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Article

The Fume Detecting Dual Tone Modulation Frequency Based Rover Using BLDC Motors

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I N F O

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A B S T R A C T

The purpose of this project is to improve the control and precision of any rover by replacing the conventional DC motors or servo motors with the BLDC motors. The BLDC motors are much accurate to control because of the sensors they are equipped with. The telephonic signal from the receiver generates two frequencies one is a higher frequency and the other is a lower frequency. The higher frequency is used to drive the motors. The signal is then received by the receiver phone which then transmits the DTMF signal to the DTMF decoder. The DTMF decoder then decodes the signal and then transmits to the Gate Driver IC (which is connected to the Arduino for motor control). The Gate Driver IC which has the BLDC motors connected to it drives the motors. Furthermore this rover is being operated by Dual Tone Modulation Frequency (DTMF). In addition the rover is equipped with a Gas Sensor.

Keywords: DTMF, BLDC Motor, ESC, PWM Signals, MQ-2 Gas Sensor

Introduction

The application of Dual Tone Modulation Frequency for controlling a rover is one of the most primitive methods of controlling a rover. Can DTMF be used to drive a rover with BLDC motors as its working motors?

First let us see how a DTMF powered rover works.

A phone transmits the signal which is eventually captured by another phone acting as a receiver. Every key in the keypad generates two frequencies when pressed, one is a higher frequency and the other is a lower frequency. Here the higher frequency is used to drive the motors. The receiver then transmits the signal further to the motor driver IC supplied with a DC voltage source. The motor driver IC then drives the motors according to the command given by the user (operator).

In the above discussion we have seen the working of a DTMF controlled rover. Now, the following discussion will let us know the prominence of this paper.

The working motors of any kind of DTMF controlled rover has been the conventional DC motors. The control of dc motors is often a drawback as they can't be controlled instantaneously at the instant of the signal. In technical terms the control of DC motors is less precise compared to the control of BLDC motors.

Speed control of BLDC motors can be easily achieved by using various methods such as square wave control, sine wave control, Field Oriented Control, Pulse Width Modulation, using an Electronic Speed Controller

(ESC), etc. In this paper the speed control of BLDC motors is achieved by using an ESC. The ESC is programmed using an Arduino board.

Any rover can easily run on BLDC motors. But the question is can a rover powered by BLDC motors be controlled with DTMF signal?

The difficulty in driving BLDC motors with DTMF signal is that the output of DTMF module is digital whereas the BLDC motors require an AC input. In such a case how can a BLDC motor be driven by DTMF signal? The answer to this question is in 'methodologies' section that follows

Methodologies

Initial Rotor Position

The initial rotor position of the BLDC Motor is determined using 'Direct Current Controlled PWM Technique (also known as Hysteresis Current Control)'. In this method, a conventional six switch converter is used to drive the three phase motor. It may then result in the possibility of four switch configuration instead of six switch configuration. Now, this drive consists of two switch legs and split capacitor bank. Hence, two phases are connected to the switch legs and the third phase to the mid-point of DC-link capacitors.

In a PWM control strategy for the four-switch three-phase BLDC motor drive, the three-phase currents always meet the condition of,

$I_C = - (I_B + I_A)$

It means that the control of two-phase currents can guarantee the generation of the 120° conducting three-phase currents profiles. For achieving this, the two-phase currents are directly controlled using the 'hysteresis current control' method by four switches.

Now, let's look into the methodology of the paper.

Working procedure

The above flow diagram shows the complete representation of 'The Fume Detecting Dual Tone Modulation Frequency Based Rover Using Brushless Direct Current Motors.' The DTMF rover works on the DTMF principle and is run by BLDC motors. The connections of the rover as mentioned above in the block diagram are as follows.

Initially, the user makes a call from the mobile phone which

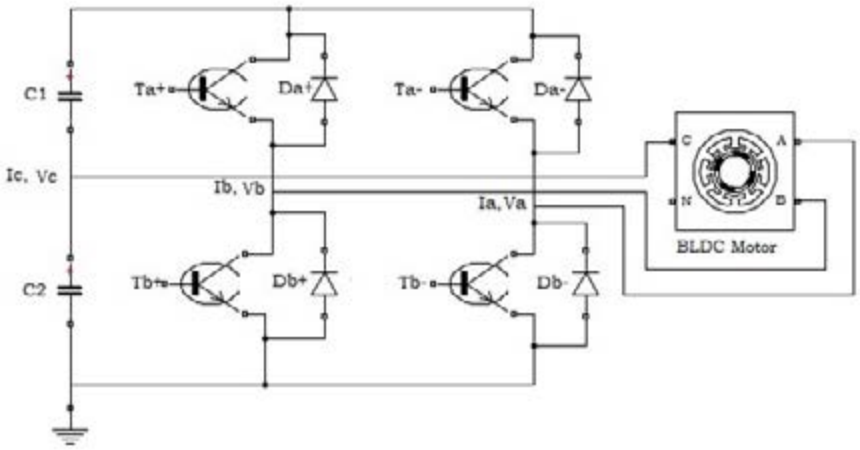

Figure 1.Four switch converter for driving a three-phase BLDC motor

But, with this configuration the limited voltages make it very difficult to obtain the 120° conducting profiles. Now, this is a well known problem known as 'Asymmetric Voltage'. This results in PWM wave with 60° phase shift. The conventional PWM schemes cannot be directly applied to this configuration.

The direct current PWM control technique is based on the current controlled PWM method instead of the voltage controlled PWM. This generates robust speed-torque responses and is simple to be implemented from the hardware and software aspects. Therefore, the four-switch three-phase BLDC motor drive mainly applied to AC induction motor drives till now could be a possible alternative to the conventional configuration due to low cost and high performance.

acts as a transmitter to the receiver mobile connected to the rover. The received signal by the receiver mobile is then transmitted to the DTMF decoder i.e. HT9170B which decodes the signal into dual tone frequency, whose value determines the motion of the rover. The DTMF decoder is powered by a 9 volt battery connected to it. The DTMF module is then connected to a gate driver IC i.e. MP3565 which regulates the supply given to the motors, enabling them to run and stop based on the command given by the user through the receiver and the DTMF decoder. This gate driver IC MP3565 is powered by a 12 volts battery which also powers the BLDC motors rated 1400kV (i.e. for every 1 volt passing through it, it runs at a speed of 1400 rpm), through the gate driver.

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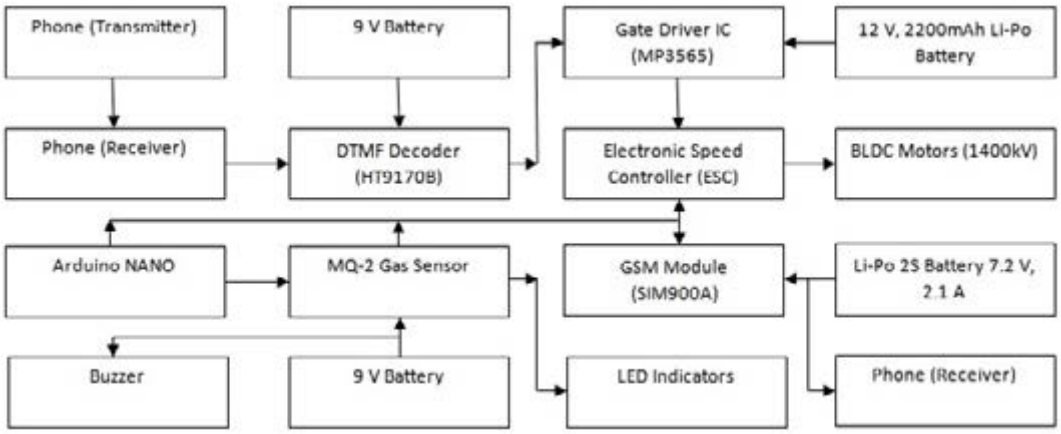

Figure 2.Block Diagram of the Rover

The BLDC motors are connected to the Electronic Speed Controller (ESC) and Arduino Uno unit which gives the required PWM input signals to the ESC unit which then converts the PWM signals into analogue signals for the BLDC motors. The BLDC motors require a program written and dumped in the Arduino in order to function mentioning the delays and the required threshold voltage to run. This code is dumped into the Arduino Uno board which transmits the signals accordingly to the BLDC motors through the ESC unit. The ESC unit is powered from a 12 V, 2200mAh Lithium-Polymer battery. The Arduino Uno board gets its required power of 5v from any of the ESCs i.e. indirectly from the 12v supply given to the gate driver.

2.3 Gas Sensor

Another functionality of the DTMF rover is the ability to detect fumes through the gas sensor equipped to it. This gas sensor MQ-2 has the ability to detect hydro carbons. This MQ-2 gas sensor is connected to the Arduino board which has the required coding which mentions the threshold limit of the concentration of the gas i.e. 100 for the sensor to detect the fumes present in the air. This gas sensor consists of two LEDs (red and green) and a buzzer. It is also connected to a GSM module. The GSM module is powered by a 7.2 V, 2.1 A Lithium-Polymer battery. Whenever the sensor senses that the gas concentration exceeds the threshold limit, the red led glows, the buzzer shrills and the GSM module sends an alert to the user as an indication to the higher gas concentrations. If the gas concentration is less than the threshold limit, the green led glows and the GSM module sends an alert to the user indicating that the gas concentration is within the limits.

The only limitation that we came across is that the supply of the BLDC motor should somewhat be like an analog signal whereas the output of the DTMF module is digital. We've overcome it by using a gate driver IC instead of a motor driver IC, which is capable of converting the digital signal into an analog signal.

To increase the output voltage range of the gas sensor an additional potentiometer (according to the requirement of the user) can be used in series with that of the one equipped in the sensor.

Results

'The Fume Detecting Dual Tone Modulation Frequency Based Rover Using Brushless Direct Current Motors' can be controlled from anywhere in the world as it receives its signal from a phone provided the signal is efficient enough to make a phone call. The rover is specifically efficient in precisely starting, stopping, braking, turning and reversing at the instant signal is received. The rover is run at an optimum speed which will guide it to perform its additional function of fume detection, the results of which are given below.

Gas Sensor Results

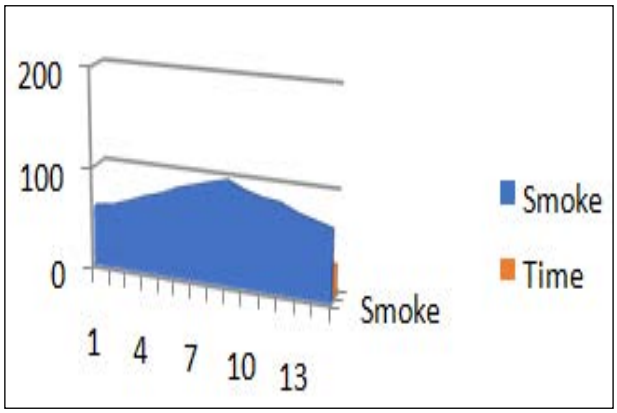

Figure 3.Concentration of Smoke

The above fig 3.1.1 shows the results of gas sensor with the concentration of smoke. Initially at the instant of detection of smoke the output voltage of the sensor is around 61V, as long as concentration of smoke kept rising it continued to rise exponentially to a maximum value of around 104 V. When the concentration of smoke started decaying, the output voltage of the sensor started decaying to a value of around 72.

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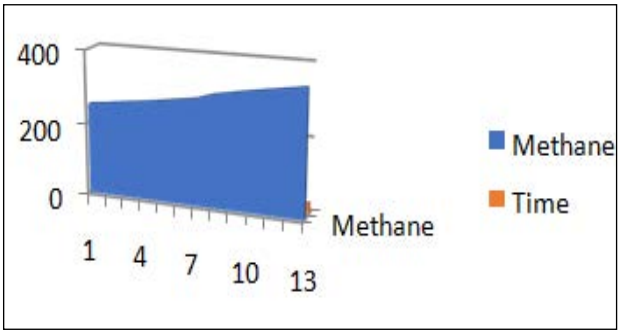

Figure 4.Concentration of Methane

The following figures show the output of Gas Sensor with Methane (fig 3.1.2), Carbon Monoxide (fig 3.1.3) and LPG (fig 3.1.4) concentrations.

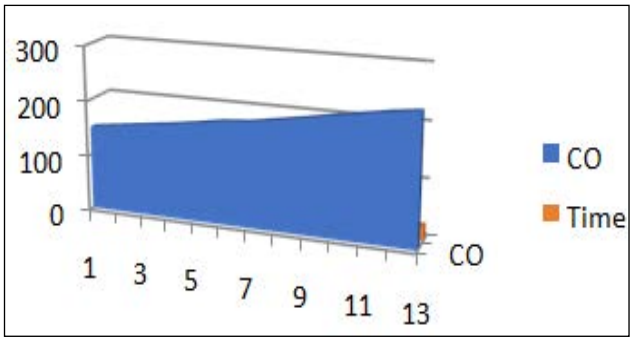

Figure 5.Concentration of Carbon Monoxide

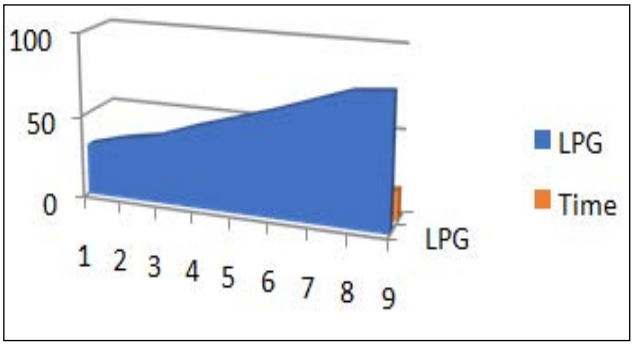

Figure 6.Concentration of LPG

Therefore, it can be inferred that the output voltage of the sensor is directly proportional to the concentration of gas.

Discussions

Advantages of using BLDC Motors over Conventional DC Motors

The advantages of using BLDC motors over Conventional DC motors are the efficiency of BLDC motors because torque can be continuously controlled. They are highly reliable with low electrical noise generation as they lack brushes. They are more effective as their velocity is governed by the frequency at which the current is supplied but not by the voltage. The absence of brushes reduces the loss of mechanical energy due to friction as a result performance is enhanced. More electromagnets can be used on the stator for much precise control. Electrical interference is minimized as there are no ionizing sparks seen from the commutator. They accelerate and decelerate quickly due to low rotor inertia. Also, longer life span (due to absence of brushes and lack of commutator corrosion) is the most desired advantage.

Near-elimination of electromagnetic interference (EMI) is another added advantage.

Advantages of Using DTMF module over RF module

The drawbacks of RF circuit are limited working range and limited control. DTMF increases the range of working and also gives good results in case of motion and direction of robot using mobile phone through micro controller. This type of wireless communication gives the remote handling operation of Robot using DTMF. Also the power consumption will be reduced and power efficiency will be increased compared to RF.

Progressive works and Applications

This DTMF rover is first of its kind, because of the use of Brushless DC motors instead of conventional DC motors, providing higher efficiency, speed and better torque to speed ratio to the rover.

Also, the receiver phone can be replaced with a GSM module equipped with an audio jack that could accommodate the DTMF signals from the transmitting phone and transfer them further to the gate driver IC.

The programming libraries can be developed such that all the equipment including the GSM module can be programmed within a single program.

Also there are wide applications with this rover, as it is an externally useable unit; it can be upgraded with various other sensors like human detection, proximity sensor, moisture detection etc. Since both the motors and the sensor works due to the Arduino interfacing, the necessary code can be dumped into the Arduino, and the necessary sensors can be equipped without necessity to make much change.

Conclusions

In this project, THE DUAL TONE MODULATION FREQUENCY ROVER is discussed with BRUSHLESS DC MOTORS as its working motors instead of conventional DC motors and also a gas sensor as an addition to the rover is studied and explained in detail. This project concludes that the DTMF with BLDC motors is an advanced as well as much precisely controllable rover having various applications in the industry. Also, the rover is equipped with a gas sensor which could detect the presence of gases like Smoke, Methane, Carbon Monoxide and LPG. This rover

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will probably be a solution in containing the industrial accidents (gas leakages) which is also the need of the hour. Also, this rover can be upgraded with various other sensors like human detection sensors (applicable during natural calamities and accidents in finding the lives under the remains), proximity sensor (applicable during curfews which help the forces to maintain the situation under control) and many other sensors as per the requirement of the user.

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References

1. www.electronicshub.org ('DTMF Robot without Microcontroller' main reference for this project has been taken from this website.)
2. www.arduino.cc (The references for the programs used to run the motors and for the testing of sensor have been taken from this website.)
3. www.motioncontrolonline.org (The references about the description of the ESC used for this project has been taken from this website.)
4. www.engineersedge.com (The references for Advantages of BLDC Motors and DTMF Module have been taken from this site.)
5. www.wikipedia.org (The references for the study of Electronic Speed Controllers have been taken from this website.)
6. www.ednasia.com (The references for the study of Gate Driver ICs have been taken from this website.)
7. www.kdedirect.com (The references for the study of BLDC motors has been taken from this website.)
8. www.mepits.com (The references about the descripton of various modules used in this project have been taken from this website.)
9. www.elprocus.com (The references about the various electronic components used in this project have been taken from this website.)
10. www.emworks.com (The references for the study of BLDC motors and various previous theories have been taken from this website.)

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