iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 Issue: IV Month of publication: April 2026

DOI: https://doi.org/10.22214/ijraset.2026.80099

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue IV Apr 2026- Available at www.ijraset.com

Design and Implement of Speed Control of Dc Motor Using PLC

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Abstract: Design and Implementation of Speed Control of DC Motor Using PLCThe precise control of motor speed is an essential requirement in modern industrial automation systems. This project focuses on the design and implementation of a DC motor speed control system using a Programmable Logic Controller (PLC). A DC motor is widely used in applications requiring variable speed and high starting torque, making it suitable for controlled operations.
In this system, the PLC is used as the main control unit to regulate the speed of the DC motor by varying the input voltage through appropriate control techniques such as Pulse Width Modulation (PWM) or analog output control. The motor speed is monitored using feedback devices like a tachometer or encoder, and the PLC processes this feedback to maintain the desired speed accurately. The system includes input devices such as push buttons and sensors, and output devices like motor drivers and displays. The PLC is programmed using ladder logic to achieve automatic and manual speed control, ensuring flexibility and reliability in operation..
Keywords: DC Motor, Speed Control, Electrical safey, Industrial Automation

I. INTRODUCTION

Design and Implementation of Speed Control of DC Motor Using PLCIn modern industries, automation plays a crucial role in improving productivity, accuracy, and reliability. One of the key aspects of industrial automation is the precise control of motor speed, especially in applications such as conveyors, machine tools, rolling mills, and robotic systems. Among various types of motors, DC motors are widely preferred due to their excellent speed control characteristics, high starting torque, and simple control methods.

Traditionally, DC motor speed control was achieved using mechanical or analog techniques, which had limitations such as low efficiency, poor accuracy, and high maintenance requirements. With the advancement in digital control technology, Programmable Logic Controllers (PLCs) have become a popular choice for motor control applications due to their flexibility, robustness, and ease of programming.

A PLC is an industrial digital computer used to automate electromechanical processes. It can monitor inputs, process logic based on a program, and control outputs efficiently. In this project, the PLC is used to control the speed of a DC motor by regulating the applied voltage using methods such as analog output control or Pulse Width Modulation (PWM). Feedback from speed sensing devices like tachometers or encoders is used to achieve accurate and stable speed control.

II. LITERATURE REVIEW

1) Thue A. S. (2004)

Thue A. S. (2004) discussed the fundamentals of power system protection and emphasized protection schemes against faults such as overloads and short circuits. He highlighted that overload conditions primarily lead to overheating and insulation damage. The study explains that continuous monitoring of current is essential for preventing transformer failure and ensuring early fault detection. His work forms the foundation for modern digital protection systems and concludes that early detection greatly improves transformer reliability and lifespan.

2) B. Ravindranath & M. Chander (2007)

Ravindranath and Chander (2007) focused on protective relaying schemes used in power systems. They explained various transformer protection methods including overcurrent, differential, and thermal relays. Their work highlights the limitations of

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conventional electromechanical relays. They suggested adopting microprocessor-based protection systems for better performance. Their study supports the use of advanced electronic systems for increasing system safety, reliability, and faster response time.

3) C. L. Wadhwa (2010)

C. L. Wadhwa (2010) provided a detailed explanation of electrical power systems and transformer operation. He described how overloading affects equipment and transformers, leading to overheating and insulation failure. He emphasized the role of protective devices in preventing equipment failure.

According to him, thermal protection is one of the most reliable methods. The study supports continuous load monitoring for safety. It forms a theoretical base for transformer protection design.

4) J. Blackburn (2014)

Blackburn (2014) analyzed modern protective relaying techniques used in smart grids. He explained that digital relays offer improved speed and accuracy compared to traditional systems. The study emphasized communication-based protection systems and the integration of sensors with intelligent controllers.

5) Badr Ram & D. N. Vishwakarma (2015)

Badr Ram and Vishwakarma (2015) discussed power system protection in detail, focusing on transformer overload conditions. They explained that overload conditions cause gradual heating leading to insulation damage. The authors suggested using thermal and current-based protection methods.

Their work highlights the importance of coordinated protection schemes. They also discussed relay coordination for effective equipment protection.

6) J. Nagrath & D. P. Kothari (2016)

Nagrath and Kothari (2016) provided comprehensive coverage of electrical machines and power systems. They explained transformer losses under different load conditions and emphasized the importance of avoiding continuous overload. Their work shows how efficiency decreases with increasing load. They also suggested protective devices to maintain safe operation.

7) Paul Anderson (2017)

Paul Anderson (2017) focused on microcontroller-based protection systems for electrical equipment. He demonstrated how sensors can be integrated with controllers for real-time monitoring.

The study highlights the use of current sensors like ACS712 and emphasizes automated decision-making for fault isolation. His work supports modern embedded protection solutions.

III. PROBLEM DEFINITION

Design and Implementation of Speed Control of DC Motor Using PLC In many industrial applications, maintaining precise and stable control of DC motor speed is a critical requirement. Conventional methods of speed control, such as manual adjustment or analog controllers, often suffer from limitations like low accuracy, poor response to load variations, and high maintenance requirements.

IV. FUTURE SCOPE

1) Implementation of Advanced Controllers
2) Integration with HMI
3) IoT-Based Monitoring and Control
4) Energy Efficiency Improvement

V. OBJECTIVE

1) To design a PLC-based control system for regulating the speed of a DC motor efficiently.
2) To implement speed control techniques such as voltage variation or Pulse Width Modulation (PWM) using PLC.
3) To develop ladder logic programming for automatic and manual control of motor speed.
4) To achieve precise and stable speed control under varying load conditions using feedback mechanisms.

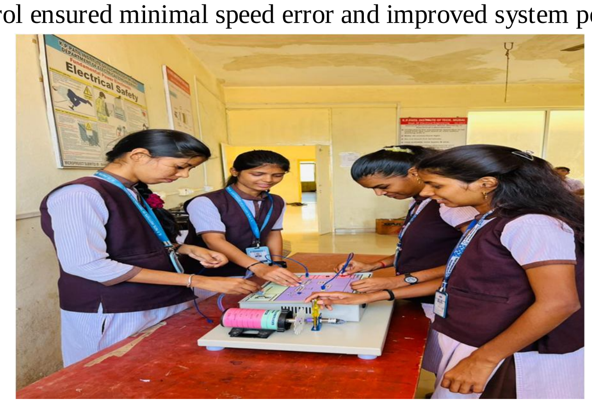
VI. METHODOLOGY

Start
↓
Power ON System
↓
Initialize PLC Program
↓
Input Desired Speed (Setpoint)
↓
Start DC Motor
↓
Read Actual Speed (Sensor Feedback)
↓
Compare Set Speed with Actual Speed
↓
Is Speed Equal to Setpoint?
↓ ↓
Yes No
↓ ↓
Maintain Speed | Adjust Speed (Increase/Decrease Voltage using PLC)
↓ ↓
←———————
Loop
↓
Stop Command Received?
↓ ↓
Yes No
↓ ↓
Stop Motor | Continue Process
↓
End

VII. RESULTS

Design and Implementation of Speed Control of DC Motor Using PLC

The PLC-based DC motor speed control system was successfully designed and implemented. The system was able to control the speed of the DC motor effectively using programmed ladder logic and appropriate control techniques such as voltage variation/PWM. The motor responded accurately to different speed setpoints provided through the input system. With the implementation of feedback (using a tachometer/encoder), the system maintained a stable and consistent speed even under varying load conditions. The closed-loop control ensured minimal speed error and improved system performance.



VIII. CONCLUSION

Design and Implementation of Speed Control of DC Motor Using PLC

The project successfully demonstrated the design and implementation of a DC motor speed control system using a Programmable Logic Controller (PLC). The system effectively controlled motor speed by regulating the input voltage through programmed ladder logic.

The use of PLC provided high accuracy, flexibility, and reliable performance compared to conventional control methods. With the implementation of a feedback mechanism, the system maintained stable speed even under varying load conditions, ensuring better efficiency and reduced errors.

IX. APPLICATIONS

1) Conveyor Belt Systems
2) Machine Tools
3) Robotics and
4) Rolling Mills
5) Elevators and Hoists

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