MASTER

Kinematic and Dynamic Modeling and System Identification of the MUSA Robot

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Public Summary

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Abstract

The MUSA is a robotic system designed to aid surgeons in microsurgerical applications. It is designed to provide high precision, enabling interventions that are impossible to perform by hand or only possible by a select group of surgeons. To achieve high precision, the MUSA should be well designed and feature an accurate control system. For this reason, the need for an accurate model describing the motion dynamics of the system arises. The dynamic model of a robotic system is often employed as a simulation tool in the design stage, as well as in the implementation of model-based control strategies. Therefore, the main objective of this thesis is to derive an accurate dynamic model of the MUSA. This goal is separated into two steps, namely dynamic model derivation and parameter identification. Much research has been done regarding dynamic modelling of robotic systems. However, what makes the MUSA unique is the presence of a parallelogram mechanism and multi degree of freedom (DOF) joints. The dynamic model is derived by first deriving a geometric model using the modified Denavit-Hartenberg (MDH) approach. Then, a kinematic model is derived, relating the twist of every body to the joint variables. Finally, the dynamic model is derived in terms of the base parameters, a minimum set of dynamic parameters describing the dynamics of the system. This model can be extended by incorporating parasitic dynamics, on which a literature survey is presented.

In order to identify the unknown dynamic parameters, a parameter identification method has to be employed. Dynamic parameter identification has been studied thoroughly, as it is a necessary step in the identification process of any robotic system. To apply the most popular identification approaches, the dynamic model of the MUSA is integrated within the BIRDy (Benchmark for Identification of Robot Dynamics) framework. The approach consists of excitation trajectory generation, experimentation, data pre-processing and parameter estimation. The full approach is tested on a case study, in which the behaviour of the MUSA is simulated, due to absence of real experiment data. The results indicate that the identification approach works as intended, thereby providing a starting point for when experimentation on the MUSA would be possible in the future.