

**TRANSPARENCY AND OPERATIONALITY
IMPROVEMENTS IN SCALED BILATERAL CONTROL
SYSTEM**

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Thesis submitted in partial fulfillment of the requirements for the degree Master
of Science of Engineering

Department of Electrical Engineering

University of Moratuwa

Sri Lanka

February 2015

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

My sincere thanks and gratitude go to Prof. N. Wickramarachchi, Prof. Sisil Kumarawadu, Dr. Chandima D. Pathirana, Dr. W. D. Asanka S. Rodrigo and Dr. A. G. Buddhika P. Jayasekara, Electrical Engineering Department, Faculty of Engineering, University of Moratuwa. Being the members of the review panels, their valuable comments, encouragements and discussions in the progress review meetings helped me to fulfill this research task successfully.



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I deeply thank to the other postgraduate students: Mr. Branesh Pillai, Mr. Dinesh Chinthaka, Ms. Medhani Menikdiwela, Mr. Nishal Dayarathna, Ms. Maheshi Ruwanthika, Mr. Shanaka Abeysiriwardana and Mr. Viraj Muthugala who helped me in many ways during this postgraduate program. All members of the Department of Electrical Engineering, University of Moratuwa are also gratefully acknowledged. They constantly helped me during my research activity.

Godagama Vidana Arachchilage Gayan Asanka Perera

University of Moratuwa

February 2015

ABSTRACT

Scaled bilateral teleoperation is a very useful and highly researching concept in motion control arena. There are many researches available in the areas of bilateral teleoperation related performance optimizing. This research addresses the most important two objectives of the bilateral teleoperation: transparency and operability. The research consists of two main parts: Transparency and Operability Improvements in bilateral teleoperation and Inertia Estimation for Robust Bilateral Control.

In the first part of the research, a bilateral control system is proposed with the scaling factors derived in terms of the master and slave inertia values. Further, this concept is improved by introducing arbitrary force and position scaling factors in addition to the nominal inertias. The main objectives of bilateral teleoperation are to achieve the ideal transparency and operability conditions. In the proposed design, a condition for ideal transparency and operability is introduced for a bilateral teleoperation system which performs force and position scaling tasks. The system performance is analyzed considering the system frequency responses and root loci. This proposed system is simulated and verified the performance using the standard stability analysis tools.

In the second part of the research, a method to estimate the accurate master and slave inertias is proposed. Estimating the correct inertia values is very important to achieve the desired transparency and operability. The basic building block of the master and slave robots is the DC motor. Usually, the manufacturer given inertia value differs from its actual value due to various reasons. In this approach, a method to accurately estimate the DC motor inertia value is proposed. This method was tested on the real bilateral platform and proved the validity by measuring the force and position responses. The inertia value calculated using proposed method is applied to the bilateral controller and compared with the inertia values calculated using the conventional methods. The experimental results show the validity of the proposed method.

Keywords: bilateral teleoperation, bilateral scaling, force scaling, position scaling, bilateral transparency, bilateral operability, inertia estimation.

TABLE OF CONTENTS

DECLARATION	i
ACKNOWLEDGEMENTS	ii
ABSTRACT	iii
LIST OF FIGURES	vi
LIST OF TABLES	vi
1 INTRODUCTION	1
1.1 Background.....	1
1.2 Scaled Bilateral Teleoperation Literature Review.....	3
1.2.1 Overview.....	3
1.2.2 Bilateral scaling.....	4
1.2.3 Power scaling.....	5
1.2.4 Impedance scaling.....	7
1.2.5 Force/position scaling.....	12
1.2.6 Disturbance observer.....	12
1.2.7 Reaction Torque Observer.....	14
1.3 Originality.....	15
1.4 Content of the paper.....	16
2 TRANSPARENCY AND OPERATIONALITY IMPROVEMENTS	18
2.1 Transparency and Operability.....	18
2.2 Hybrid parameters.....	20
2.3 Design of scaled bilateral controller.....	21
2.4 The proposed architecture.....	22
2.5 Frequency analysis of hybrid parameters.....	26
2.6 Stability.....	27
2.7 Root locus analysis.....	29
2.8 Discussion.....	31
3 INERTIA ESTIMATION FOR ROBUST BILATERAL CONTROL	32
3.1 Introduction.....	32
3.2 System modeling.....	33
3.2.1 Conventional inertia estimation methods.....	35
3.2.2 Proposed change of inertia observer.....	35
3.2.3 Inverse motion acceleration test.....	38
3.3 Results and discussion.....	39
3.3.1 Selecting bilateral control for inertia verification.....	39
3.3.2 Experimental setup.....	41

3.3.3	Estimation of motor inertia experimentally.....	42
3.3.4	Validating the results with bilateral teleoperation.....	45
3.4	Conclusion.....	47
4	CONCLUSIONS.....	49
4.1	Recommendation for future developments.....	50
5	REFERENCES.....	51
6	APPENDIX.....	54



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LIST OF FIGURES

Figure 1: Bilateral teleoperation system.	2
Figure 2: Bilateral force and position scaling	5
Figure 3: One DOF teleoperator system with an ideal power scaling.	6
Figure 4: Two-port network representation of teleoperator system.....	7
Figure 5: Scattering-wave variable architecture for bilateral teleoperation.....	9
Figure 6: General four-channel bilateral teleoperation system block diagram.	11
Figure 7: Disturbance observer.....	13
Figure 8: Reaction torque observer.....	14
Figure 9: Flow of environmental information in a general two port bilateral model	19
Figure 10: 4-channel bilateral controller with disturbance observer	20
Figure 11: Conventional bilateral control system [44]	25
Figure 12: Proposed bilateral control system.....	25
Figure 13: Frequency response of the system.....	28
Figure 14: Phase-gain plot of transparency and operability.....	29
Figure 15: Root locus analysis.....	30
Figure 16: Change of inertia observer.	36
Figure 17: Torque responses.....	38
Figure 18: Velocity response of the inverse motion acceleration test.	38
Figure 19: Frequency response of the master or slave system.....	41
Figure 20: Bilateral test platform.....	42
Figure 21: Velocity responses.....	44
Figure 22: Torque response of CIOB test.....	45
Figure 23: Position and torque responses.	46



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LIST OF TABLES

Table 1: System parameters used for analysis	27
Table 2: DC motor parameters.....	42
Table 3: Inertia estimation results.....	43