REACTION TORQUE OBSERVER BASED FORCE FEEDBACK GRIPPER WITH FORCE LOCK

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(148032B)

Degree of Master of Science

Department of Electrical Engineering

University of Moratuwa

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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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Dr. A. M. Harsha S. Abeykoon

ACKNOWLEDGEMENTS

This thesis is a partial requirement for the completion of Master of Science degree in University of Moratuwa. This text is a compilation of research work that has been carried out at the Control and Robotics Laboratory, Electrical Engineering Department, Faculty of Engineering, University of Moratuwa, SriLanka.

This research was performed under the supervision of **Dr. A. M. Harsha S. Abeykoon**. I would like to show him my gratitude for his continuous guidance and support to fulfill this task.

Many thanks and gratitude to **Prof. Sudath Rohan Munasinghe,** Electronic and Telecommunication Engineering Department and **Dr. W. D. Asanka S. Rodrigo,** Electrical Engineering Department, Faculty of Engineering, University of Moratuwa. As the review panel, their valuable comments, encouragements and discussions in the progress review meetings helped me to achieve this task.

I deeply thank to my postgraduate colleagues Mr. W. A. S. P. Abeysiriwardhana, Mr. M.A. V. J. Muthugala and Mrs. M. P. Menikdiwela at the Department of Electrical Engineering, Faculty of Engineering, University of Moratuwa for their helping hand during difficult tasks.

All members of Electrical Engineering Department, University of Moratuwa are also gratefully acknowledged. They constantly helped me during my research activity.

I would like to express my sincere gratitude to all those who have assisted me in my life specially my parents Mr. R. M. Gunawardhana and Mrs. L. Karunawathie. Last but not least, I should thank Dr. A. M. Harsha S. Abeykoon for his guidance.

Finally, I would like to thank everybody who was important to the successful realization of thesis, as well as expressing my apology that I could not mention personally one by one.

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University of Moratuwa
September 2015

ABSTRACT

Haptic information is a bilateral information of the law of action and reaction. Most of the researchers have done experiments on bilateral teleoperation but still they haven't given much attention on force lock during bilateral teleoperation even though it's important in the latest technology. This research proposes an enhanced force limiting gripper to avoid object deformation when it is in contact with the slave due to excessive forces imposed by the master operator in bilateral control. The force lock protects the gripped object on the slave and the attainment of the force limit is notified to the master operator via a small vibration. Master operator is expected to experience a spring effect if the operator presses his leaver towards the force increasing direction. The continuous copying of the slave position as the reference to the virtual spring controller's spring equilibrium point allows smooth releasing. In addition to vibration the loss of reaction force coming from the slave environment could also be sensed by the master operator. Releasing logic of force lock can be determined by the operator. In this proposed system sensor-less sensing is used. Disturbance Observer (DOB) is used to estimate disturbances and Reaction Torque Observer (RTOB) estimates reaction forces.

The reaction from real world includes not only position and force information but also environmental impedance. The griped object impedance variation with the motion parameters of the actuator should also be analyzed. In this research, the behavior of environmental object impedance has been studied with the changes of the different motion parameters of the actuator, like applied force, velocity, position and depth on the object 3D space. This idea is exemplified using a rubber balloon and a rubber sponge which is often modeled using simple linear equations.

The proposed system is tested using hardware setup and results prove the applicability of RTOB and DOB for force feedback gripper for haptic teleoperation. The results of variable impedance model as function of its motion parameters suggests nonlinear impedance variations against the motion parameters of the environmental object.

Key words; Haptic teleoperation, Disturbance Observer, Reaction Torque Observer, Force lock, variable impedance model.

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LIST OF ABBREVIATIONS

Abbreviation	Description
DOB	Disturbance Observer
RTOB	Reaction Torque Observer
DOF	Degree of Freedom
FSR	Force Sensing Resister
SPI	Serial Peripheral Interface
QEI	Quadrature Encoder Interface
ppr	pulses per revolution