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IOT BASED ENERGY EFFICIENT CEILING FAN WITH BLDC MOTOR FOR HOME AUTOMATION

Jayasree N[1], Jomin M Jacob[2], Malik Ibnu Easa[3] ,Dr.Aji Joy

[1,2,3]*Student,Dept. of Electronics and Communication Engineering ,Mar Athanasius College of Engineering Kothamangalam, Kerala, India*

[4] Assistant Professor, Dept. of Electronics and Communication Engineering, *Mar Athanasius College of Engineering Kothamangalam, Kerala, India*

Abstract - *Brushless DC electric motors also known as electronically commutated motors or synchronous DC motors are synchronous motors powered by DC electricity via an inverter or switching power supply which produces an AC electric current to drive each phase of the motor via a closed loop controller. The controller provides pulses of current to the motor windings that control the speed and torque of the motor. This project results in the use of Wi-Fi module ESP8266 which is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability. Thus incorporating the Wi-Fi module and with the help of smart phones which are getting more compact and well equipped with every passing day. They have become a very strong tool when it comes to business. Integrating smartphones, BLDC motor and IOT technology to control home appliances is an effective way to save energy. Thus in this project we are trying to control the speed of BLDC motor ceiling fan with help of smartphones.*

Key Words*: *Wi-Fi, BrushlessDC, Internet of Things, ESP8266

1.INTRODUCTION

A brushless DC electric motor (BLDC motor or BL motor), also known as electronically commutated motor (ECM or EC motor) and synchronous DC motors, are synchronous motors powered by DC electricity via an inverter or switching power supply which produces an AC electric current to drive each phase of the motor via a closed loop controller. The controller provides pulses of current to the motor windings that control the speed and torque of the motor.

The construction of a brushless motor system is typically similar to a permanent magnet synchronous motor (PMSM), but can also be a switched reluctance motor, or an induction (asynchronous) motor.

The advantages of a brushless motor over brushed motors are high power to weight ratio, high speed, and electronic control. Brushless motors find applications in such places as computer peripherals (disk drives, printers), hand-held power tools, and vehicles ranging from model aircraft to automobiles.

1.1 Brushless VS Brushed motors

Brushed DC motors were invented in the 19th century and are common. Brushless DC motors were made possible by the development of solid state electronics in the 1960s.An electric motor develops torque by alternating the polarity of rotating magnets attached to the rotor, the rotating part of the machine, and stationary magnets on the stator which surrounds the rotor. One or both sets of magnets are electromagnets, made of a coil of wire wound around an iron core. DC running through the wire winding creates the magnetic field, providing the power which runs the motor. However, each time the rotor rotates by 180° (a half-turn), the position of the north and south poles on the rotor are reversed. If the magnetic field of the poles remained the same, this would cause a reversal of the torque on the rotor each half-turn, and so the average torque would be zero and the rotor would not turn. Therefore, in a DC motor, in order to create torque in one direction, the direction of electric current through the windings must be reversed with every 180° turn of the rotor (or turned off during the time that it is in the wrong direction). This reverses the direction of the magnetic field as the rotor turns, so the torque on the rotor is always in the same direction.

1.2 Brushless Solution

Brushed DC motors develop a maximum torque when stationary, linearly decreasing as velocity increases. Some limitations of brushed motors can be overcome by brushless motors; they include higher efficiency and a lower susceptibility to mechanical wear. These benefits come at the cost of potentially less rugged, more complex, and more expensive control electronics.A typical brushless motor has permanent magnets which rotate around a fixed armature, eliminating problems associated with connecting current to the moving armature. An electronic controller replaces the

brush/commutator assembly of the brushed DC motor, which continually switches the phase to the windings to keep the motor turning. The controller performs similar timed power distribution by using a solid-state circuit rather than the brush/commutator system.

Brushless motors offer several advantages over brushed DC motors, including high torque to weight ratio, more torque per watt (increased efficiency), increased reliability, reduced noise, longer lifetime (no brush and commutator erosion), elimination of ionizing sparks from the commutator, and overall reduction of electromagnetic interference (EMI). With no windings on the rotor, they are not subjected to centrifugal forces, and because the windings are supported by the housing, they can be cooled by conduction, requiring no airflow inside the motor for cooling. This in turn means that the motor's internals can be entirely enclosed and protected from dirt or other foreign matter.

Brushless motor commutation can be implemented in software using a microcontroller or microprocessor computer, or may alternatively be implemented in analogue hardware, or in digital firmware using a field-programmable gate array (FPGA).

2. LITERATURE REVIEW

Research papers related to the topic of BLDC motors and fans are studied. Conventional methods of speed control and torque variations are described in the literature review.

2.1 EXISTING TECHNOLOGY AND INTELLECTUAL PROPERTY

Brushless DC (BLDC) motors are widely used for many industrial applications because of their high efficiency, high torque and low volume. An improved Fuzzy PID controller to control speed of Brushless DC motor proposed by Arulmozhiyal & Kandiban (2012). The proposed controller is called proportional integral derivative (PID) controller and Fuzzy proportional integral derivative controller. The work provides an overview of performance conventional PID controller and Fuzzy PID controller.

Integrated environment for the rapid prototyping of a robust fuzzy proportional integral derivative (PID) controller that allows rapid realization of novel designs Proposed by Ahmed Rubaai et al (2008). Both the design of the fuzzy PID controller and its integration with the classical PID in a global control system are developed. The architecture of the fuzzy PID controller is basically composed of three parallel fuzzy sub controllers. Then, the parallel sub controllers are grouped together to form the overall fuzzy PID controller.

Fuzzy proportional integral derivative (PID) controller, which can be tuned by carrying the tuning rules from PID domain to fuzzy domain proposed by Asim Ali Khan & Nishkam Rapal (2006). As a nonlinear controller can control a nonlinear process more efficiently, fuzzy controller can provide better performance in terms of rise time and smaller overshoot. Design of fuzzy PID controllers based on theoretical fuzzy analysis and genetic-based optimization proposed by Baogang Hu et al (1999). An important feature of the proposed controller is simple in structure. It uses a one-input fuzzy inference with three rules and at most six tuning parameters.

2.2 PRESENT SCENARIO

The use of ceiling fan with BLDC motor is rare.Available remote control is based on IR.As the speed of fan increased for more airflow it generate more sound/noise.

2.3 OBJECTIVES AND SCOPE OF STUDY

The BLDC motors are considered more energy efficient than induction motors. The objective of this study is to design and develop an energy efficient ceiling fan which can be controlled by smartphone thus involving home automation The scope of this study is to commercially produce the product.

3. METHODOLOGY

It can be segregated into different sections although not entirely mutually exclusive.

3.1 Block Diagram

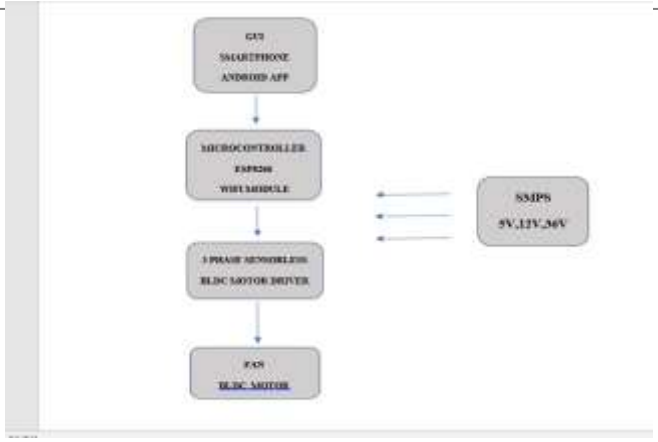

Fig -1: Block diagram

STEP 1: Motor control is enabled by the microcontroller within the ESP module.

STEP 2: The control signals are generated for speed and direction. The high efficiency of the BLDC motor is ensured by applying the PWM pulse for high frequency switching.

STEP 3: The microcontroller to drive board communication is enabled using a high speed serial communication.

STEP 4: An application in android is also developed for the user interface like ON/OFF and speed control. Since the motor driver is based on standard motor control and the controller is based on ES8266 the overall circuit is cost effective in volume production.

STEP 5: The home automation system can be extended to control lighting ,climate, entertainment systems and appliances . It may also include home security as access control and alarm systems. When connected with the internet , home devices are an important constituent of the Internet of things.

3.2 Configuring NODEMCU with Ardunio

IDE

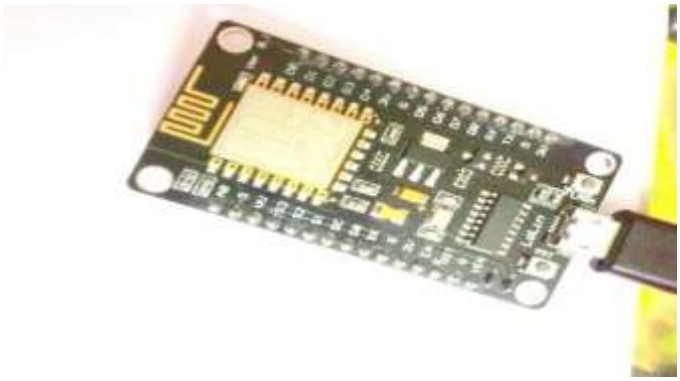

Fig -2: ESP8266

First of all connect the Nodemcu with computer or laptop.Now install the driver of nodemcu. After this open the Arduino IDE Click on "Tools" on Arduino toolbar.Click on "BoardSelect "Board Manager" and search for esp8266 install it .Now, select "Sketch" from arduino toolbar .Select

"Include Library" from there select "Manage libraries".Search for "IRremoteESP8266" and install it.

3.3 Decoding of IR Remote signals

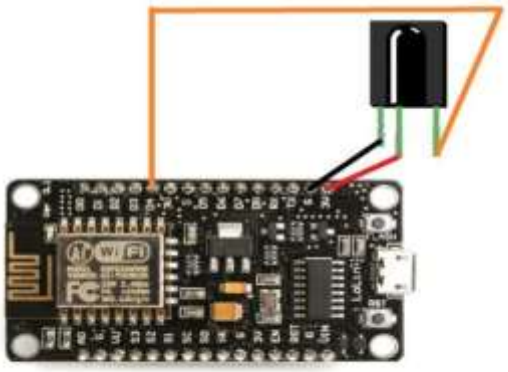

Fig -3:Decoding circuit

So components needed to decode a remote:

1. Nodemcu board

2. TSOP1738 IR reciever or some other IR recievers 3. Jumpers

Now, follow the above circuit but after uploading the sketch to the nodemcu through Arduino.Open Arduino and connect the nodemcu to laptop or computer.From "Files" select example go down and from IRremoteESP8266 select the IRrecvDump.Upload to nodemcu. Connect the TSOP1738 to Nodemcu as the circuit and open the "serial monitor" from Arduino to see the decoded hex-code of any remote .

3.4 Encoding ESP8266 Circuit

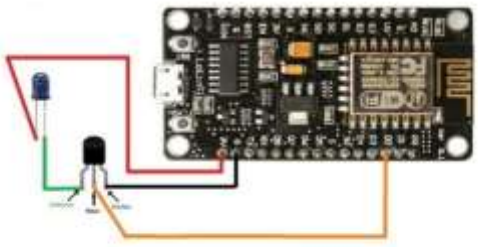

Fig -4: Encoding circuit

After decoding the remotes now it's turn to upload the hex-codes to Nodemcu so that it can give IR led commands to emit those hex-code signals. So need transistor moderated IR LED i.e. signal from Nodemcu goes to transistor then IR LED. Transistor like 2N222, 2N3904, BC547 works but Transistor 2N222,2N3904 collector current : 600mA,Transistor BC547 collector current : 100mA.

3.5 Encoding of IR Remote Signals Using ESP8266

Fig -5: Decimal conversion

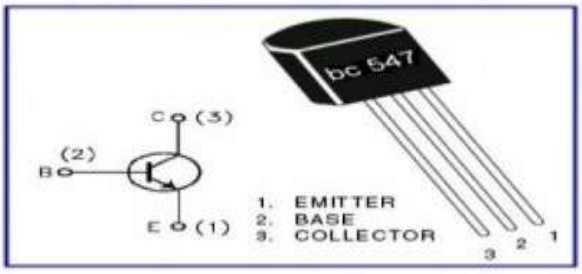

Fig -6: BC547

4.3 IR LED

A **light-emitting diode** (**LED**) is a semiconductor light source that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. This effect is called electroluminescence.

The code from examples of "IRremoteESP8266",

"IRserver".But there are some changes to be done your wifi credentials - Wifi ssid, Wifi password.The Web server based codes - This codes are the decimal form of the hexadecimal IR codes. This decimal values are passed to ESP8266 as arguments converted to hex-code and transmitted to IR LED.

4. COMPONENTS

Various components used in the circuit design is discussed here in detail. The major components include microcontroller, BC547 transistor, IR LED, IR sensor , voltage regulator, smartphone(mobile application).

4.1 ESP8266 Wi-Fi Module

The ESP8266 is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability. The ESP8285 is an ESP8266 with 1 MiB of built-in flash, allowing for single-chip devices capable of connecting to Wi-Fi.

4.2 Transistor BC547

A transistor is a semiconductor device used to amplify or switch electronic signals and electrical power. It is composed of semiconductor material usually with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals controls the current through another pair of terminals.

The color of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor. White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device.

4.4 IR Sensor

An infrared sensor is an electronic device, that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor

4.5 Voltage Regulator

78xx (sometimes **L78xx**, **LM78xx**, **MC78xx**...) is a family of self-contained fixed linear voltage regulator integrated circuits. The 78xx family is commonly used in electronic circuits requiring a regulated power supply due to their ease-of-use and

low cost.

4.6 Mobile Application

Blynk is a Platform with iOS and Android apps to control Arduino, Raspberry Pi and the likes over the Internet. It's a digital dashboard where you can build a graphic interface for your project by simply dragging and dropping widgets

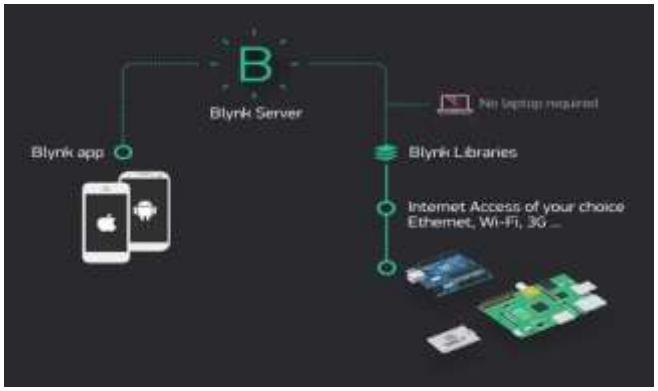

Fig -7: Blynk app

4.7 Ceiling BLDC Fan

Fig -8: BLDC fan

A **ceiling fan** is a mechanical fan mounted on the ceiling of a room or space, usually electrically powered, suspended from the ceiling of a room, that uses hub-mounted rotating blades to circulate air.

Ceiling fans typically rotate more slowly than other types of circulating fans, such as electric desk fans. They cool people effectively by introducing slow movement into the otherwise still, hot air of a room.

5 RESULTS & OBSERVATIONS

The design and development of smartphone controlled BLDC ceiling fan for commercial utility was designed and completed.

The response of the fan was as similar to that of normal response when controlled with remote.

5.1 Advantages

Can be used or operated using smartphone,No long cables are needed,No separate remote,Mobility ,Efficiency ,Security.

5.2 Disadvantages

Speed of response it slightly less than normal remote operated..If connectivity is lost , the speed cannot be further controlled.Its highly reliable.

5.3 Future Scope

The developed setup can be made more user friendly. Further modifications can include incoperation of voice controlled fan using ALEXA. Alexa built-in is a category of devices created with the Alexa Voice Service (AVS) that have a microphone and speaker. You can talk to these products directly with the wake word "Alexa," and receive voice responses and content instantly. Alexa built-in products work with Alexa skills and Alexa-compatible smart home devices, bringing familiar capabilities.

5.4 Output

The circuit was completed on a dotted PCB and all the mechanical parts was joined together to form the required output. The output was verified using smartphone. The app provided the required instructions for the user and wifi module working was verified and also the speed of the fan was controlled using smartphone.

Fig -9: Actual view of product

6. CONCLUSIONS

The project provides a straight forward and intuitive user experience,while enabling the full range of functionalities assigned.The proposed idea make the use of bldc motor ceiling fan for home automation.

Final design produces a potential product that makes ease to human thus controlling fan on our fingertip.

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BIOGRAPHIES

Dr. Aji Joy
Project Guide , Dept. of ECE , Mar Athanasius College of Engineering, Kothamangalam, India

Jayasree N
Student ,ECE, Mar Athanasius College of Engineering, Kothamangalam, India

Jomin M Jacob
Student,ECE, Mar Athanasius College of Engineering, Kothamangalam, India

Malik Ibnu Easa
Student,ECE Mar Athanasius College of Engineering, Kothamangalam, India