TRANSPARENCY AND OPERATIONALITY IMPROVEMENTS IN SCALED BILATERAL CONTROL SYSTEM

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DECLARATION

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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 operationality. The research consists of two main parts: Transparency and Operationality 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 operationality conditions. In the proposed design, a condition for ideal transparency and operationality 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 operationality. 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 operationality, inertia estimation.

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