (Machine to Machine) command over manual undertakings. This paper presents an automation system for the household. This can be applied for any household independent of size and the number of appliances. In this paper a framework is designed which is based on the NodeMCU board. The NodeMCU is an IoT specific product with an inbuilt Wi-Fi module. This board is designed by EXPRESS IF with their own Wi-Fi module The ESP8266. Here the framework comprises of a NodeMCU and three relays connected to three relays, these loads can be anything from a simple lamp to an intelligent air conditioner. Here we take a fan, bulb and a DC motor. The main factor in picking this framework is its effortlessness and adaptability to change as per the requirement. The control of these loads is done through a webpage designed using HTML. Here the NodeMCU acts as a local server hosting all the clients that is connected to the network. When executing for the first time NodeMCU will return an IP address utilizing which we can get to the website page. The IP got here can be used as URL to load the page in any browser that is available in your mobile phone or a PC. It is feasible to plan the website page depending on the need of the house. The usage of all the appliances can be monitored and controlled on the webpage. All the devices are connected using the mesh protocol. As we can control and monitor the appliances remotely without a particular device designated for the same purpose this system turns out to be the best. It also helps us to conserve electricity by reducing the usage of electricity.

Keywords: NodeMCU, ESP8266, Wi-Fi, URL, HTML, Home Automation, IoT.

I. INTRODUCTION

[12][25] Smart home is a typical utilization of Internet of Things (IoT) Technology. It acknowledges the house as a stage, utilizing the joined wiring innovation, network correspondence innovation, and security innovation and programmed control innovation to create a gainful, pleasing, ensured, beneficial and financial cordial living experience environment. With the all over usage of advances that are solidly related to IoT, for instance, distributed computing, profound learning and remote sensor organizations, smart home has very critical improvement potential in future years [12][25]. Disabled people in general face many problems in their everyday

life. One of the problems they frequently face is controlling the home appliances without another person's help. Here in this paper this problem is addressed and a home automation system is designed and implemented to solve this problem. In this case unlike many conventional methods the complexity of the system is very low hence the maintenance and cost is also low. Unlike many other frameworks there is no need to use a particular device for controlling the appliances remotely; any device which can access a Wi-Fi network and open a webpage can do the monitoring and controlling. [18] These systems are arranged with a singular 8-or 16-piece microcontroller; they have little hardware and programming intricacies and incorporate board level construction. They may even be working with the assistance of a battery. When making embedded programming for these, a publication director, building specialist and cross developing specialist, unequivocal to the microcontroller or processor used, are the essential programming mechanical assemblies. By and large, 'C' is utilized for developing these systems [18]. The NodeMCU we use is the ESP8266. The ESP8266 is an easy-to-understand and user-friendly gadget for internet connectivity for our project and as we use mesh protocol to connect the devices to the NodeMCU the devices can also transfer and receive commands among themselves. [22] The module can work both as an Access point (can make area of interest) and as a station (can interface with Wi-Fi), thusly it can without a doubt bring data and move it to the web causing the Internet of Things as basic as could it normal. It can similarly bring data from the web using API's subsequently our undertaking could get any information that is available through the web and also from the other nodes connected to it [22], in this manner making it more keen. We utilize a PIR sensor to associate the security based machines in the house. A Passive Infrared sensor is a sensor that activities infrared light radiating from objects in its field of view. They are by and large used in security alerts and customized or programmed lighting applications. A PIR-based development identifier is utilized to perceive the headway of individuals, creatures and different things. We use a relay for connecting the appliances to the circuit board. A relay is an electromagnetic switch that is used to kill on and turn a circuit by a low power signal, or where a couple of circuits ought to be compelled by one sign. A DC motor is used to connect the appliances which may need a regulation in the speed. One end of the DC motor will be connected to relay and the other part to fans etc. [16] A machine that changes over the DC electrical power into mechanical power is known as a Direct Current engine. The DC engine working relies upon the standard that when a current-conveying conductor is placed in an attractive field, the conductor experiences a mechanical force [16]. All these are connected using Wi-Fi mesh. The devices can be accessed through a webpage from any device. The mesh protocol is one of the safest and most reliable protocols for our system. It allows us to connect all the devices to each other. The residents will be provided with their login credentials.

II. RELATED WORK

The existing model consists of a framework where the appliances are controlled using an IR-based remote control device. They are also controlled using claps and gestures. As per our survey, a lot of techniques have been used previously which had their benefits and drawbacks. [12]A home automation system was developed where MQTT protocol has been used which comprise of complexity in the system which was developed. As it had a lot of hardware requirements apart from the appliances present in the house. They were developed either for checking hazards in the environment or for commercial purposes [12]. A system with Access Control List (ACL), Constrained Application Protocol (COAP) was made which gave access to the user in a limited level and also helped people to connect low bandwidth devices to the system. A system with low power wide area network automation was developed where we can connect a limited number of nodes to the system. A system with MQTT publisher/subscriber protocol was made. [13][23]The primary idea of this exploration work is trying to improve MQ-Service parts, which are utilized to tie associated way other programming applications with the goal that they can work in an associated way [13][23]. A smart GSM-based smart home system was developed where SMS was the mode of communication. A PIC microcontroller was used to control the entire system. They had remote access to all the devices. A system with ZigBee Transceivers was developed where Differential Pulse Code Modulation (DPCM) and Analog to Digital converters (ADC) were used to provide voice commands to operate the devices connected to the system. [6]A system with Bluetooth to control the devices is made where Ad-hoc communication took place. To control the appliances in the house a pairing between the controlling device and the main system was made. Such security might be a threat as any device with Bluetooth can be paired [6]. [10]A framework with TI Wi-Fi CC3200 Launchpad is created. The effect got by slanting toward this framework over the basically indistinguishable sorts of existing designs is that the alarms and the

status sent by the Wi-Fi related microcontroller-related construction can be gotten by the client on his portable from any distance whether his cell phone is connected with the web [10]. [7]A comparison between different home automation protocols was made. X10, ZWAVE, ZigBee, EnOcean, Insteon, and Wi-Fi were part of the comparison. EnOcean is one of the most current advancements in home automation, fundamentally focused on zero energy utilization through energy harvesting [7]. Wi-Fi was the most feasible part which was low cost and had a higher bandwidth. We have developed a system with Wi-Fi and the Wi-Fi module NodeMCU ESP8266. The appliances can be controlled through a webpage.

III. PROPOSED MODEL

Wireless Fidelity (Wi-Fi) is changing into preferred technology as an alternate to Zigbee and Bluetooth. Wi-Fi plays a major role in our project. All the devices are interconnected using Wi-Fi. The NodeMCU gains access to all the components of the house through Wi-Fi. In this paper, we use the ESP8266 as the NodeMCU. All the appliances are connected to the ESP8266 through the relays or PIR sensor. This system can be controlled by using a webpage. This webpage is created using HTML. It is accessible from any device. The NodeMCU serves as the local host for the entire system. The webpage can be used to monitor and control the appliances. Thus the person who wants to control the appliances can open the webpage on his smartphone or his Desktop/Laptop. The NodeMCU is connected to the relays which is an electromagnetic switch that is used to activate or deactivate a circuit by a low force signal, or where a couple of circuits ought to be compelled by one signal. This system ensures secure data transfer as the login credentials of the webpage controlling the household is known only to the people residing in the house. The data can be transmitted in a fast way as Wi-Fi has a high transmission rate. As the webpage is updated in real-time it will be easy for the residents to monitor the working of the appliances in real-time. This also helps us to reduce the consumption of electricity as we can know the usage of unwanted appliances in the house.

IV. ARCHITECTURE DIAGRAM

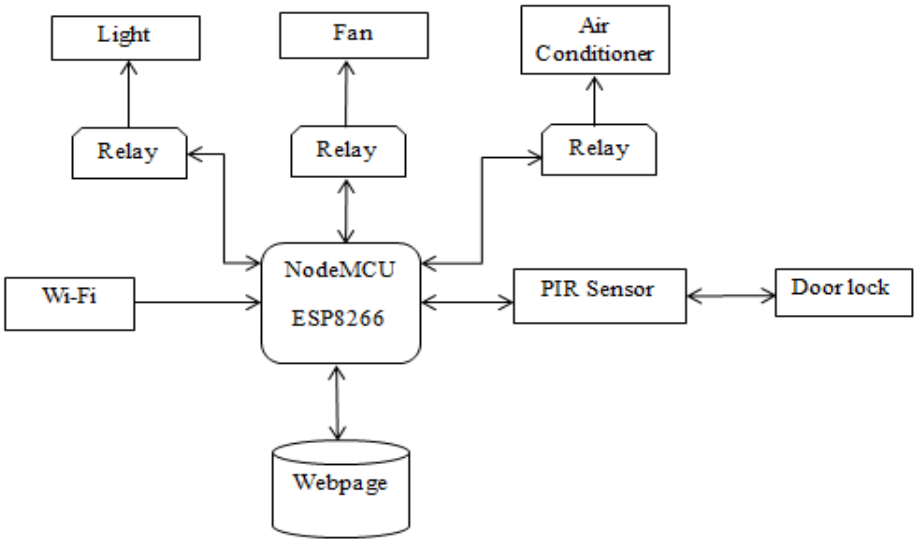

FIG. 1 Architecture diagram

As given in Fig. 1, This model highlights a framework that consists of the NodeMCU ESP8266, PIR sensor, Relay, DC motor, which is connected wirelessly through Wi-Fi and accessed using a webpage which is created using HTML. The NodeMCU is the main part of the system. The ESP8266 is used as the NodeMCU in this system. This provides internet connectivity to the system. It acts as a station. It is connected to other devices using a relay. This relay is associated with the appliances that are available in the house. The relay is associated with the ESP8266 by interfacing the ground of the ESP8266 to the negative of the relay, the supply to the positive of the relay and the digital to the input of the relay. The ESP8266 is powered by Wi-Fi. The ESP8266

acts as the access point and provide Wi-Fi network to other appliances. A PIR sensor is also connected to the ESP8266 which is connected to the system that requires security cautions and appliances that can work automatically. This is related by interfacing the VCC of the PIR to the +3v of the ESP8266, the yield of the PIR to the electronic pin of the ESP8266, Ground of the PIR to the ground of the ESP8266. The ESP8266 collects all this data and sends it to the webpage where the resident can control and monitor the appliances that are connected to it.

V. MODULES

5.1 ESP8266-

ESP8266 is a powerful chip required for the necessities of the interconnected world. It offers a free Wi-Fi figuring out arrangement, allowing it to either have the application or to offload Wi-Fi sorting limits from another processor. ESP8266 has an improvised on-board processing and storage abilities that allows it to be incorporated with the sensor-specific gadgets through its GPIO with in significant improvement in advance and high negligence loading during runtime which can be seen in Fig. 2.

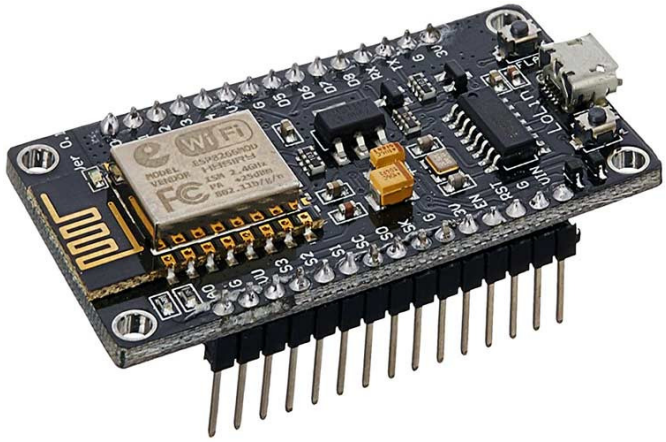

FIG. 2 ESP8266

5.1.1 GPIO Pins-

[17]NodeMCU Development pack gives admittance to these GPIOs of ESP8266. The only thing to take [17] care of is that NodeMCUDev unit pins are numbered uniquely in contrast to inward GPIO documentation of ESP8266 as demonstrated in Fig. 3 and table 1. For instance, the D0 nail to the NodeMCUDev unit is planned to the inward GPIO pin 16 of ESP8266.The general purpose input/output pins that appear within the blue box (1, 3, 9, 10) are generally never utilized for General purpose input/output reason on [17]Development Kit. ESP8266 is a framework on a chip (SoC) plan with segments like the processor chip [17]. The processor has around 16 GPIO lines, some of which are used inside to interface with various sections of the SoC, like streak memory. Since a couple of lines are used inside the ESP8266 SoC, we have around 11 GPIO pins staying for General Purpose Input/Output. 2 pins out of 11 are everything considered for receiving and transfer of chat with a host PC from what accumulated article code is downloaded.

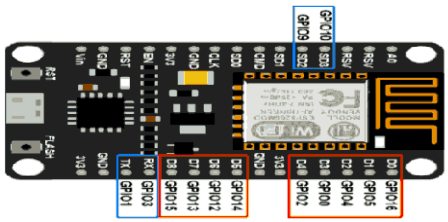

FIG. 3 ESP8266 GPIO Pins

Pin Names on NodeMCU Development Kit	ESP8266 Internal GPIO Pin number
D0	GPIO16
D1	GPIO5
D2	GPIO4
D3	GPIO0
D4	GPIO2
D5	GPIO14
D6	GPIO12
D7	GPIO13
D8	GPIO15
D9/RX	GPIO3
D10/TX	GPIO1
D11/SD2	GPIO9
D12/SD3	GPIO10

Table 1 Pin Description

[17] Thus finally, this leaves just 9 comprehensively helpful I/O sticks for instance D0 to D8. As shown in the figure 3 of the NodeMCUDev Kit. We can see RX, TX, SD2, and SD3 are not by and large used as general purpose Input/output since they are used for other internal cycles. However, we can endeavour with SD3 (D12) which for the most part likes to respond for general purpose input/output/pulse width modulation/interrupt like limits. Note that D0/GPIO16 can be simply used as general purpose input/output read/create; no extraordinary limits are maintained on it [17].

5.1.2 Power Requirements-

[15]As exhibited in Fig. 4. the voltage at which the ESP8266 works is 3V to 3.6V, the board accompanies an LDO voltage controller to keep the voltage consistent at 3.3V. It can dependably supply up to 600mA, which

ought to be a sizable amount of at the point when ESP8266 pulls as much as 80mA during Radio frequency transmissions. The yield of the regulator is moreover broken out to one of the sides of the board and set apart as 3V3. This pin can be used to supply ability to external parts.

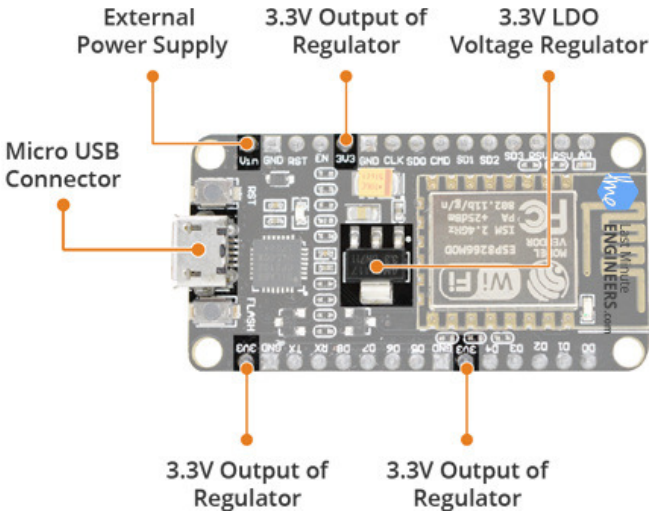

FIG. 4 ESP8266 Power Pins

Capacity to the ESP8266 NodeMCU is given through the locally available Micro USB connector. Of course, if you have a managed 5V voltage source, the VIN pin can be utilized to straightforwardly supply the ESP8266 and its peripherals [15].

5.1.3 ESP8266 and Mesh Protocol-

The mesh protocol is a convention wherein every one of the gadgets is associated with one another. This should be possible by utilizing the painlessMesh library. This library assists us with associating the gadgets to the ESP8266 utilizing the mesh protocol. The hubs that are available in this organization don't need a focal gadget. The gadgets are liable for the transmission of information between themselves. They can self-arrange themselves and impart inside them for the exchange of information from the underlying gadget to the last gadget. They can coordinate themselves if any of the gadgets is debilitated or eliminated from the organization.

5.2 PIR Sensor-

The term PIR is the truncation of the Passive Infra-Red sensor. The clarification "passive" shows that the sensor doesn't sufficiently share then, which proposes, it do not bestow the induced Infrared signals on its own, rather idly perceives the IR radiations coming from the human body in the wrapping zone. IR radiation is the pieces of the electromagnetic arrive at that has frequencies not as much as microwaves and more than the obvious light frequencies. It has a dome like structure as shown in Fig. 5. The infrared locale is from 0.75um to 1000um and the IR radiates are too little to even think about evening consider being seen with naked eyes. If the recurrence zone is from 0.75 to 3 um – it is called as close to IR; the domain from 3 to 6 um is the mid-infrared; and, expecting the zone is higher than 6 um, it is the far-infrared.

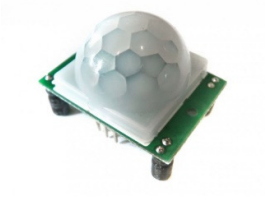

FIG. 5 PIR Sensor

The PIR sensors are more astounded than different sensors as they contain two openings. These openings are made of an exceptional material that is fragile to IR. The Fresnel point of assembly is utilized to see that the two spaces of the PIR can see out past some distance. [14]At the moment that the sensor is torpid, by then the two openings sense a comparable proportion of IR. The enveloping entirety radiates from an external perspective, dividers or room, etc. right when a human or animal travels by, by then, it gets the chief space of the PIR. This causes a non-negative differential change in between the two isolates. Exactly when a human leaves the recognizing territory, the PIR makes a non-positive differential change between the two isolates. The IR sensor itself is mantled in an impervious non movable metal to improve dampness/temperature/disturbance as shown in Fig. 6. There is a window that is made of regularly covered silicon material to guarantee the identifying part [14].

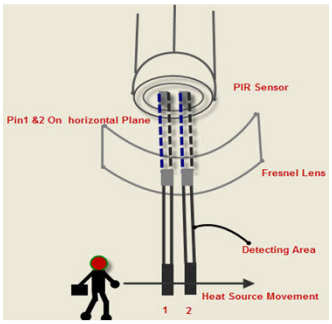

FIG. 6 PIR Sensor function

5.2.1 Pin Configuration-

[20]The Passive infrared sensors comprise three pins as demonstrated in the outline appearing in Fig. 7.

- The first pin relates to the source terminal of the gadget, which ought to be associated with the ground through a 100K ohm or 47K ohm resistor. The first pin is the yield of the PIR, and the IR signal which is recognized is conveyed forward to an amplifier from the first pin of the PIR.
- The second pin in fig. 7 of the sensor is associated with the ground.
- The third pin relates to the channel terminal of the PIR, which ought to be associated with the positive stockpile 5V DC.[20]

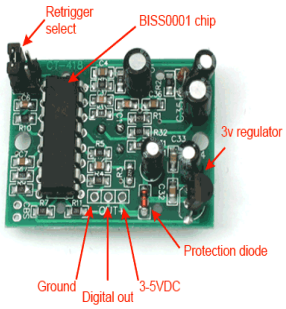

FIG. 7 PIR Pin description

5.3 Relay-

A Relay in Fig. 8 is an electromagnetic switch that is used to activate or deactivate a circuit by a low power signal, or where a couple of circuits ought to be compelled by one signal.[21] The crucial use of a relay comes in when just a low-power sign can be used to control an entire circuit. The relay is moreover used in where only one sign can be used to control a lot of circuits

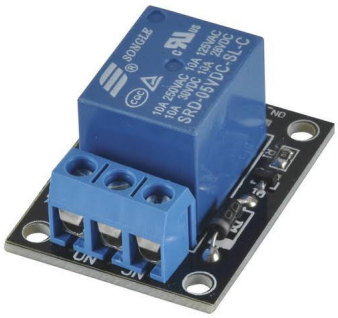

FIG. 8 Relay

The utilization of relays started during the improvement of telephones. They expected a huge part in trading gets telephone exchanges. They were similarly used in critical distance media transmission. They were used to change the sign coming beginning with one source then onto the following target. After the development of PCs, they were likewise used to perform Boolean and other lucid undertakings. They generally have excellent quality use of transfers requires a high capacity to be driven by the electric motors; and so on such relays are called contactors [21].

5.4 DC Motor-

A DC motor is utilized to associate the machines which may require a guideline in the speed. One finish of the DC engine will be associated with relay and the other part to fans and so on [16] a machine that has the capability to change the DC electrical power into mechanical power is known as a Direct Current engine. Its working relies upon the standard that when a current-conveying conductor is placed in magnetic field, the conductor experiences a mechanical force. It works under the guideline of Fleming's Left hand rule [16].

FIG. 9 DC Motor

5.5 Wi-Fi-

Wi-Fi plays a major role in the project by providing network connectivity to all the devices that are present in the framework. The NodeMCU ESP8266 gains access to all the components of the house through Wi-Fi. Wi-Fi utilizes radio frequencies to convey messages between gadgets. These signals differ from normal walky-talky, car radio or mobile phones as these send signals in Kilohertz and Megahertz but Wi-Fi sends the signal in Gigahertz. A WLAN Router will be connected to all the devices that are present in the home as in Fig. 10. As we use mesh protocol the ESP-Wi-Fi-Mesh is used to connect the devices that are present in the vulnerable regions of the house.

FIG. 10 WLAN Router

5.6 Webpage

We utilize a webpage to control the machines present in the house. This page is written in Hypertext Mark-up Language (HTML). The client will be furnished with the URL of the page. The inhabitants can utilize it in any Web programs to open the Webpage. This site page moves the information between the gadgets utilizing the HTTP convention. The ESP8266 that interfaces with a current Wi-Fi affiliation (the one made by our remote switch) are called Station as in Fig. 11. In STA mode ESP8266 gets IP from the remote switch to which it is connected. With this IP address, it can set up a worker and pass on Webpages to all connected machines under the current Wi-Fi affiliation.

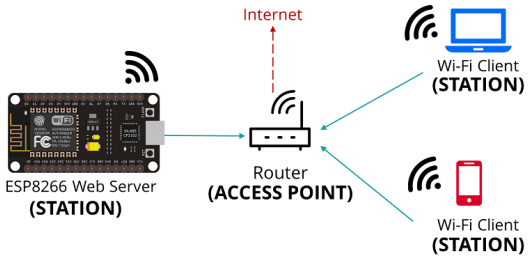

Fig 11. ESP8266 as Station

The ESP8266 that makes its Wi-Fi association and goes about as a hub for at least one station is called Access Point (AP). Rather than a Wi-Fi router, it doesn't have an interface to a wired affiliation. Consequently, such a technique for activity is called Soft Access Point (Soft AP) as in Fig. 12. Besides, as far as possible number of stations that can be connected with it is restricted to five. In AP mode ESP8266 makes another Wi-Fi affiliation and sets SSID (Name of the affiliation) and IP address to it. With this IP address, it can give site pages to all connected gadgets under its affiliation.

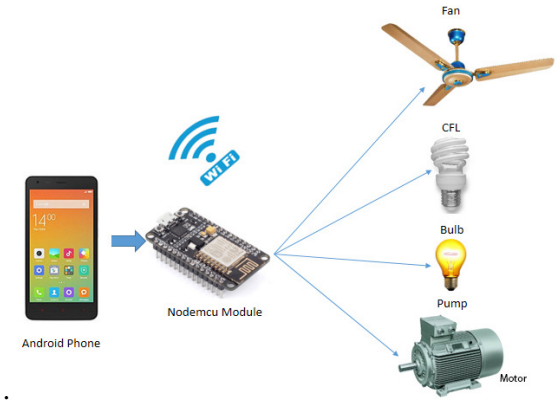

Fig 12. ESP8266 as Access Point

5.7 Mesh Protocol-

The mesh protocol is a protocol which can be utilized to interface gadgets to one another in an organization. Here we utilize a wireless mesh protocol as wired lattice convention is a costly strategy as it requires parcel of wiring to associate every one of the gadgets. It is likewise an impediment over the long haul. The mesh protocol is utilized as it is a safe cycle. We utilize the ESP-Wi-Fi-MESH which is utilized to convey between the gadgets in a remote way. We can interface up to 1000 gadgets and can contact the vulnerable sides where the Wi-Fi signal can't reach in the house. It utilizes standard Wi-Fi Protected Access 2 organization security among the gadgets. The Wi-Fi Protected Access 2 organization security utilizes Advanced Encryption Standard to ensure the information and they prescribe the clients to set long passwords with less rehashed characters.

VI RESULT

In the wake of transferring the sketch, open the Serial Monitor at a baud rate of 115200. Furthermore, press the RESET button on ESP8266. In this case, if all is great, it will yield the IP address acquired from your router and will display whether the HTTP server began or not as in Fig. 13.

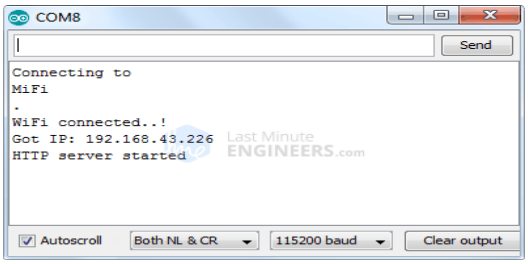

Fig 13. IP address Generation

- Copy the IP address which is being shown on the Serial Monitor and paste it in the browser of our framework (which is associated with a similar Wi-Fi organization).
- Use the ON and OFF button to send an ON or OFF order to ESP8266.

At that point open the program and copy the IP address from the monitor and we will track down the webpage. The webpage can be used to track down the device whose IP address is generated and produced by the Esp8266. We will get a screen as in Fig. 14 using which we can control the functionality of the device.

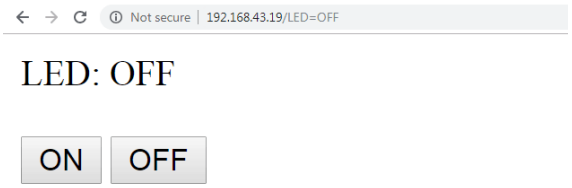

Fig 14. Output in the Webpage

VII CONCLUSION

In our project, we have created a framework to monitor and control the devices and components that are present in a house remotely using a webpage. This system provides a way for the devices to communicate with each other and work accordingly. We can also monitor the usage of a particular appliance/device and can reduce the usage of appliances that are not necessary. This system is most helpful for houses where differently-abled people are residing. Thus the usage of electricity can be reduced as there is an automatic way to switch on/off the appliances/devices. This project has been implemented and tested, it is very helpful in controlling home appliances. Since this system uses WIFI it is low power and low cost also easy to implement. The OS of the advanced mobile phone and PC controller program are associated with Wi-Fi to speak with the home machines. Remote control is the main essential requirement for all individuals. Remote organization controlled home appliances use Wi-Fi modules. The webpage will transmit commands using Wi-Fi to the home appliances so that it can control the required command like Fan ON & OFF, Bulb ON & OFF.

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