Advances and Applications in Mathematical Sciences
Volume 21, Issue 9, July 2022, Pages 5117-5124

SIMULATION OF TEMPERATURE BASED CLOSED LOOP SPEED CONTROL OF BLDC MOTOR USING LABVIEW

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Abstract

Energy is the backbone of a developing country like India. Electrical energy plays a major role in manufacturing, agriculture and other commercial activities. Electrical machine play a major role in all these activities. In emerging and recent applications like robotics, electric vehicles, process control etc. speed control of a motor is usually required. Brushless DC motors are being used in a variety of applications in today's world. They require greater economy, increased speed, improved torque speed characteristics, and a faster dynamic reaction in comparison with the normal motors. An improved BLDC motor speed system using PID Controller and temperature sensor, a closed loop system is used to improve the accuracy of control. PID Controller is the combination of Proportional, Integral, and Derivative control. This helps in improving rise time, reducing the overshoot and steady state error. PID controller is more accurate and stable compared to other basic controllers. Speed of motor has been varied in line with the predefined temperature and this helps in maintaining the desired temperature. This has been implemented using LabVIEW software, a graphical programming language. The execution of the system and results were verified using LabVIEW.

2020 Mathematics Subject Classification: 74G65.

Keywords: BLDC Motor, LabVIEW, Speed Control, PID Controller.
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Received January 22, 2022; Accepted May 23, 2022

1. Introduction

Motor speed control is frequently required in industrial applications, robotics, and home appliances, among other things. Automatic controls play an important role in human ways of living to make it more comfortable and efficient. A BLDC Motor speed control system is implemented and making it automatic by using Temperature sensor. The goal of speed control is to keep the motor running at the desired speed under various circumstances.

Brushless DC motors are electronic commutated DC motors without brushes. Brushless Motor replaces the mechanical commutation functions with Electronic Control. An ESC (Electronic Speed Controller) to control the brushless motor movement and Speed. A closed loop control system is a collection of devices that autonomously regulate process variables to a desired state or set point without the need for human intervention. Closed loop control systems are meant to achieve and maintain the target output condition automatically by comparing it to the actual situation.

The controller decreases the deviation of the actual value from the desired value. The controller's control action is to generate a control signal based on the applied input and feedback. On the basis of the input applied, controllers are majorly classified as:

- Proportional Controller
- Integral Controller
- Derivatives Controller

Steady state stability is described as an electric power systems ability to maintain its initial condition after a minor interruption or to return to a condition that is very similar to it when the disturbance persists. When planning and creating a power system, developing a particular automatic control device, bringing new elements of the system into operation, or adjusting its new operating condition, steady state stability is critical. The stability is chosen based on the needs of the stability limit or electrical energy quality in a steady state or during a transient. When power is increased very rapidly, the steady state limit refers to the maximum flow of power through a certain place without generating instability.

The project's goal is to create a system that can:

(a) Change the speed of the BLDC motor based on real-time situations and monitoring.

(b) Control the temperature and ensure proper ventilation of room automatically controlling the speed of the BLDC Motor using PID Controller.

2. Methodology

The diagram below Figure 1 depicts a block diagram of how the temperature based closed loop speed control of BLDC motor can be implemented.

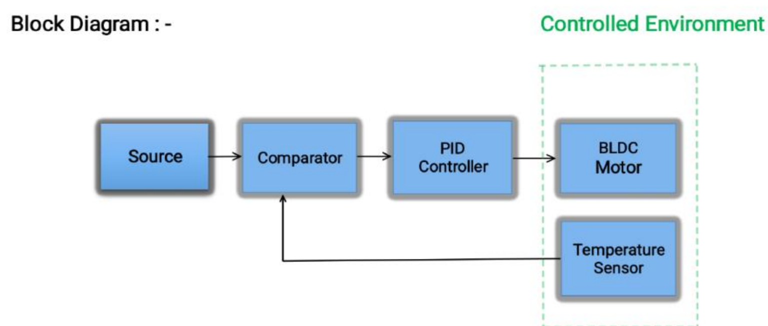

Figure 1. Block Diagram.

Source is the power supply of whole system which can be AC or DC as per use. Source gives the required power to operate the system efficiently. As the system is switched ON, initially the system will sense the temperature by using temperature sensor and gives the feedback to the comparator. Comparator is the important part which compares the input value and feedback from the temperature sensor simultaneously and according to that it gives input to the PID controller which uses its logic and processes it for that sensed surrounding temperature and sends it to the BLDC motor according to which its adjusts its speed and exhales out the inner heat which in results in cooling the surrounding where it is fixed.

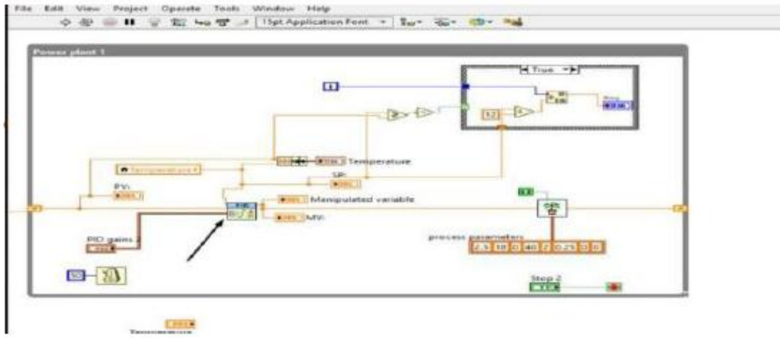

Figure 2. LabVIEW Circuit Diagram.

Figure 2 shows the system implemented in LabVIEW. In this way one cycle of speed control is done. If it decreases the temperature below the set value it got sensed by sensors and then again another cycle is processed and this is how the system maintains the set temperature by controlling the speed of BLDC motor.

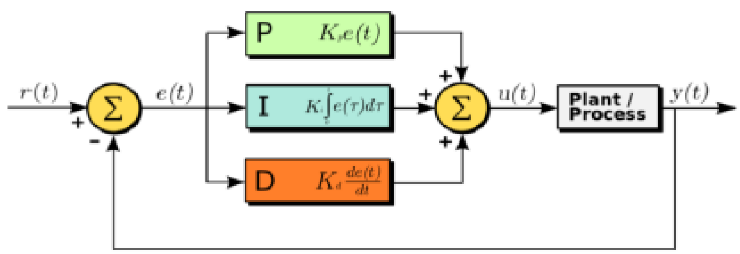

Figure 3. PID Controller.

A PID controller is a device that regulates temperature, flow, pressure, speed, and other process variables in industrial control applications. A basic PID controller is shown in Figure 3. Because they use a control loop feedback mechanism to control process variables, PID (proportional integral derivative) controllers are the most exact and stable controllers. The performance of P, PI, and PID controllers is compared. It should be noted that increasing the gain enhances the speed of reaction in the *P* and PID controllers, but decreases the gain of response in the PI controller. As a result, the steady-state error remains constant, putting the PID controller ahead of the *P* and PI controllers.

3. Results and Discussions

Temperature is rising to the set temperature that is 100.71° C and fan is not rotating as our process variable i.e. surrounding temperate in not above the desired temperature so there will be no feedback to controller and hence no changes until PV reaches to SP. Figure 4 shows the result for this condition.

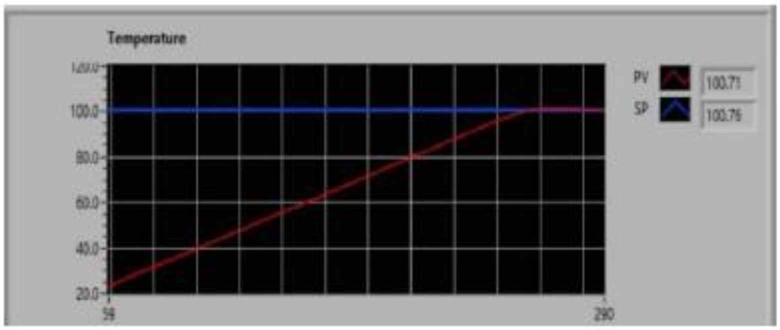

Figure 4. LabVIEW - based Real-Time Application Results.

As temperature(PV) rises above the set point it gives feedback to controller to work its algorithm and minimize the error and its input in given the motor which increases its speed from zero to the manipulated speed by PID so to maintain the given temperature BLDC Motor starts to rotate and try to decrease the temperature. The Set Temperature is 100.76° C for Figure 5.

Figure 5. LabVIEW based Real-Time Application Result.

Figure 6 shows the results when the system is monitoring real time. The system is continuously maintaining the set temperature by switching it ON and OFF as directed by the input of PID controller.

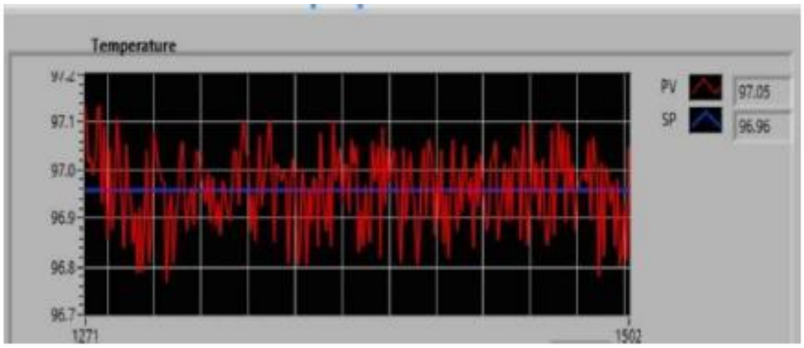

Figure 6. LabVIEW based Real-Time Application Result.

If the system is started at higher temperature let's say 125.23°C motor starts instantaneously as the temperature(PV) is above the set value(SP) which gives feedback to PID controller which gives input to motor and its starts rotating with high speed and tries to maintain the set temperature. Figure 7 showcases results for the above condition.

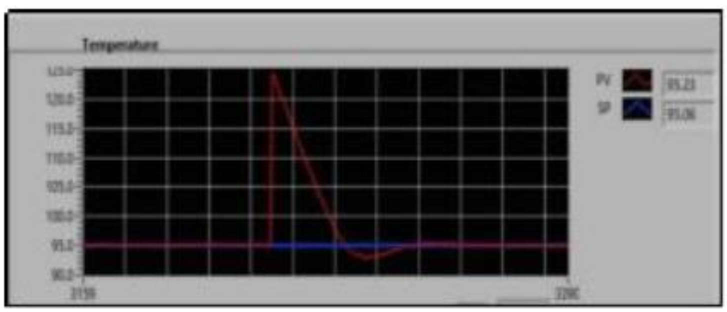

Figure 7. LabVIEW based Real-Time Application Result.

Table 2. Shows the results produced by our system from a PID controller based on LabVIEW for maintaining the set temperature at various values of Kc, Ti, and Td.

Table 2. Different Values of Kc, Ti, and Td.

S. No.	Kc (Proportional gain)	Ti (Integral time)	Td (Derivative time)	Settling Time
1.	2.000	0.008	0.001	60sec
2.	10.000	0.005	0.008	43sec
3.	20.000	0.008	0.001	28sec
4.	25.000	2.000	0.005	840sec
5.	30.000	0.015	0.005	30sec

4. Conclusion

In this project, a LabVIEW module was created to control the speed of a BLDC motor using a PID controller. The simulation has been done in LabVIEW software using DSC module and PID controller. The system is tested on different

- Set values of temperature
- Kc, Td and Ti values

and it is successfully able to maintain those set temperature without getting much deviated from the set point and without taking much time to settle on that desired temperature.

The framework once completely implemented it will empower LabVIEW observing of the parameters of BLDC motor. This project successfully showed that the speed control technique for BLDC motor using LabVIEW can be easily done. The System can be further enhanced by combining it with an IOT system which will make monitoring and controlling the system easier from different places. The system will find widespread use in places where continuous monitoring of temperature is needed as in a battery pack of electrical vehicles to avoid accidents and explosions happening.

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