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Design and Implementation of a Wi-Fi-based Ceiling Fan Regulator System

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ABSTRACT

This paper presents the Design and Implementation of Wi-Fi- based Ceiling Fan Regulator System using Arduino Nano board and an ESP8266 Wi-Fi Module. It is born out of the need to provide a flexible and convenient means of regulating the speed of a ceiling fan without resorting to the manual means of doing same. The components used are: An Arduino Nano board featuring an Atmega 328p Microcontroller, an Esp8266 Wi-Fi Module, a coil inside an old manual fan regulator, a relay board comprising of four relays, a 3.3V regulated power supply unit and connecting leads. The appropriate drivers were installed for the boards while the necessary libraries were included on to codes written using the Arduino Integrated Development Environment (IDE). The 5V power supply from the Arduino board was taken on to the power board for regulation using the LM 1117 voltage regulator. The RST terminal of the Arduino board and the GPIO0 of the ESP8266 module were connected to GRD. The codes were uploaded on to the flash memory of the Wi-Fi module. Any Wi-Fi device can be used to select the speed of the ceiling fan through an interface designed using html language. The system proved very efficient and reliable for both office and domestic use within the required range of 40 - 300 feet.

1. INTRODUCTION

The determination for Wi-Fi control of ceiling fans both in homes and offices is the main focus of this design. Technology is rapidly growing in various directions and it has been necessary to apply it to all sections of human needs. This need has been so necessary in order to reduce stress and other inconveniences associated with switching on or off of ceilings fans either in our homes or offices. Wi-Fi control of appliances may include centralized control of fans, doors, lighting, and air conditioning. It also entails appliances and other security apparatus such as burglar alarms, motorized closed circuit television cameras in order to provide improved convenience. The idea of "Internet of Things" is globally becoming closely associated with the rapid commercialization of domestic and industrial automation [1]. Home automation can be realized through telephone line, wireless transmission, or the internet to provide control and monitoring via smartphone or browser. The idea of smart house concept was first conceived in the early 80's as a project of the National Research Centre of the National Association of Home Builders [2].

1.1 RELATED WORK

1.1.1 GSM OR SMS Based Home Automation System

In [3][4][5], a GSM or SMS based home automation is presented. In this design, a remote control system for electrical appliances and lighting is provided. A GSM shield is used for receiving short messages service from the user's cellphone which automatically enables an Arduino Microcontroller to activate necessary actions like switching ON and OFF of electrical appliances such as fans, air conditioners, lighting points etc.

1.1.2 BLUETOOTH Based Home Automation System

[6] Presents a Bluetooth based home automation system in which Bluetooth devices are used to connect to interfaces controlling connected home appliances and lighting. The design depends on a stand -alone Arduino Uno and Bluetooth board.

1.1.3 IOT Based Home Automation System

In [7], IOT based home automation system is presented. It uses a NODEMCU ESP866 Wi-Fi module which hosts a webserver. By connecting to the webserver through mobiles, tablets or PCs, the home appliance and lighting can be controlled through sets of relay drivers and switches.

2 MATERIALS AND METHODS

The proposed system comprises two main parts, namely; hardware and software. The hardware segment consists of: An Arduino Nano board featuring an Atmega 328P Microcontroller, an Esp8266 Wi-Fi Module, a coil inside an old manual fan regulator, a relay board comprising of four relays, a USB -to Serial converter, a USB cable, a 3.3V regulated power supply unit, connecting leads and Wi-Fi network to connect to. The appropriate drivers are installed for the boards while the necessary libraries are included on to codes written using the Arduino Integrated Development Environment (IDE). The 5V power supply from the Arduino board is taken on to the power board for regulation using the LM 1117 voltage regulator. The RST terminal of the Arduino board and the GPIO0 of the ESP8266 module are connected to GRD. Enable the Chip by connecting the CH_PD pin to V_{cc} through a 1k resistor. Nothing should be connected to the GPIO1 pin while the ESP8266 Wi-Fi is in the flash mode. A reset button is added by connecting one between the RST pin and ground. The codes are uploaded on to the flash memory of the ESP8266 Wi-Fi module. Thereafter, the GPIO0 pin is removed from ground in order to put the ESP8266 in to the normal mode. Any Wi-Fi device can be used to select the speed of the ceiling fan through an interface designed using html language. An android phone (Infinite Note 4) and a Dell Inspiron11 Laptop is used to send data to the esp8266 module which control the relay board on to which the fan control coil is connected.

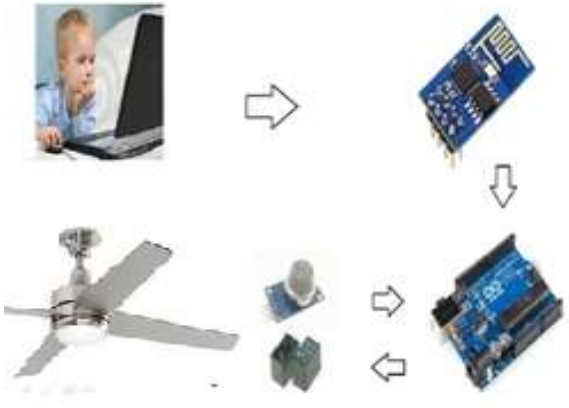

Figure 1. Block diagram of the Wi-Fi fan speed regulator system [7]

In figure 1, a PC or an Android Phone sends data to Esp8266 module which receives the data and passes it to the Atmega 382P microcontroller. The data is processed by the microcontroller which executes the necessary decision to activate the relay board. All the connected appliances are driven by the relay board.

2.1 Esp8266 Wi-Fi Module

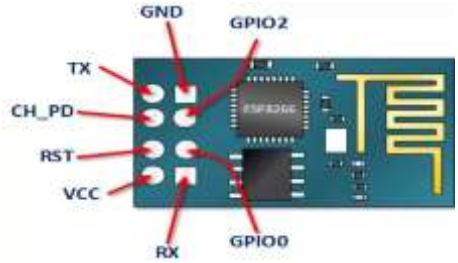

Figure 2. Pin arrangement of the esp8266 Wi-Fi module.

The Rx pin of the esp8266 module is connected to the TX pin on the Arduino board as defined in the set-up file. The TX pin of the Wi-Fi module goes to the Rx on the Arduino board. The Vcc should be connected to a constant 4.3 Volts d.c. The power requirement is necessary otherwise the Wi-Fi module will not work. The GPIO0 pin must be grounded while uploading codes onto the board. The RST pin should be connected to Vcc while the GPIO2 port is used as the general input and output channel.

2.2 Relay Board

Sending commands from software to turn ON/ OFF an appliance may not guarantee the correct operation of the appliance as the device may be defective. To solve this problem, a feedback circuit is provided to indicate the actual status of the device after it receives the command (ON/OFF) from the cell phone. Once a command is sent to turn ON a device, circuit senses the current and gives an output signal by turning ON a light emitting diode on the switching circuitry indicating the device is turn ON. If perchance the device is not turned ON when a command is sent, it indicates that the concerned relay is defective. Figure 3 and figure 4 shows the relay board and the switching circuitry of the relay board.

Figure 3: Relay Board

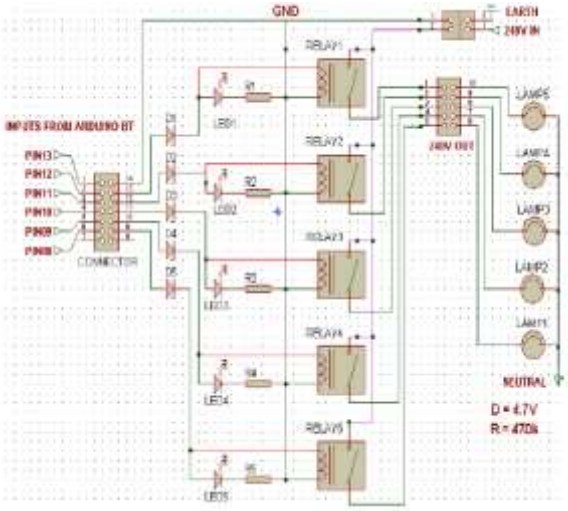

Figure 4. 5V -240 V switching circuit of the relay board [6]

2.3 Variable Power Supply Unit

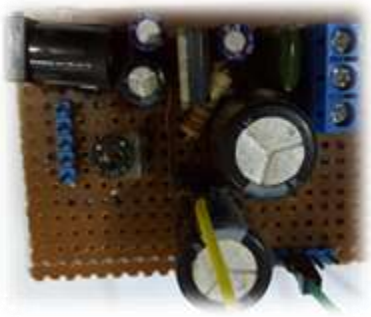

Figure 5. Variable Power supply unit used in the construction.

The power supply unit shown in figure 5 is obtained by connecting the 5V pin on the Arduino Nano board to an LM1117 voltage regulator which gives the stabilized 3.3V required to power the ESP8266 Wi-Fi module. The first pin of the regulator is connected to ground. A 10uf capacitor is placed between pin 2 (Vout) and ground. Also place a 10uf capacitor between pin 3 (Vin) and ground. Now the pin 2 of the LM1117 is connected to the 3.3V or the Vcc of the ESP8266 wi-fi module. The pin 3 of the LM1117 regulator must be connected to 5V pin of the Arduino Nano.

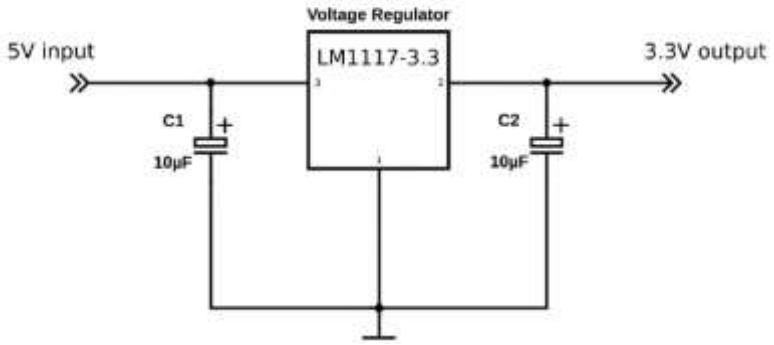

Figure 6. The circuit diagram featuring the 3.3-volt regulator.

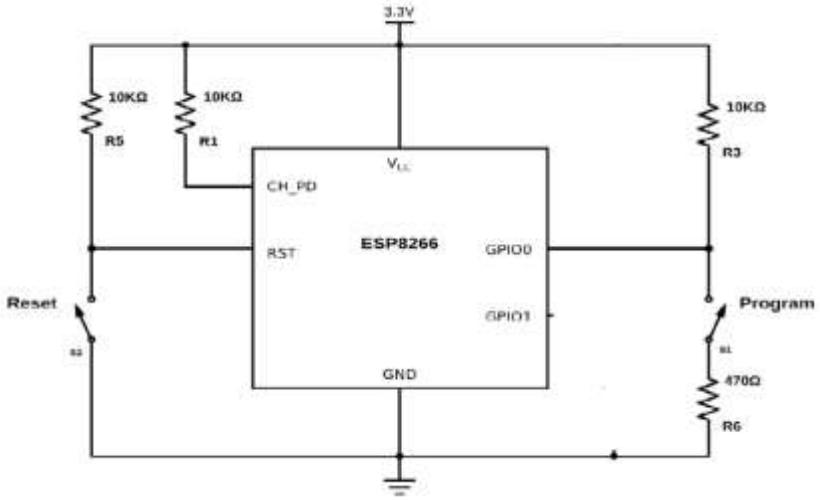

Figure 7. The ESP8266 wiring diagram

3 ARCHITECTURE OF THE SYSTEM

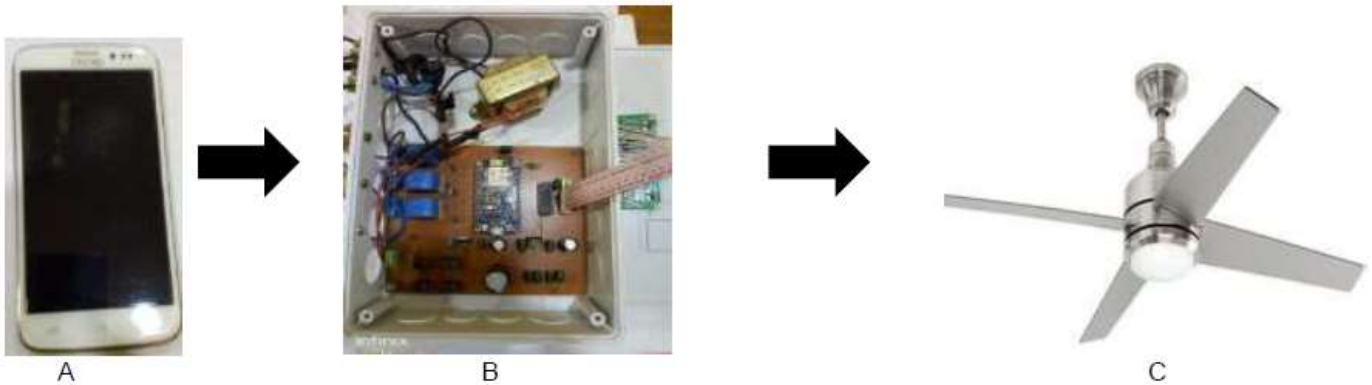

Figure 8. Complete system design of the wi-fi based fan speed regulator system.

In this system we have established a wireless connection between the application on the mobile phone and the Arduino esp8266 Wi-Fi module. Having established the connection, we send messages through a graphical user interface on the phone to the wi-fi module as shown in figure 6b. The data sent is processed and interpreted by microcontroller which sent control signals to the relay board to drive the lamps. In figure 6c, none of the lamps is activated. In figure 6c, only the white lamp is activated while in figure 6c, all the lamps including the 13A socket are activated.

4 GRAPHICAL USER INTERFACE (GUI)

The graphical user application allows user easily select the required command button to turn the fan on maximum speed or power off the fan. From the interface the user can also select medium speed or turn off the fan.

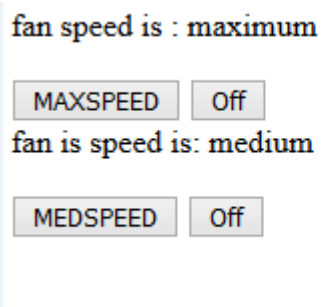

Figure. 9. Cell Phone Graphical user Interface for controlling the speed of the fan.

5. RESULTS AND DISCUSSION

The complete system is shown in figure 8. The system works by initializing the hot spot on the mobile phone and connecting the phone to the fan regulator as shown in figure 8. Once the wi-fi link is established between the phone and the fan regulator, any wi-fi enabled device can then be used to connect to the fan regulator through the default I.P address of the wi-fi module. Once the IP address is accessed, an interface is displayed through which the fan speed can be selected. On the interface, we have only provided two speed levels: the maximum speed and the medium speed as shown in figure 9. A computer system with a wi-fi facility was also used to control the speed of the ceiling fan.

6. CONCLUSION

In this presentation, we have designed and implemented a wi-fi based ceiling fan speed regulator. The system is protected against access from unauthorized users. The user is required to provide a username and password for authentication before access is provided to access the webserver hosted on the ESP8266 Wi-Fi module.

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