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Automatic Speed Control of Motor with Over Current and Thermal Protection

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Abstract: *This paper aims to design a controller to minimize the accidents of mechanical failure of industrial generators and motors under heavy load or malfunction. The controlling parameters such as the speed of motor is done via controlling the voltage and current fed to the motor. The speed control can be possible by using PWM technique. The factors which affect the motor can be sense using temperature and current sensor. The system also utilizes Over current & Thermal based backup protection scheme for failure protection.*

Keywords: Current sensor, Temperature, Speed, PWM, Fault Detection

I. INTRODUCTION

Over the time, the DC machine have attained huge popularity in the market, especially where high performance is required having adjustable speed control etc. Furthermore, DC motors are used extensively in wide varieties of application where accurate speed tracking is required. DC motors are still preferred in some applications even when it is known that AC motors are cheaper and lighter and more resilient. The controlled rectifier and chopper are commonly used in the DC motors speed controlling. The main feature of the DC motor is that it can be used extensively in variable speed drives with variable characteristics both above and below the rated speeds which can be attained using field control method and armature control method. With the advancement in the field of battery technology and drive system along with eco-friendly nature, the portable electronic drives such as E-Rickshaw are becoming popular. It is more efficient and consumes less fuel compared to pulled rickshaws. The power source of E-Rickshaws are DC electrics portable batteries. Its controller can be formed by either a Variable Frequency Drive technique (VFD) or pulse width modulation technique (PWM) based speed deciding microcontroller.

II. LITERATURE SURVEY

The problem of regulation for a DC motor with autonomous voltage inverter is discussed. The considered control system consists of two feedback loops. In the first one, the armature current control for a DC motor is provided by means of pulse-width modulated control of such autonomous voltage inverter as the Hbridge. In the second one, DC motor speed control is maintained. Proportional-integral (PI) controllers are designed for armature current and motor speed control based on singular perturbation technique such that multi-time-scale motions are artificially induced in the closed-loop system. Multi-time-scale motions analysis allows getting analytical expressions for selection of controller parameters. Simulation results are presented as well [1].

Design and implementation of speed controller to control the speed of separately excited DC motor using a class A chopper. The speed of Separately Excited DC motor is controlled to a maximum of its rated speed using chopper as a converter. The speed controller used is Proportional Integral type which reduces steady state error and provides fast control. The parameters of the speed controller have been designed using control system theory. The validity of the proposed approach is presented by simulating the DC drive system in SCILAB (XCOS) and also by implementing the same using TI'sF28027 launch pad under varying speed and varying load conditions [2].

The performance of Chopper fed DC motor drive with fuzzy logic controller for speed control is analyzed. Even though conventional Proportional-Integral (PI) controller for dc motor control allows good speed regulation, quick starting, braking and reversing, it is tedious to tune and difficult to control sometimes because of system nonlinearities. To overcome such problems, here a mamdani inference based fuzzy logic controller is proposed where rules are based on motor inputs which are speed error and change in error. MATLAB Simulink software is used for performance analysis [3].

One of the industrial challenges for verifying, analyzing and controlling aggregates powered by DC motors is to provide protection against variations beyond the nominal operating limits of these machines, which makes it opportune to study and test a digital system able to cope with the requirements analysis and control at a low cost, easy to deploy and use. The present paper proposes an optimized technical solution for a wide range of continuous current motors to achieve low voltage, overvoltage and overload protection[4-5].

There is a need for industrial coordination environment between multiple devices, so it should be synchronization between engines. System built based on these factors; can control DC motors and be multiple RPS or speed. The DC motor is widely used for convenience of control. One of the benefits of DC motors is speed reduction smoothly to zero without the need to change the power circuit, which leads to the formation of acceleration in another guidance. There are DC motor control systems such as a pulse Control of width modulation (PWM) motor voltage. Cars steering is controlled by precise control of the system language (Singh, 2014). Cars use electric power to produce machinery power, as they use multiple devices and engines for easy operation orderly goals. DC motors for industrial use, marine, and other applications that require high torque as well speed change (Singh, 2014).

The most important variables are the temperature, as it is wide many scales are measured. Depending on the temperature in the area to be measured, the method of measurement will vary.

It is necessary to control such heavy scales remove the temperature of the gas leaving the arrow and the flue gas in empowerment (Mike, 2015).Speed and torque control the power of a car, therefore power control leads to power control. I the effect of temperature on the performance of the brushless DC motor read (Ewa Garnewa, 2019). Temperature effect in the KARTING electric car engine learned from it Indonesia. The results of the study were to note changes in the vehicle engine performance due to temperature changes, e.g. the speed changes depending on the temperature.

III. Proposed Design

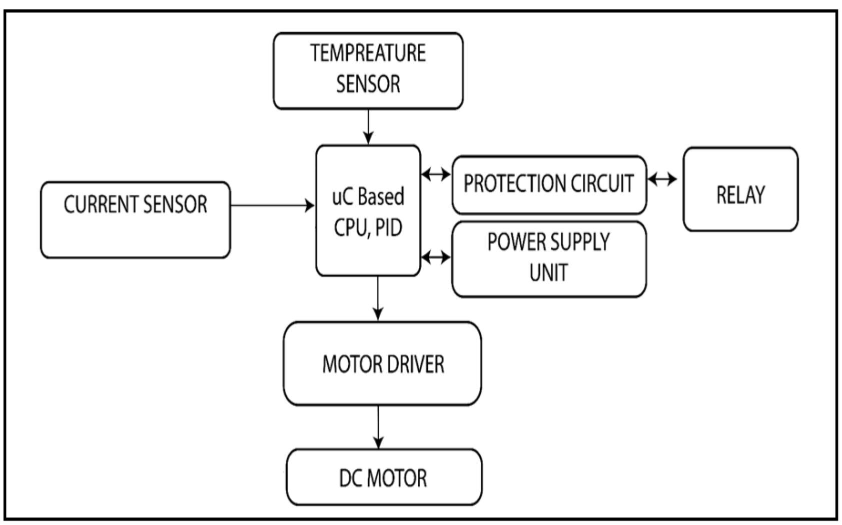

Figure 1: Block diagram of proposed system

The system uses the the motor where the speed of motor is controlled using the pwm technique. The motor is connected to the motor using L293D motor driver ic, The acs 712 current sensor is used for getting the value of current of motor and provide protection for the over current. The temperature sensor which use for the thermal protection of motor. The detail explanation is summarised below.

3.1 Fault Detection and Protection System

This system consists of various sensors and measurement circuits which measure the parameters of the motor continuously. These sensors have to be compatible with the Arduino i.e., their output voltage range should be between 0-5V DC. So, some of the sensors needs signal conditioning equipment as we are measuring the AC.

A. Current Detection

In our system, current is measured using the ACS712 which can measure the current between +5A to -5A. It requires a 5V supply for its operation and itsoutput voltage varies linearly with respect to current. Its operation is based on the hall effect. This can be connected to one of the analog pins of the Arduino.

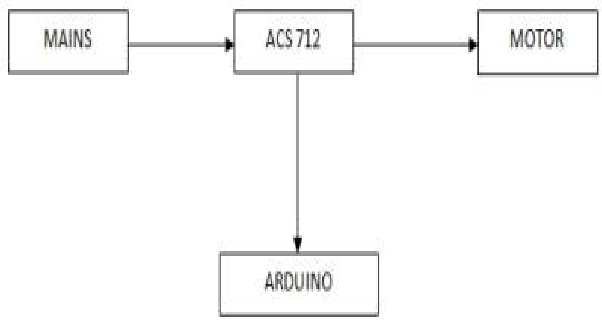

Figure 2: Block diagram of current sensor with motor and Arduino

As we have used the ACS712 it gives linear output voltage for current between +5A to -5A. An arduino analog channel converts the analog input voltage into a number between 0-1023. This means that for 0V the converted value would be 0 while for 5V it is 1023. Similarly +5A would be 1023 , - 5A would be 0 and 0A would be 512. So for AC current measurement we would take samples for about 500 milliseconds. From these samples we will find the maximum value. Let the maximum value measured by the Arduino be Amax. Therefore the input RMS current I can be derived as follows: Let Im be the max current.

$$Im = (Amax - 512) / 512 * 5 \text{ A}$$

Therefore I is given by $I = Im/\sqrt{2}$ A

B. Temperature Detection

In our system, temperature is measured using the LM 35 which also operates on a voltage of 5V. The range of the sensor is -55oC to 150oC. Its output voltage varies linearly with respect to current. This can be connected to one of the analog pins of the arduino. The temperature of motor detect by the temperature sensor and takes the necessary action if required.

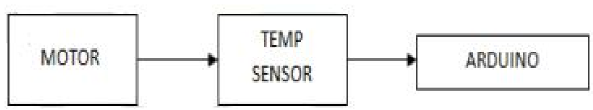

Figure 3: Block diagram of Temperature sensor with Arduino

Fig 3: Temperature measurement We have used LM 35 for the temperature measurement which gives a linear output voltage between the range -55°C - 150°C. Therefore let the analog value be At. The temperature is given by $T = At/1023*5*100$ °C.

C. PWM based Speed Control

PWM has many control features system. An easy way to control DC speed The motor is to control the driving voltage, where the voltage is high speed can be high. In most programs conventional power control can cause a lot of power loss control system, so the PWM method is widely used in DC car speed control app. When using PWM method of control, remember that using the engine is as it is low pass system. PWM method is high frequency avoided and we know that a large engine is very powerful therefore avoid high frequency, so it will not work properly using high waves. This method works slowly frequency so low frequency is better than high usually. We can easily understand by example. On an The rest period is called the Duty cycle[dc]. Figure 2 shows 10%, 50% and 90% activity cycle signal waves. As we see in Figure 2, with 10% waveform 10% of the work the signal is turned on with a 90% discount while the waveform is 90%.90% activity cycle signal is on and 10% discount. These symptoms send to car. The end result of PWM is power send to mortgage and can adjust from 0% to 100% dc with stable control and high efficiency .

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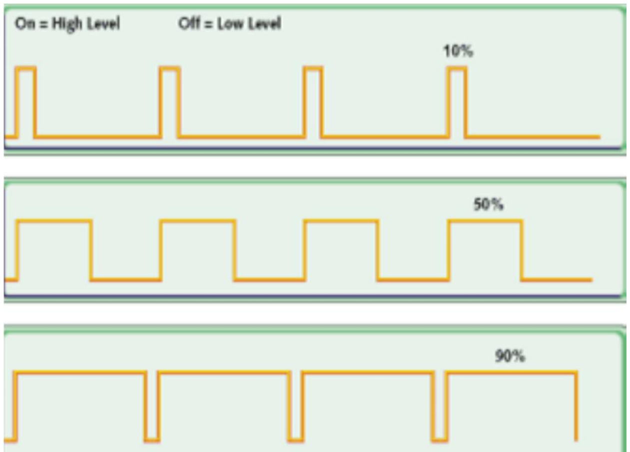

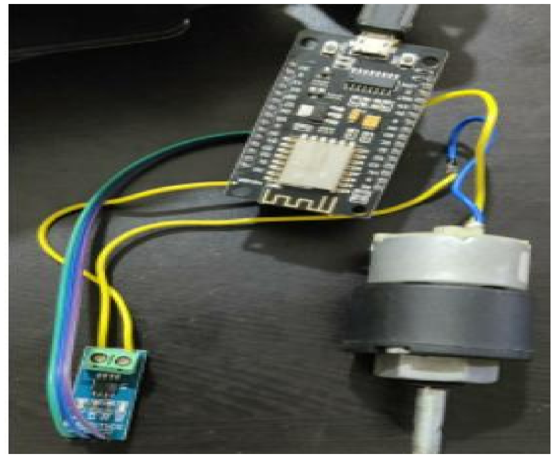

Figure 4: Different duty cycle waveform **Figure 5:** Node mcu with current sensor and motor

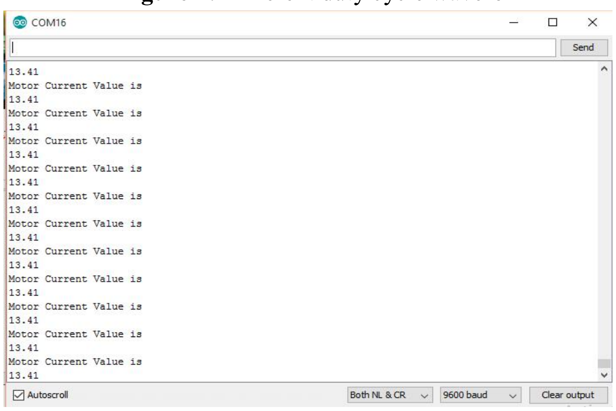

Figure 6: Current value of the Dc motor **Figure 7:** Node mcu with Temperature sensor LM35

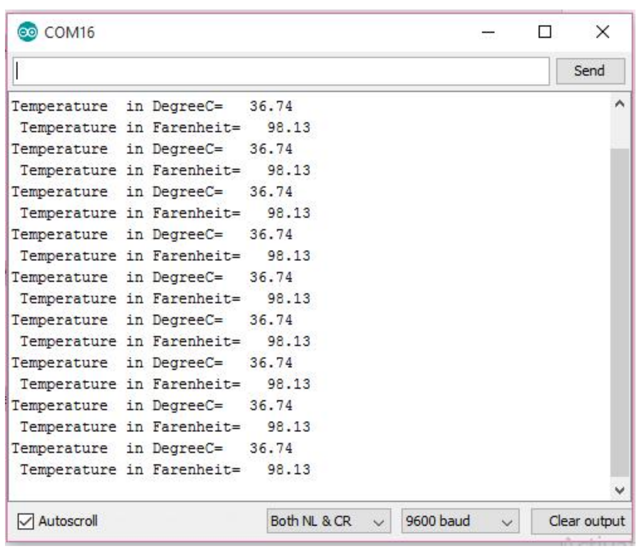

Figure 8: Temperature reading in degree and Farenheit

IV. Result

Interfacing of current sensor with Node mcu is shown in figure 5. The result are obtained from the Acs712 current sensor module which takes the reading and provide it to the nodemcu module. Furthermore hardware connection of LM35 Temperature with the esp8266 is shown. cycle signal is on and 10% discount. These symptoms send to car. The end result of PWM is power send to mortgage and can adjust from 0% to 100% dc with stable control and high efficiency.

V. Conclusion

Fixed DC speed control system motor, reliable, accurate and adaptable a different system rating for feedback. The engine will operate at a set speed and if the motor increases the temperature then the speed of motor is reduced. The design makes the system work for the over current and thermal protection mode. the amount of load applied speed does not vary software is made according to the speed requirement control. This program designed and operated automatically DC motor speed control system, controls the speed of DC motor using the PWM method.

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