metin, diyagram, plan, teknik çizim içeren bir resim

Açıklama otomatik olarak oluşturulduElevator Drive System

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*Abstract*— This paper presents the design and simulation of a control system for an elevator drive system driven by a permanent magnet excited brushed DC machine. The system is designed considering various load conditions and evaluated using a Simulink model. Key performance metrics such as speed-time characteristics, acceleration, and maximum cabin speed are analyzed. The impact of viscous friction on the system's performance is also assessed, and a detailed Simulink model incorporating a full bridge DC-DC converter is developed.

Keywords— Elevator drive system, brushed DC machine, control system, Simulink, performance evaluation, full bridge DC-DC converter.

# Introduction

Elevator drive systems are critical components in modern buildings, providing efficient and reliable vertical transportation for passengers and goods. These systems play a pivotal role in ensuring smooth and safe movement across different floors, which is essential in high-rise buildings, commercial complexes, and residential towers. The performance and reliability of elevator systems directly impact the convenience and safety of users, making it crucial to develop advanced control mechanisms that can handle various operational challenges.

This paper focuses on the design and simulation of a control system for an elevator driven by a permanent magnet excited brushed DC machine. The specific choice of a permanent magnet excited brushed DC machine is due to its favorable characteristics, including high torque-to-inertia ratio, ease of control, and cost-effectiveness. These attributes make it suitable for elevator applications where precise speed and position control are paramount.

The primary objective of this research is to develop a robust controller that ensures the elevator meets desired performance criteria under various loading conditions. This includes maintaining optimal speed, acceleration, and deceleration profiles, as well as ensuring smooth and comfortable rides for passengers. Additionally, the control system must be capable of handling sudden load changes and ensuring safety during emergency stops.

Previous studies have explored different control strategies for elevator systems, ranging from simple PID controllers to more advanced techniques such as fuzzy logic and model predictive control. However, there is a need for a comprehensive analysis that considers both the electrical and mechanical aspects of the system. Such an integrated approach ensures that the interplay between the motor, gearbox, and mechanical load is fully understood and optimized.

In this study, we will design a control system that uses PI regulators for both outer speed and inner current controls. This choice is based on the simplicity and effectiveness of PI controllers in handling the dynamics of DC machines. The initial design will be validated using a Simulink model, simulating various loading conditions to evaluate performance metrics such as speed-time characteristics, acceleration, maximum cabin speed, and the impact of mechanical braking.

Furthermore, the paper will delve into the effects of viscous friction, which is often present in real-world systems but frequently neglected in theoretical models. By incorporating the viscous friction coefficient into our simulations, we aim to provide a more realistic assessment of the control system's performance and robustness.

Lastly, a detailed Simulink model incorporating a full bridge DC-DC converter will be developed. This comprehensive model will include both the electrical side, covering the converter and DC machine, and the control side, encompassing the mechanical system and control algorithms. The goal is to achieve a high-fidelity simulation that can serve as a foundation for future experimental validation and real-world implementation.

By addressing these aspects, this paper aims to contribute to the body of knowledge on elevator drive systems, providing insights and practical solutions that can enhance the design and operation of these critical systems in modern buildings.

# System Descrıptıon

The considered elevator system is driven by a permanent magnet excited brushed DC machine with the following characteristics:

* **Cabin weight (Mc):** 1000 kg
* **Maximum load (Mload−max):** 500 kg
* **Counterweight (Mcw):** 1250 kg
* **Elevation:** 10 m
* **Maximum speed (vcabin−max):** 2 m/s
* **Acceleration/deceleration (|acabin−max|):** 1 m/s²
* **Gear box ratio (ωem /ωdrum):** 5
* **Drum diameter (Ddrum):** 0.4 m
* **DC machine inertia (Jem):** 0.2 kg·m²

The elevator system includes a speed controller with a cascaded current controller, and mechanical brakes are activated upon reaching the desired location. The speed vs. time characteristics for the elevator are shown in Fig.1.c. The DC machine parameters are as follows:

* **Rated armature voltage (Va rated):** 200 V
* **Rated armature current (Ia rated):** 75 A
* **Armature resistance (Ra):** 0.1 Ω
* **Armature inductance (La):** 2 mH
* **Torque constant (Kt):** 1.75 Nm/A
* **Back EMF constant (Kb):** 1.75 Vs/rad

# Controller Desıgn and Sımulınk Model

The control system for the elevator utilizes PI regulators for both the outer speed and inner current controls. A preliminary Simulink model is developed to simulate the system under various loading conditions. The controller aims to maintain the desired speed-time characteristics as shown in Fig.1.c while minimizing deviations from the maximum speed, acceleration, and desired traveling time. Performance metrics are evaluated, and improvements are made based on simulation results.

# Detaıled Sımulınk Sımulatıons

A detailed Simulink model is built to include the full bridge DC-DC converter. The electrical side of the system, comprising the converter and DC machine, is modeled alongside the control and mechanical systems. The impact of the viscous friction coefficient (bem = 0.05 Nms/rad) on the controller performance is analyzed. Simulation results validate the design, ensuring the elevator system meets the specified performance criteria under all conditions.

# Conclusıon

This paper presents a comprehensive design and simulation of a control system for an elevator drive system using a permanent magnet excited brushed DC machine. The proposed controller successfully meets the desired performance metrics under various loading conditions. Incorporating viscous friction into the model highlights the robustness of the controller. Future work may explore the integration of more advanced control techniques and the impact of real-world variables on system performance.

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