

**LOWER-LIMB EXOSKELETON WITH MODERN CONTROL
ENGINEERING APPROACH**

By

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LOWER-LIMB EXOSKELETON WITH MODERN CONTROL ENGINEERING APPROACH

STATEMENT BY THE AUTHOR

I hereby declare that this submission is my own work and to the best of my knowledge, it contains no material previously published or written by another person, nor material which to a substantial extent has been accepted for the award of any other degree or diploma at any educational institution, except where due acknowledgement is made in the thesis.



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ABSTRACT

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This research presents an integrated control and electrical system framework for a lower-limb exoskeleton, with the primary goal of making this assistive technology more affordable and accessible. The purpose of this study is to address the high cost and complexity of current systems by demonstrating a co-designed framework from hardware architecture to control implementation. The methodology involves three core objectives: first, designing an electrical system architecture capable of supporting high-fidelity, closed-loop feedback; second, developing an algorithm for generating smooth, physiologically realistic gait trajectories using a Fourier series approximation; and third, designing and validating, through simulation, a modern control algorithm to solve the trajectory tracking problem with high accuracy. This study concludes by presenting a validated, practical framework that serves as a blueprint for future development of cost-effective, high-performance exoskeletons, contributing valuable knowledge to the fields of mechatronics and rehabilitation robotics.

Keywords: Lower-Limb Exoskeleton, Modern Control Engineering, Fourier Series, Gait Rehabilitation, Nonlinear System

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DEDICATION

I dedicate this work to my beloved family, who always ask me what I study.



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First and foremost, I would like to thank my God, the Triune God, for His mercy and love. So I can write this book and work on my thesis. I thank my advisor and co-advisor, Dr. Eka Budiarto, S.T., M.Sc., and Ms. Lydia Anggraeni Kidarsa, S.T., M.Sc., MA(RCA) DIC. Also, as a part of the research team, member Mr. Hartono, S.T., M.T., for the advice that they gave to me, I would like to thank my partner in this thesis, Nathanael Wijaya Saputra, for helping me with many things in this thesis work. Also, Maria Esperanza, who always asks me what she can do in order to help me. Not forgetting my family, who have always supported me throughout my life, and my friends who are not coming from SGU. May these works contribute, be an inspiration for others to embrace the nonlinearities in life, and make sure that chaos is just a part of life that is inseparable from our lives. Let this work also glorify my God, the living God, the triune God.

Soli Deo Gloria.

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