Modeling and Parameter Estimation of a Linear Motion Unit

Team 2, Section 2

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***Abstract*—This project aims to build a mathematical model for a mechatronic system, estimate its parameters, and validate its performance. The system, a DC motor-driven linear motion unit, is experimentally tested to collect input and output data. The model is replicated in Simulink, and the Parameter Estimation tool is used to determine system parameters. The simulated response is compared with the physical model to evaluate accuracy and identify potential discrepancies. This work highlights the application of modeling, simulation, and parameter estimation methodologies in engineering practice.**

I. Introduction

The modeling and simulation of dynamic systems are fundamental to understanding and optimizing mechatronic systems. This project involves the design and testing of a linear motion unit driven by a DC motor. The project emphasizes the integration of theoretical modeling, experimental validation, and simulation using MATLAB Simulink. Parameter estimation is used to ensure that the model reflects the system's physical behavior accurately.

Fig. 1: Ain Shams University Logo

II. System Design and Components

A. Physical System

The physical system consists of:

- A DC motor coupled to a linear motion unit via a belt drive.
- A cart moving on a linear guide rail.
- Measurement interfaces for capturing input and output signals.

B. Simulation Environment

The simulation environment is developed in MATLAB Simulink, including:

- A block diagram representing the system's mathematical model.
- Parameter estimation tools to refine model accuracy.

III. Mathematical Modeling

A. Model Development

- Schematic representation of the system components.
- Derivation of mathematical equations governing the system dynamics.

B. Block Diagram

The system's block diagram is developed in Simulink to simulate its behavior under various conditions.

IV. Parameter Estimation

- Experimental data is collected by applying input signals to the physical system and measuring its response.
- The Parameter Estimation tool in MATLAB is used to adjust model parameters.
- Validation is performed by comparing the simulated response with experimental data.

V. Results and Analysis

A. Comparison of Models

[Provide graphical and numerical comparisons between the physical system's measured response and the simulated response.]

B. Discussion

[Discuss the accuracy of the parameter estimation and identify possible sources of error or improvement.]

VI. Conclusion

This work demonstrates the practical application of parameter estimation in mechatronic system modeling. The comparison between the physical and simulated systems highlights the effectiveness of the chosen methodologies and tools.

ACKNOWLEDGMENTS

The authors would like to thank the Department of Mechatronics Engineering at Ain Shams University for their support and resources.

REFERENCES

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