Variable Speed Multi-tap Brushless DC motor using Wireless Technology

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Abstract

The brushless dc motors are widely used in the servo motor application because of their advantages over conventional DC motors. In this paper,the motor is operated remotely using wireless technology and thereby reduces labour cost, maintenance cost and improves ease of operation. Speed control of BLDC motor is quite complicated. A novel tapped field open loop control method using wireless technology is proposed in this paper. Many applications such as heating and ventilation, industrial engineering, transport, motion control systems, radio control cars etc can be more efficient using this method.

Key Words: Speed Control, Brushless DC Motor, Wireless Technology

1. INTRODUCTION

A brushless DC motor consists of a permanent magnet as rotor and poly-phase armature windings as stator. Unlike conventional DC motor, BLDC motor is electronically commutated using an electronic drive to feed the stator windings.

The working principle of BLDC motor is same as the Brushed DC motor. The speed control of a BLDC motor can be closed loop or open loop. Open loop speed control involves, controlling the DC voltage applied to motor terminals by chopping the DC voltage. Closed loop speed control involves controlling the input supply voltage through the speed feedback from the motor. Here, speed control of the BLDC motor is designed by open loop technique with tapped field control.

Brushless DC motors are widely used in many applications such as automotive, computer, industrial, aerospace, etc. BLDC motors have several advantages over Brushed DC motor. They have lower maintenance due to the elimination of mechanical commutator and its high power density makes them ideal for high torque to weight ratio applications. On comparison to Induction motors they have virtually zero losses. With the advent of the proposed method of remotely controlling the speed of the motor, many applications alike become cost effective and more ease of operation and maintenance.

Since speed control of BLDC motor is complicated, many conventional controllers are used. However, these are likely less preferred after the advent of Fuzzy logic controller since it provided better performance [1], [2], [4] and [7]. Further PID controller using genetic algorithm was been designed which provided far better response to fuzzy logic controller [1]. However, for small scale industries, speed control of BLDC motor using simpler technique is the most applicable considering cost, ease of operation and maintenance factors. Therefore, PWM technique that varies duty cycle is used to control the speed of the BLDC Motor through mobile application via secured Bluetooth [3]. The proposed project demonstrates the open loop tapped field speed control of the BLDC motor. This task is performed on the short range wireless platform, Bluetooth which is an open specification for short range wireless communication, which reduces time and human effort for transferring data [5-6].

2. DESCRIPTION OF THE SYSTEM

The circuit diagram of the BLDC motor with tapped field winding is shown in Figure 1. In tapped field control method, the speed is increased by reducing the flux and it is executed by lowering number of turns of field winding through which current flows.

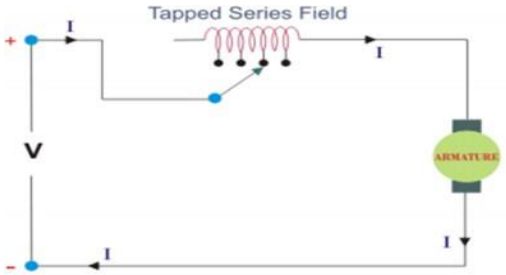

Fig. 1 Circuit diagram of BLDC motor with tapping in the field winding

The working of the system proposed is illustrated in Figure 2. It can be observed that the system works when the active components are turned ON with power supply and the GSM/ Bluetooth senses the message sent from the recognized android device (such as cellular phone) and signals transmits the message to activate the relay accordingly. The relay activates the motor to run in the specified speed (speed that is sent as message). A 4-relay module is used to activate the motor because of the motor construction, where it is tapped in 3 steps. The three taps of winding are altered to attain the desired speed. Hence whenever, the command is sent from the android device the motor starts running in the specified speed. Hence, the motor's speed can be controlled from anywhere at any-time through the GSM application. On similar lines the speed of the motor can be controlled using Bluetooth. Using tachometer, the speed of the motor is noted and verified for its working.

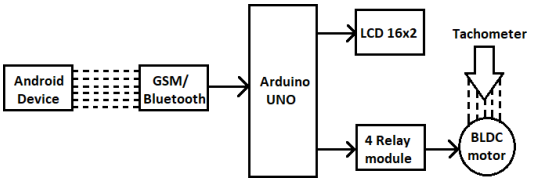

Fig. 2 Block diagram of the proposed system

3. FLOW CHART

The system is operated using GSM and Bluetooth. The control algorithm used for the speed control are depicted in the flowcharts shown in Figure 3 and Figure 4 for GSM and Bluetooth respectively.

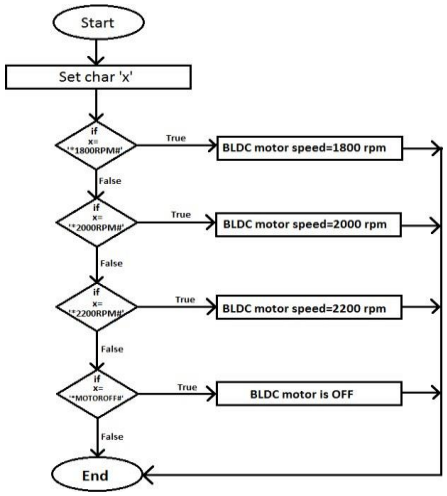

Fig. 3 Flowchart of working model using GSM

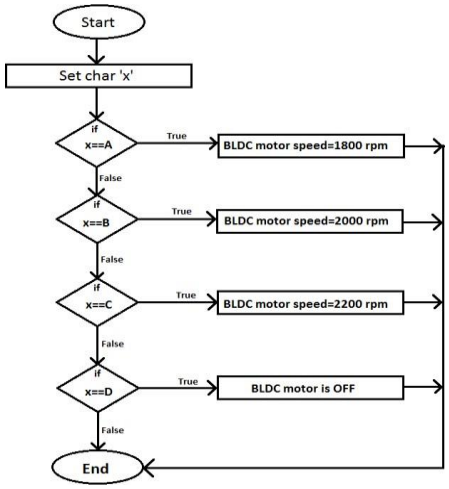

Fig. 4 Flowchart of working model using Bluetooth

4. HARDWARE SET UP

The list of components used for this experimental setup is given in Table 1. The results or the outcome of the set-up can be observed and verified using LCD display and tachometer. Arduino UNO is used to control the sequence of operations for smooth functioning of the setup.

Table 1. Components used

SL. NO.	MATERIAL NAME	QUANTITY
1	BLDC motor	1 no.
2	Relay(4 channel) module	1 no.
3	Arduino UNO	1 no.
4	Capacitor	1 no.
5	GSM/BLUETOOTH	1 no.
6	Connecting wires	Lump sum
7	LCD	1 no.

The hardware set up for the proposed system is shown in Figure 5.

Fig. 5 Experimental setup using GSM and Bluetooth

5. RESULTS

a. Using GSM technology:

The speed of motor is varied by giving the command from the android device to GSM. The message format sent from android device is shown in Figure 6. The GSM is interfaced with the Arduino board for activating the relay, which gives the input to the motor. After operating the relay a message is received back from the control unit indicating which relay is ON and speed of operation of motor as shown in Figure 7.

For the first step, the command 1800rpm is sent from the GSM and the control unit activates relay 1. The motor starts running at 1800rpm and speed of the motor is measured by using tachometer. The real time measurement is shown in Figure 7.

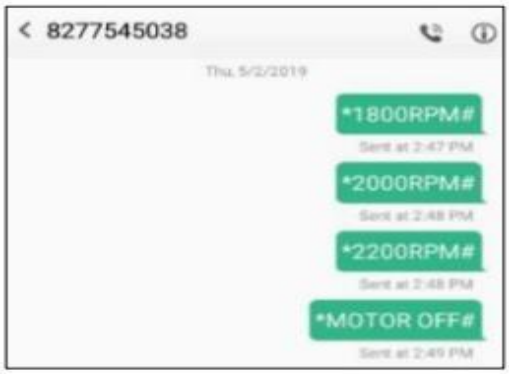

Fig. 6 Command sent to the control unit to run the motor in a particular speed

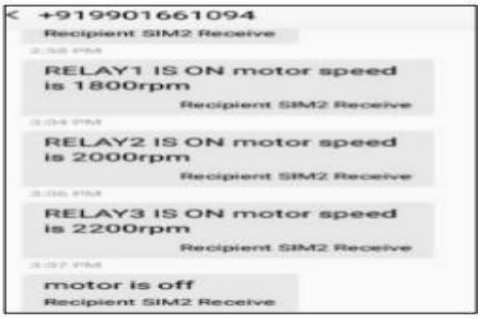

Fig. 7 Message received from the control unit after relay operation

Fig. 8 Real time motor speed measurement using tachometer

b. Using Bluetooth technology:

Using a mobile application called Bluetooth controller, the motor speed is controlled with ease using bluetooth. In this application, data keys are set up for the operation intended and the controller is set up. This process can be observed in Figure 9 and Figure 10.

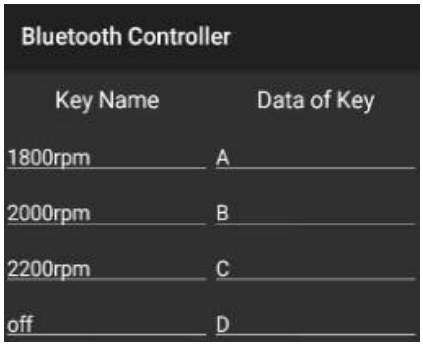

Fig. 9 setting up of data keys

Fig. 10 Bluetooth controller setup

The tachometer is used to verify the speed for the set up and it is found that the speed of the motor was almost the same as the intended speed with little variation. The result is tabulated for 4 steps in Table 2.

Table 2. Different steps and its corresponding speed

Steps	Desired Motor Speed (rpm)	Actual Motor Speed (rpm)
Step 1	1800	1799
Step 2	2000	2003
Step 3	2200	2155
Step 4	0 (OFF)	0 (OFF)

6. CONCLUSION AND DISCUSSION

The proposed system is potentially useful for the home appliances like chimneys which operates at three different speeds. The speed control is done by wireless technology using Bluetooth and GSM. The former will give an operating range of 100m, whereas using latter we can control the speed at any time from any distance. Bluetooth and GSM module acts as an interface between the mobile and Arduino board. When Bluetooth is interfaced between mobile and Arduino UNO, the user can give input command for operating the motor at a particular speed from the mobile (which has Bluetooth Controller App).The present model developed is only for three speed control, it can be upgraded to closed loop speed control which enables the BLDC motor to run at any speed. This can be expanded to many applications that uses BLDC motors such as heating and ventilation, industrial engineering, transport, motion control systems, radio control cars etc.

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