Automatic speed controller of a DC motor using Arduino and Variable Frequency Drive techniques

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Abstract. The programmed speed control of a DC engine is basic in numerous mechanical applications, where exact control of engine speed is required. In this paper, we propose a arrangement for programmed speed control of a DC engine utilizing an Arduino microcontroller and Variable Recurrence Drive (VFD) methods. The proposed framework utilizes an input circle that compares the real speed of the DC engine with the required speed and alters the engine speed appropriately. The Arduino microcontroller is utilized to handle the criticism flag and create the suitable control signals to alter the engine speed. The VFD is utilized to change over the DC voltage to a variable AC voltage that can be utilized to control the speed of the engine. The system can be easily implemented and customized for various industrial applications.

1 Introduction

Because of their four various types, DC motors can be used in a wide range of applications and since each type of DC motor has its own set of advantages, they are used in a variety of ways. Small ones are utilized in tools, toys, and a variety of household equipment at home. Conveyors and turntables are examples of other DC applications, while braking and reversing applications are common in industries. We attempted to provide some concrete examples of DCs applications: Pumps, Toys, Electric Cars, and Robots. Industry's powerhouses are electric cars. They have a very high performance in converting electricity into mechanical. Electric motors are used by the most of electricity usage, and their uses range from commercial production and transport to commercial and residential settings. Pumps, fans, mixers, compressors, conveyors, mills, cranes, automobiles, and machine parts are some of the common use cases of electric motors. Electric motors have a wide range of uses, which is not surprising given their low cost, excellent reliability, and simplicity. When connected to the main power source, all Air compressors are basically consistent speed machines (with appropriate starter mechanism) [1-4]. In fact, the speed difference between load and full load is no more than 5%. Variable-speed motors are frequently used for a variety of reasons,

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including energy conservation, increased efficiency, and process torque control. Variable Speed Drives of AC Motors are the result of the automation of industrial operations [5,6].

This variety of application needs many types of speed control for d.c. motor. One of this types is the mechanical methods which involve the use of mechanical devices, such as gears and pulleys, to control the speed of the motor. These methods are simple and inexpensive but often inefficient and prone to wear and tear. The another one is the electrical strategies which include the utilize of voltage control procedures, such as armature voltage control and field control, to differ the speed of the engine. These strategies are more productive than mechanical strategies but offer restricted speed control run. The final one strategies is the electronic strategies which include the utilize of electronic speed controllers (ESCs), such as beat width balance (PWM) controllers and chopper controllers, to realize exact speed control of DC engines. These strategies are profoundly productive and offer a wide run of speed control, making them perfect for different mechanical applications [7-10].

2 Material and method

2.1 Block diagram of system

To alter the speed of the D.C engine, A variable D.C voltage is required to provide to the D.C engine. Figure 1 represents the variable D.C voltage which can be obtained using VFD techniques. The variable AC voltage supplied by the VFD can be converted to variable D.C voltage using a bridge rectifier. Controlling the DC voltage can be done in two ways: manually and automatically [11].

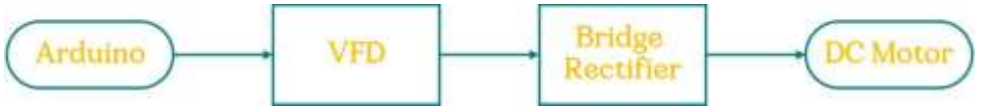

Fig. 1. General block diagram control system.

2.2 Hardware description

2.2.1 Micro controller

One of the most important components of the ARD is the controller, as in figure 2, which represents the power and performance of the board in terms of speed and storage space. It plays an important role in determining the number of digital and analog ports. It is responsible for driving the ARD board. The boards differ in speed and flash memory. These are the basic characteristics that must be studied when purchasing an ARD board. Some types of ARD boards can be changed easily, which has a base that can replace the unit, but some types can only be disassembled using dedicated soldering tools, and in the ARD Uno R3 a controller of the type ATmega328P is used, which is popular for many uses [12,13].

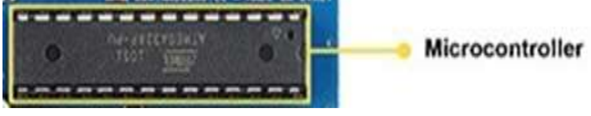

Fig. 2. Microcontroller.

2.2.2 Variable frequency drive

Variable Frequency Drive (VFD), figure 3, is a common technique for controlling the speed and torque of AC motors.

Fig. 3. Variable Frequency Drive.

The basic parts of VFD are shown in figure 4; the rectifier is responsible for converting the incoming AC power from the power source (usually the electrical grid) into DC power. It typically consists of diodes arranged in a specific configuration, such as a 6-pulse or 12-pulse rectifier, to convert the AC waveform into a pulsating DC waveform. The DC Bus acts as a storage capacitor or bus capacitor, smoothing out the pulsating DC waveform generated by the rectifier. It helps maintain a constant voltage level for the subsequent stages of the VFD. The inverter section is responsible for converting the DC power from the DC Bus back into an AC waveform with variable frequency and voltage. It ordinarily comprises of control transistors or protects entryway bipolar transistors (IGBTs) that switch on and off quickly to make the specified AC waveform [14-16]..

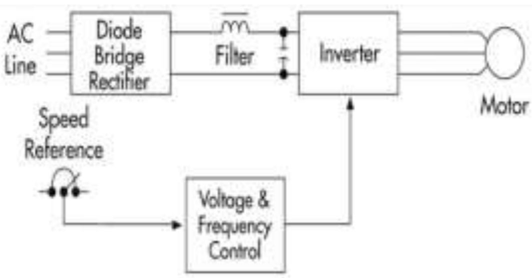

Fig. 4. Variable frequency drive diagram.

The primary step is to put through the Arduino board to the VFD through the communication interface, such as a serial or Modbus association. This permits the Arduino to send commands to the VFD and control the speed of the engine. The another step is to program the Arduino to create a PWM flag that shifts the engine speed. This includes setting up the Arduino IDE, composing the code to create the PWM flag, and uploading it to the board. The VFD is at that point modified to get the PWM flag and alter the recurrence and voltage provided to the engine in like manner. This includes setting up the VFD parameters, such as recurrence extend, voltage extend, and control mode. The equipment components, such as resistors, capacitors, diodes, and optocouplers, are at that point associated to the Arduino and VFD to empower legitimate communication and flag handling. The DC engine is associated to the VFD, and the system is powered up to test the speed control usefulness. The framework is at that point fine-tuned to realize the specified speed extend and execution [17-21].

2.3 Software programming

Within the Stream Chart of the planned control Framework, figure 5, the microcontroller peruses the required speed set by the client. The microcontroller peruses the current speed of the motor employing a input flag. The microcontroller compares the required speed with the current speed. If the current speed is lower than the desired speed, the microcontroller increases the VFD frequency to increase the motor speed. If the current speed is higher than the desired speed, the microcontroller decreases the VFD frequency to decrease the motor speed. The microcontroller continuously adjusts the VFD frequency until the motor speed reaches the desired speed. The microcontroller monitors the motor speed and adjusts the VFD frequency as necessary to maintain the desired speed. The user can change the desired speed at any time, and the microcontroller will adjust the motor speed accordingly[22-24].

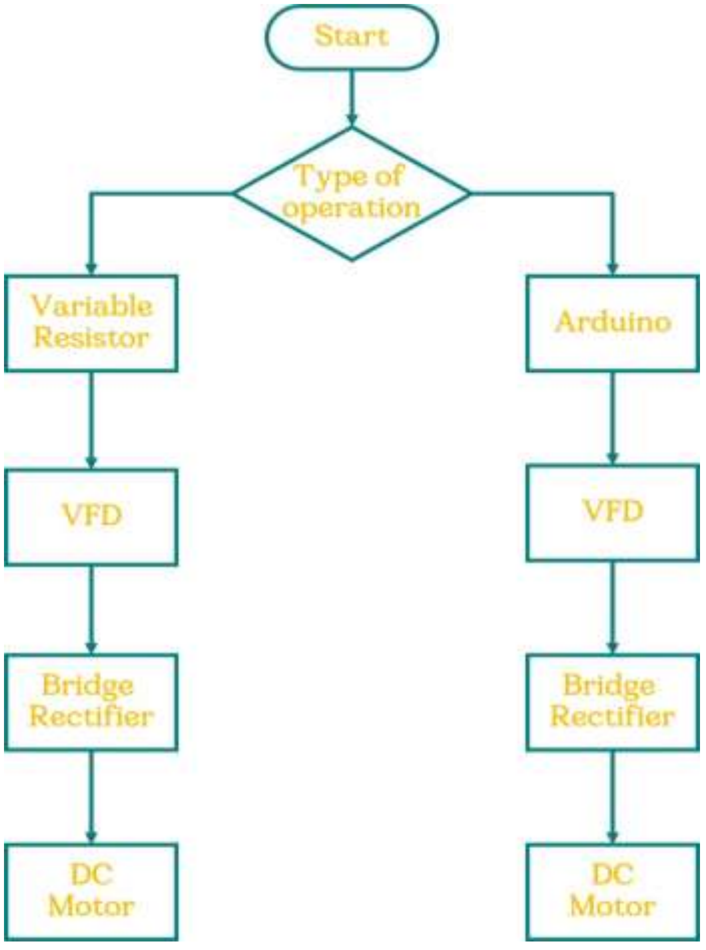

Fig.5. Flow chart of controller system.

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The programming of arduino figure 6, had been achieved for all inputs and outputs of the controller system and proved practically

Fig. 6. Code of Arduino.

3 Results and analysis

The function of the Arduino is to Supply (0-5v) where it is converted into (0- 20 HZ) where using Arduino controller gives us the automatic operation of the project. The final project is shown in figure 7

Fig. 7. Final association of the clinical clever bed.

In manual operation, figure 8, the speed of the DC motor is controlled by adjusting the potentiometer manually. The user has to monitor the motor speed continuously and adjust the potentiometer accordingly to maintain the desired speed. This method is not very precise, and it requires constant attention from the user.

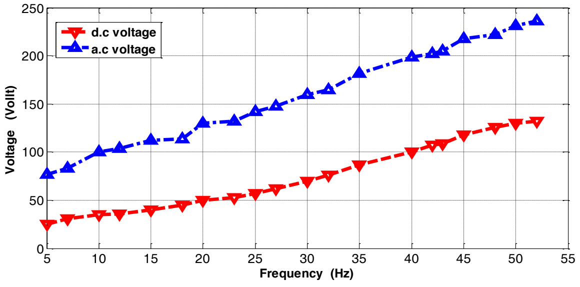

Fig. 8. Relation between frequency and voltage of manual operation VFD.

In programmed operation, figure 9, the speed of the DC engine is controlled consequently utilizing an Arduino microcontroller and a VFD. The microcontroller ceaselessly screens the engine speed and alters the VFD recurrence to preserve the required speed.

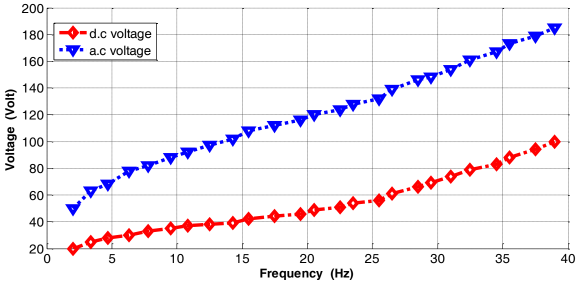

Fig. 9. Relation between frequency and voltage of automatic operation VFD.

The programmed operation is more exact and requires less consideration from the client. It too permits for the engine to be controlled remotely and can be coordinates into a bigger control framework.

4 Conclusion

The programmed speed controller of a DC motor utilizing Arduino and VFD procedures is an compelling arrangement for exact control of engine speed in mechanical applications. The framework offers a few preferences, counting tall exactness, moved forward proficiency, and decreased vitality utilization, compared to conventional speed control strategies. The criticism circle that utilizes a Hall-effect sensor and the Arduino microcontroller guarantees that the genuine speed of the engine is ceaselessly observed and balanced to coordinate the required speed.

Generally, the programmed speed controller of a DC motor using Arduino and VFD methods could be a solid and productive arrangement that can altogether progress the execution and vitality productivity of mechanical applications that require exact control of engine speed.

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