

MASTER

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

van der Horst, Anne

Award date:
2023

[Link to publication](#)

Disclaimer

This document contains a student thesis (bachelor's or master's), as authored by a student at Eindhoven University of Technology. Student theses are made available in the TU/e repository upon obtaining the required degree. The grade received is not published on the document as presented in the repository. The required complexity or quality of research of student theses may vary by program, and the required minimum study period may vary in duration.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain

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.