PARAMETER OPTIMIZATION FOR REACTION TORQUE OBSERVER BASED MOTION SYSTEMS

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Master of Science (Major Component Research)

Department of Electrical Engineering
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Thesis submitted in partial fulfillment of the requirements for the degree
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DECLARATION

I declare that this is my own work and this Thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature: ***UOM Verified Signature*** Date: 29/ 07/2024

The supervisor should certify the Thesis with the following declaration.

The above candidate has carried out research for the Master of Science (Major Component Research) Thesis under my supervision. I confirm that the declaration made above by the student is true and correct.

Name of Supervisor: Dr. A. M. Harsha S. Abeykoon

Signature of the Supervisor: Date:

30/7/2024

DEDICATION

This study is wholeheartedly dedicated to my beloved parents and my wife. Their endless love, unwavering support, and constant encouragement have been my pillars of strength throughout this journey. Without their guidance and belief in me, this achievement would not have been possible. Thank you for always being there for me.

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ABSTRACT

This thesis investigates the use of reaction torque observer (RTOB)-based controllers as a solution for the challenges associated with force sensors in motion systems. RTOB-based controllers provide significant advantages, including variable bandwidth, the capability to estimate unknown disturbances, and the feedback of disturbances to enhance system robustness. The model-based architecture of this approach necessitates precise parameter estimation, which is a critical aspect of stability analysis. Consequently, this thesis proposes a rapid and accurate method for parameter estimation, aiming to minimize computational expense.

A comprehensive stability analysis is conducted to determine the conditions under which RTOB-based controllers maintain robust performance. The stability study considers various environmental conditions and controller settings to provide guidelines for achieving optimal stability. Additionally, the study explores the effects of external vibrations on system performance and the effectiveness of the controller in suppressing these vibrations.

The findings demonstrate that RTOB-based controllers can significantly improve system performance by providing variable bandwidth, enhancing robustness, and accurately estimating unknown disturbances. The proposed optimization of controller parameters and the novel parameter estimation technique offer valuable insights for scientists and engineers to implement this strategy in various motion systems.

Overall, this research advances the field of motion systems by providing a viable alternative to traditional force sensors and emphasizing the importance of vibration suppression and stability analysis. The outcomes have implications for the design and development of motion systems across different applications, enhancing their overall effectiveness and reliability.

Keywords: Disturbance Observer, Reaction Torque Observer, Parameter estimation, Stability analysis, Vibration suppression

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