

Design of a compact robotic assisted ophthalmic system

Citation for published version (APA):

Meenink, H. C. M., Steinbuch, M., & Rosielle, P. C. J. N. (2011). *Design of a compact robotic assisted ophthalmic system*. E-Abstract 6125-.

Document status and date:

Published: 01/01/2011

Document Version:

Accepted manuscript including changes made at the peer-review stage

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

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
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

www.tue.nl/taverne

Take down policy

If you believe that this document breaches copyright please contact us at:

openaccess@tue.nl

providing details and we will investigate your claim.

Design of a compact robotic-assisted ophthalmic surgical system

Thijs MEENINK^{1,*}, Maarten STEINBUCH¹, Nick ROSIELLE¹ and Marc D. DE SMET^{2,3}

1. Mechanical Engineering, Technische Universiteit Eindhoven, Eindhoven, The Netherlands; 2. Retina & Inflammation Unit, Montchoisi Clinique, Lausanne, Switzerland; 3. University of Amsterdam, The Netherlands

*Thijs Meenink MSc.
Department of Mechanical Engineering
Control Systems Technology
PO Box 513, WL 1.59
5600 MB Eindhoven
The Netherlands
Tel. +31 40 247 4580
Fax. +31 40 246 1418
h.c.m.meenink@tue.nl

Abstract

Purpose

Robotics have enhanced and refined microinvasive surgery in several disciplines. Its applicability in eye surgery has been limited by ergonomic and scaling issues. Our aim was to design and build a microrobotic system adapted to the needs of vitreoretinal surgeons.

Methods

Constraints regarding head positioning and size, ocular access, surgical execution, and procedural requirements were defined by observations at live surgeries, discussions with surgeons, operation room teams, and computer simulations. Additional design parameters for the robotic slave (RS) included a low weight, high stiffness, low friction and play-free design. For the control module (CM), intuitiveness of the controller, body posture of the operator and patient proximity were considered.

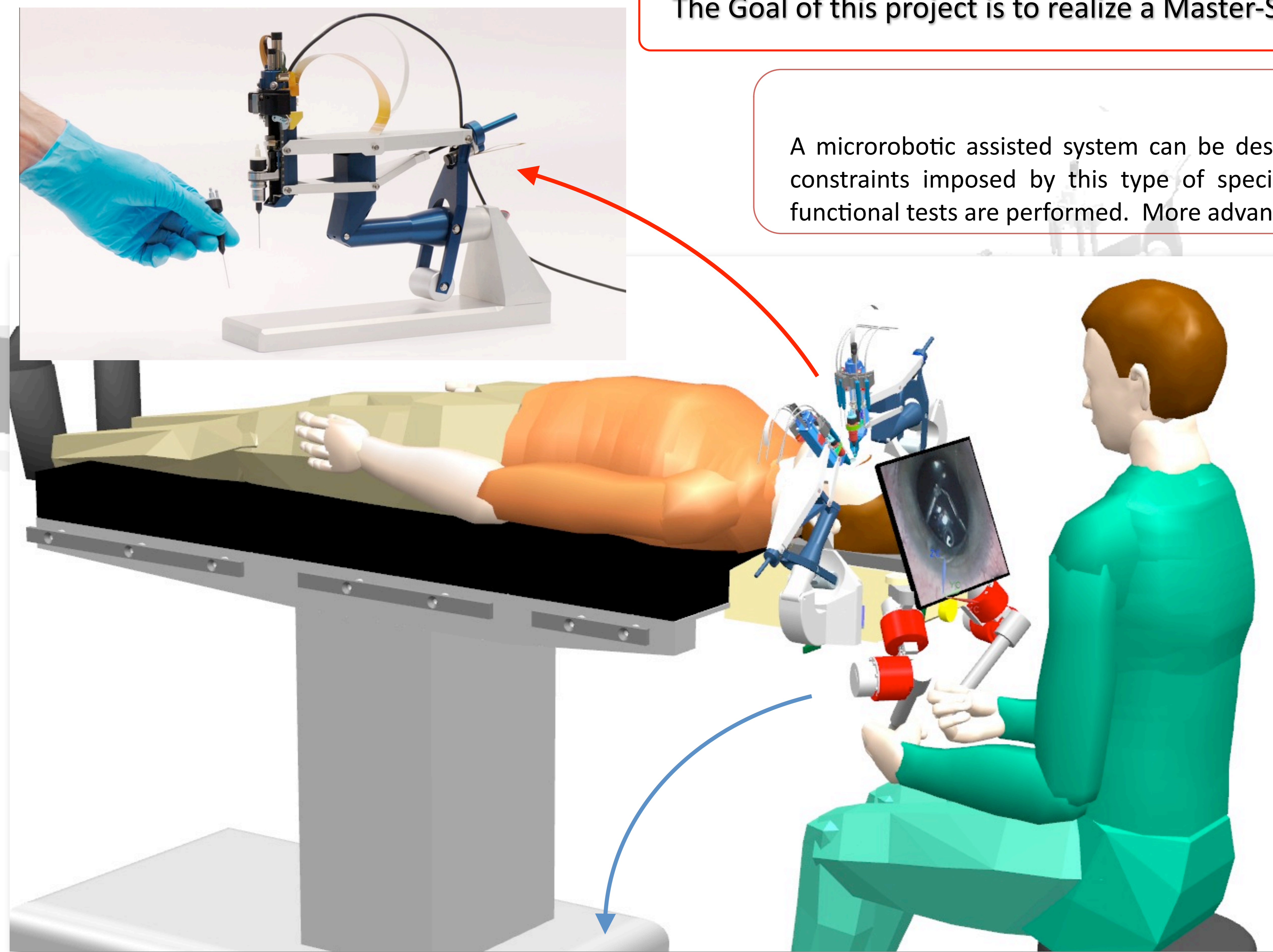
Results

The RS consists of at least two instrument manipulators (IMs). The IM's design allows 5 degrees of freedom through a kinematically defined rotation point at the entry site into the sclera. Force measurement down to 10mN is possible and manipulation with an accuracy of <10 μ m. The design allows the back 180° of the eye to be reached.

The CM portion consists of two haptic interfaces (HI) with encoders for position input and motors to provide force feedback. A comfortable and intuitive working environment was created by manipulating the HIs to simulate the instrument tip inside the eye.

Conclusion

A microrobotic assisted system can be designed for vitreoretinal surgery that meets the requirements and constraints imposed by this type of specialized surgery.



The Goal of this project is to realize a Master-Slave system for robotically assisted vitreoretinal surgery.

Conclusion

A microrobotic assisted system can be designed for vitreoretinal surgery that meets the requirements and constraints imposed by this type of specialized surgery. A master-slave system is designed, realized and functional tests are performed. More advanced tests e.g. in Vitro will be performed in the near future.

Results

Designs of a CM and RS are made, realized and first functional tests are performed. Both CM and RS are supported by a pre-surgical adjustment system, integrated into the patient's headrest (figure 1). Adjustments are made to position the RS over the left or right eye. The CM is adjusted for surgical ergonomics.

Robotic Slave

The RS is provided with multiple instrument manipulators (IMs, fig. 3). The design of the IM is such that the point where the instrument enters the eye is kinematically defined. This results in an intrinsically safe design. Four degrees of freedom (DoFs) about the entry point are desired (fig. 2, left). A fifth DoF is used to actuate the instrument, e.g. forceps. The IMs range of motion is indicated below.

ϕ - ψ	Z	θ
+/- 45°	>30 mm	360°

The instrument manipulator layout and reach, enables the surgeon to operate the vitreous humor and the complete back 180° of the retina. Key properties of the IM are: (1) force measurement with a resolution of 1 mN, (2) manipulation with an accuracy of <10 μ m, (3) high stiffness, (4) backlash free and (5) it is equipped to perform a complete intervention.

For the use of different instrument, the IMs are equipped with an onboard changing system. Changing an instrument is performed in a fast and secure matter.

Master console

The main components of the master are haptic interfaces and a 3D-display for visual feedback. A comfortable and intuitive working environment was created by manipulating the HIs to simulate the instrument tip inside the eye. Therefore the geometry of the DoFs are placed as such (figure 2). All DoF in the master are optimized, backdrivable and equipped with an electric motor to provide the most accurate force feedback. Movements are measured by encoders for position input for the RS.

Master slave system

Robotically assisted surgery has various advantages over manual performed surgery.

- Scaled instrument movements
- More delicate and accurate movements
- Filtering of hand tremor or sudden movements
- Forces below the human detection level can be measured and can be fed back amplified to the surgeon.
- The system can put on hold.
- Automation of surgical tasks
- Change of instruments can be automated
- Various safety measures can be incorporated

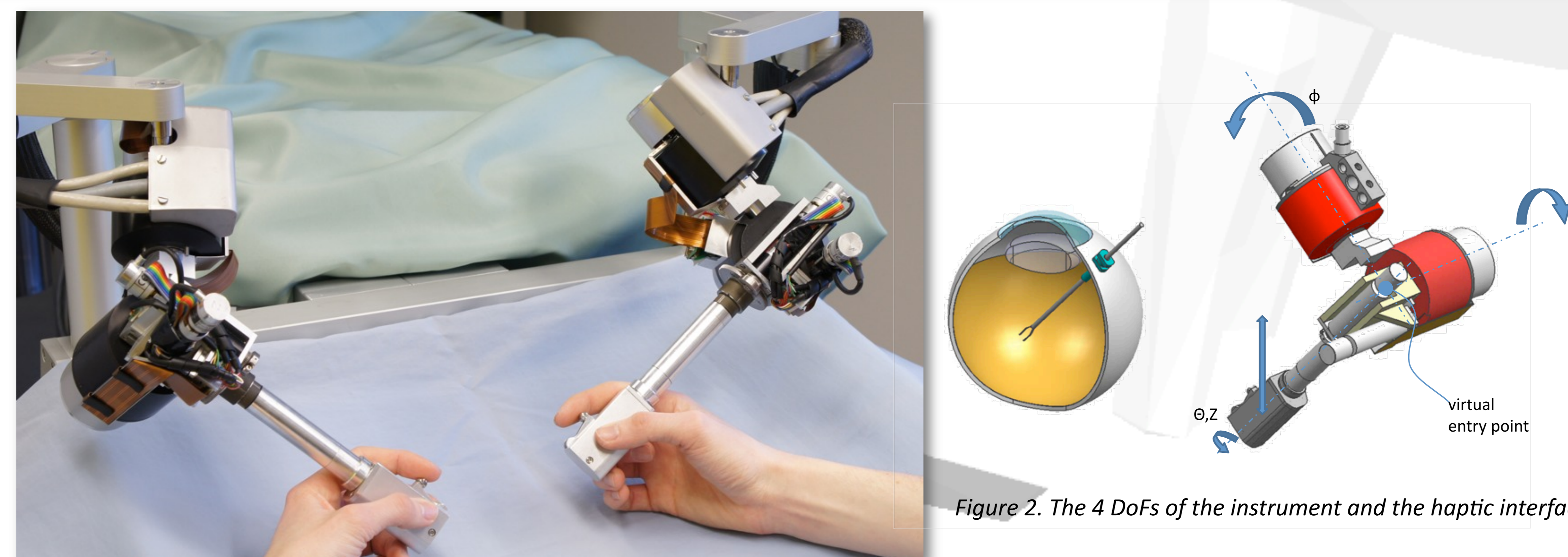


Figure 2. The 4 DoFs of the instrument and the haptic interface

