

REACTION TORQUE OBSERVER BASED FORCE FEEDBACK GRIPPER WITH FORCE LOCK

Rathnayake Mudiyansele Maheshi Ruwanthika

(148032B)



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Department of Electrical Engineering

University of Moratuwa

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Rathnayake Mudiyanse Lage Maheshi Ruwanthika

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Science

Department of Electrical Engineering

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DECLARATION

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Dr. A. M. Harsha S. Abeykoon

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Rathnayake Mudiyanseelage Maheshi Ruwanthika.

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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 lever 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 gripped 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



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