DEVELOPMENT OF AN UPPER-LIMB POWER-ASSIST EXOSKELETON ROBOT TO GENERATE HUMAN LIKE MOTION

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Degree of Master of Philosophy

Department of Mechanical Engineering

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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.

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ABSTRACT

Weakness is inherently associated with ageing society. In fact, Exoskeleton robotic technology can be used to provide assistance for age society to perform activities of daily living (ADL) without depending on others.

Upper limb exoskeleton robots are much suitable to perform ADL. Typically, upper limb exoskeleton robot consists of number of joints and links which are corresponding to joints and limbs of human upper limb. Further, exoskeleton robots differ from other conventional robots due to present of close interaction with wearer. In general, two types of interaction can be seen in exoskeleton robots: physical human robot interaction (pHRI) and cognitive human robot interaction (cHRI).Strengthening features of cHRI can be seen on recent developments of upper limb exoskeleton robots. However, there exists a vacuum to identify aspects of pHRI relating to performance of exoskeleton robots.

The research work of this thesis is focused to design an upper limb exoskeleton robot for motion assist taking effect of kinematic redundancy. The proposed exoskeleton robot (6-REXOS) has four active degree of freedom (DOF) and two passive DOF in its kinematic chain. Two passive DOF are provided to 6-REXOS by means of flexible bellow coupling and those are positioned at wrist and elbow joint of the 6-REXOS to keep their axes parallel to each other. This configuration enhances kinematic redundancy in 6-REXOS. The effect of redundancy is verified with respect to dexterity measures, such as manipulability index, minimum singular value, and condition number. Further, manipulation of end-effector of 6-REXOS due to kinematic redundancy in operational space is presented base on manipulability ellipsoids.

4DOF kinematic model for human lower arm is proposed in thesis. Manipulability measure of human kinematic model is used to benchmark the performance of 6-REXOS. Different measures are taken into account in design of 6-REXOS to ensure smooth pHRI. Passive compliance of bellow coupling in order to reduce kinematic discrepancy as well as improve the manipulation of 6-REXOS is highlighted in this thesis.

Key words: Exoskeleton robot, Redundancy, Compliance, Manipulability index, Minimum singular value.

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LIST OF ABBREVIATIONS

Abbreviation	Description
ADL	Activities of Daily Living
pHRI	Physical Human Robot Interaction
DOF	Degree of Freedom
cHRI	Cognitive Human Robot Interaction
RTB	Robotic Tool Box

LIST OF APPENDICES