

Arduino-based DC Motor Control System using Bluetooth Module

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ABSTRACT

This article implemented an Android application-based speed and direction control of DC motor using Bluetooth module. This setup consists of two basic primary elements communicating with each other: i) Bluetooth of smartphone which is connected to the Arduino microcontroller, IC and DC Motor interfaced with a L293D motor driver IC and ii) a Bluetooth module HC-05. The android application in smartphone sends/receives data to/from the microcontroller using the Bluetooth. An android application in the smartphone acts as a display panel for the user to send/receive/view the output and input of the DC motor. The display includes a screen showing the commands and responses against each other. The motor can be rotated 0-360 degrees and can even change its direction from left to right until stopped. Thus, this proposed control methodology is applied to control speed and direction of DC motor wirelessly.

Keywords: Arduino, DC motor, TRIAC, Android layout, LCD.

1. INTRODUCTION

Our is the era of confluence of multiple engineering disciplines and is marked by integration of seemingly disparate technologies. Following this paradigm, in this work, android technology has been integrated to establish secure channel over Bluetooth to provide visual control of speed of DC motor for example. Platforms and ideas developed here are general in nature and it can be used as a chassis to deploy multiple secure and digital hack-free control mechanisms for IoT (Internet of Things) and related networked devices. It is designed to improve the control and management of electrical machines through secure wireless technology. It has various signalling systems which are observed on the Bluetooth, and the micro-controller through the change in intensity of light and fluctuations of light when the change in speed is observed on the mobile app. It is designed in such a way that it can be integrated with robotics, drones, smart buildings etc. These DC Motors are normally used for industrial control, automation, and home electrical appliance. It spans everything from residential washing machines, fans, hand-held power tools, automotive window lift, traction control system, industrial drives and many more. Motor application is not completed without a control system. The inventions of microprocessor and microcontroller make the control system become easier. This control system is basically controlling the switch, speed, and direction of motor. Control signal is generated by a switch that is connected directly to the control circuit. To control and monitor the motor, user need to be at the place where the switch is located.

In [2], author utilized GSM technology to control the speed of DC motor by sending SMS from mobile phone. The GSM module will receive SMS of desired motor speed in RPM send by the user. SMS received on the GSM module will be proceed by MCU and MCU will convert the SMS into suitable duty cycle for PWM pulse to control the speed of the DC motor. MCU is programmed to continuously send an AT command to the GSM module to check for message in the SIM every 5 second at location 1. Program will go to next step after receiving the message after that, MCU will receive the SMS, extract the speed & change it to a suitable duty cycle for the PWM. Suitable voltage is produced by controlling the motor drive L2931 using PWM pulse. This suitable voltage is supplied to the motor so that desired speed can be achieved. After completing this process, message was deleted at location 1 of GSM module by using AT command and loop back to the first step & again read the SMS in SIM. R. Chaubey et al., [3] investigated about the implementation of microcontroller, to

control the speed and direction of a DC motor in either direction i.e., clockwise, or/and anticlockwise, using android mobile application.

A high frequency PWM signal is fed to dc chopper that is used to drive the dc motor. By controlling the duty cycle of this PWM signal, the terminal voltage of dc motor is controlled, which in turn directly controls the speed of dc motor. In this system, a dc motor is interfaced with the microcontroller. The major elements used in this system are Arduino UNO, Bluetooth module and DC motor. A 12v transformer powers the entire system. When an android device sends command, it is received by the Bluetooth module, which then sends the commands to microcontroller. Whenever the motor is turned on, it can run in both directions. An LCD is used to display the status and speed of dc motor. To control the signal speed and direction of dc motor, a signal from android device will be sent to microcontroller through Bluetooth module. This signal will be represented by a single direction that denotes the speed and direction of the motor. Different letters will represent the three directions of rotation i.e., clockwise, anticlockwise and stopping of the motor. This letter will vary the speed of motor with reference to Arduino code. The duty cycle of PWM signal is varied in between 0-255 to change the speed of dc motor. Direction of DC motor is controlled by using H- bridge concept. This system is advantageous as it uses Bluetooth module that consumes less power as compared to other devices providing user-friendly environment. Technically more skilled persons are not required in this system. But the problem is that the usage of Bluetooth module makes the usage only within a short range and usage of android app in smart phone consumes battery. In [4], author implemented speed and direction control of DC motor using radio frequency technology with the help of PWM and H-bridge techniques. In which PWM technique is used for the speed control of DC motor. The microcontroller is used for generating the PWM signal. The duty cycle of PWM pulse is varied to control the speed of DC motor. And the H-bridge technique is used for controlling the direction of the DC motor. It consists of four transistor switches. These four transistors are connected in bridge form, so it is called H-bridge. At a time, only two switches are turned on & remaining two switches are turned off. Radio waves are generated by RF transmitter. These radio waves are used for communication between the whole assembly. Android based speed control of DC motor via Bluetooth is presented in [5] where authors utilized 12V solar panel to power the entire system. This solar panel converts solar energy into electrical signals directly or indirectly through photovoltaic and concentrated solar power. This project is cost effective and eco-friendly as it uses the solar panels as a power source. To concentrate large area of sunlight on solar panels, lenses, tracking system and mirrors can be used. Author in [6] proposed a system, which consists of a rectifier, filter capacitor, DC/DC converter. The main component of DC/DC converter is IGBT, which is driven by PWM pulses fed from the microcontroller. An Arduino Ethernet shield is used to connect the Arduino on board microcontroller to the internet by plugging the Ethernet module to RJ45 cable. By scrolling the slider in android app, the data is sent to the microcontroller through internet. The slider is configured with 0-255 digital values. According to the value that is fixed by the user, the data is sent to Ethernet shield and the corresponding pulse with duty ratio is achieved. The speed of the motor is controlled by driving the IGBT through the microcontroller signal.

2. PROPOSED METHODOLOGY

This setup consists of two basic primary elements communicating with each other:

- Bluetooth of smartphone which is connected to the Arduino microcontroller, IC and DC Motor interfaced with a L293D motor driver IC.
- A Bluetooth module HC-05.

The android application in smartphone sends/receives data to/from the microcontroller using the Bluetooth. An android application in the smartphone acts as a display panel for the user to send/receive/view the output and input of the DC motor. The display includes a screen showing the commands and responses against each other. The motor can be rotated 0-360

degrees and can even change its direction from left to right until stopped. Thus, this proposed control methodology is applied to control speed and direction of DC motor wirelessly.

2.1. DC Motor Speed Control

Generally, the rotational speed of DC motor is proportional to the applied voltage, and the torque is proportional to the current. Speed control can be achieved by variable voltage source, resistors, or electronic controls. The direction of a wound field DC motor can be changed by reversing either the field or armature connections but not both. This is commonly done with a special set of contactors (direction contactors). Effective voltage can be varied by inserting a series resistor or by an electronically controlled switching device made of thyristors, transistors, or, historically, mercury arc rectifiers. In a circuit known as a chopper, the average voltage applied to the motor is varied by switching the supply voltage very rapidly. As the “on” to “off” ratio is varied to alter the average applied voltage, the speed of the motor varies.

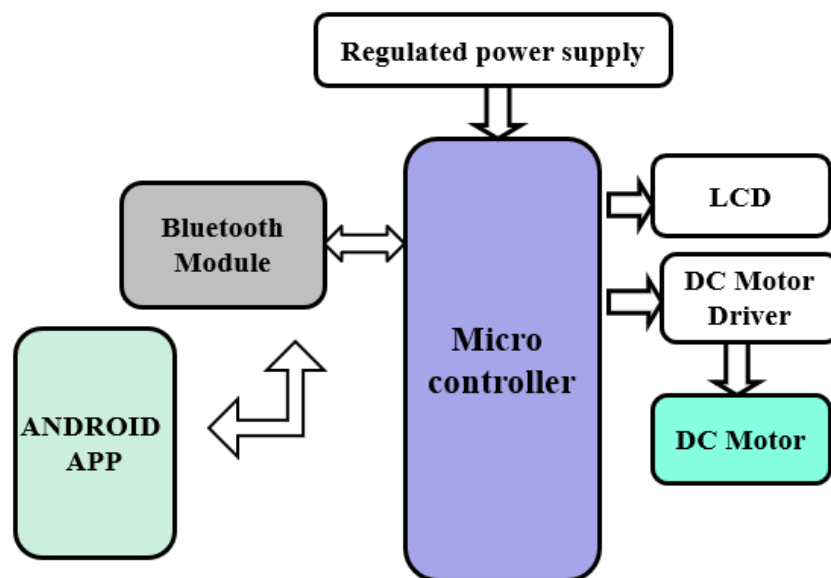


Figure 1. Block diagram of proposed speed and direction-controlled DC motor using android application.

Advantages

- Bluetooth consumes less power than other devices.
- Android applications are user-friendly.
- Technically expert persons are not required.
- Wireless communication is enhanced.
- Programming is simpler.

Applications

- Home automation.
- Many industrial applications which required adjustable speed drive and constant speed for improving the quality product.
- Intensity of light can also be controlled with the help of android app.

2.2. HARDWARE DESCRIPTION

2.2.1. Bluetooth Module

Bluetooth serial communication module has two work modes: order-response work mode and automatic connection work mode. And there are three work roles at the automatic connection work mode. When the module is at the automatic connection work mode, it will follow the

default way set lastly to transmit the data automatically. When the module is at the orderresponse work mode, user can send the AT command to the module to set the control parameters and sent control order. The work mode of this Module can be switched by controlling the module PIN (PIO11) input level. In this project Bluetooth module is used to send signals from the Arduino Uno.

Bluetooth is a wireless technology standard used for exchanging data between fixed and mobile devices over short distances using short-wavelength UHF radio waves in the industrial, scientific and medical radio bands, from 2.402 GHz to 2.480 GHz, and building personal area networks.

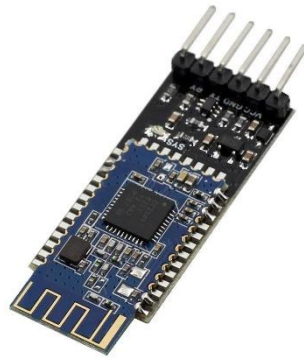


Figure 2. Bluetooth module.

2.2.2. DC Motor

Almost every mechanical movement that we see around us is accomplished by an electric motor. Electrical machines are used for the converting energy. Motors take electrical energy and produce mechanical energy. Electric motor is used to power hundreds of devices we use in everyday life. An example of small motor applications includes motors used in automobiles, robot, hand power tools and food blenders. A motor driver Integrated circuit (L293D) chip is designed to control and regulate motors. It is a dual H-bridge motor driver Integrated Circuit. They are generally used in mechanics and robotics. It acts as an interface between motor and Arduino microprocessor in the circuit. L293D, L293NE are most used motor driver Integrated circuits from L293 series. L293D is designed to control up to maximum of two direct current motors simultaneously when they are integrated with Arduino Uno. It helps to regulate the flow of current before it finally reaches the motor. It becomes a necessity and need to use IC L293D due to different requirement of current and voltages by microprocessors (low) and 5V DC motor (high) as it acts as a moderator and balances the flow of current. It protects the circuit from overload current and provides protection against overload temperature. Current should not be directly supplied to the motor because it can damage the motor or even the microcontroller. It has an output capability and provides bidirectional current of 600 mA per channel. The maximum or peak current which can flow through per channel as output is 1.2 Amp. It has Enable facility and internal clamp diodes. Input voltage is up to 1.5V-36V which is also high noise immunity (logical "0"). Various and un-similar PWM signals are received because a motor driver IC interfaces with the microcontroller. A motor driver IC is also responsible for achieving required outputs for the speed variation of the DC motor.

2.2.3. LCD

LCD is liquid crystal display technology works by blocking light. Specifically, it is made of two pieces of polarized glass that contain a liquid crystal material between them. A backlight creates light that passes through the first substrate. It is used for display purpose.



Figure 3. LCD module.

2.2.4. Arduino UNO

Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.

Arduino can be used to communicate with a computer, another Arduino board, or other microcontrollers. The ATmega328P microcontroller provides UART TTL (5V) serial communication which can be done using digital pin 0 (Rx) and digital pin 1 (Tx). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The ATmega16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. There are two RX and TX LEDs on the Arduino board which will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (not for serial communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328P also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus.

3. EXPERIMENTAL RESULTS

The android application in the mobile phone is developed with the help of Android Studio Software. Android Studio is a free integrated development environment (IDE) from Google and official development environment for Android. Android Studio is based on IntelliJ IDEA. In addition to the features that are already implemented in IntelliJ IDEA, furthermore, the following functions are available: Support for the development of Android, Android Wear and Android TV Apps. Figure 4 shows the overall hardware setup of DC motor interfacing with Arduino controller with LCD module and power supply.

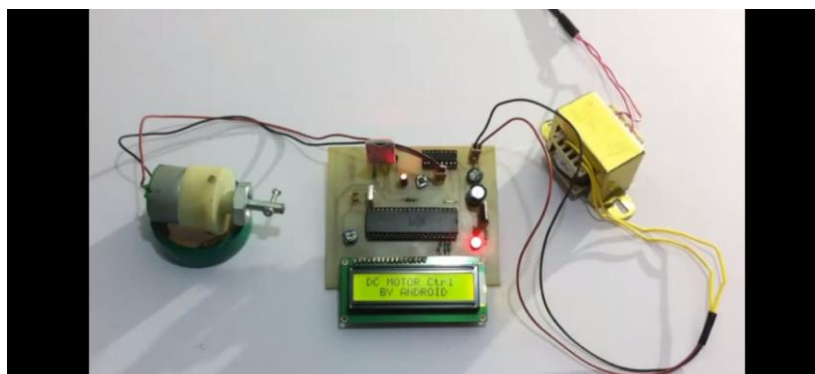


Figure 4. Hardware setup of proposed speed and direction control of DC motor.

4. CONCLUSIONS

It is seen that controlling a DC motor using Android applications gives user many advantages. Controlling the speed and direction of a DC motor by giving instruction to the microcontroller will reduce the manual work. This technology will also save the cost of wiringsince it is based on wireless technology called Bluetooth. Implementation of this system is extremely easysincethe motor is controlled by PWM to accept the desired speed that keyed by the smartphone. This system is also suitable for implementation in industries and homes. It is thus a promise that this method is especially useful to control the speed of DC motor wirelessly.

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