Design of a Shared Human and Obstacle Avoidance Control for Image-Guided Therapy Robots

van der Horst, Anne

Award date:
2023

Master Mechanical Engineering
Department of Mechanical Engineering
Control Systems Technology

Design of a Shared Human and Obstacle Avoidance Control for Image-Guided Therapy Robots

Graduation Project
CST2023.024

PUBLIC SUMMARY

A. van der Horst 1267876

dr. E. Torta (TU/e) Thesis supervisor
dr. ir. B.L. van de Vrande (Philips) Thesis supervisor

This report was made in accordance with the TU/e Code of Scientific Conduct for the Master thesis.

Eindhoven
June 4, 2023

1 Public Summary

To include a human in the loop for control systems while maintaining certain autonomous control properties, a shared control framework is designed for Image-Guided Therapy (IGT) robots. The designed shared control combines the human teleoperation input with autonomous obstacle avoidance. To optimize for both, sometimes conflicting, inputs, a Nonlinear Model Predictive Control (NMPC) approach is employed. The NMPC implements reference tracking to align with the desired end-effector velocity requested by the user and circumvents known obstacles in the environment using a penalty function that penalizes the signed distance to obstacles of the collision spheres surrounding the robotic manipulator. To optimize the performance of the shared control, a Bayesian Optimization (BO) for parameter tuning of model predictive controllers is utilized. The shared control is assessed through a within-subject experiment for both the original and BO-optimized cases using a Virtual Reality (VR) setup of the IGT robot. The experiment demonstrated that the participants are proficient in operating the manipulator utilizing the shared control system and that the BO-optimized case outperformed the original configuration.