Introducing Virtual Reality in Robot Assisted Minimally Invasive Surgery Team Training

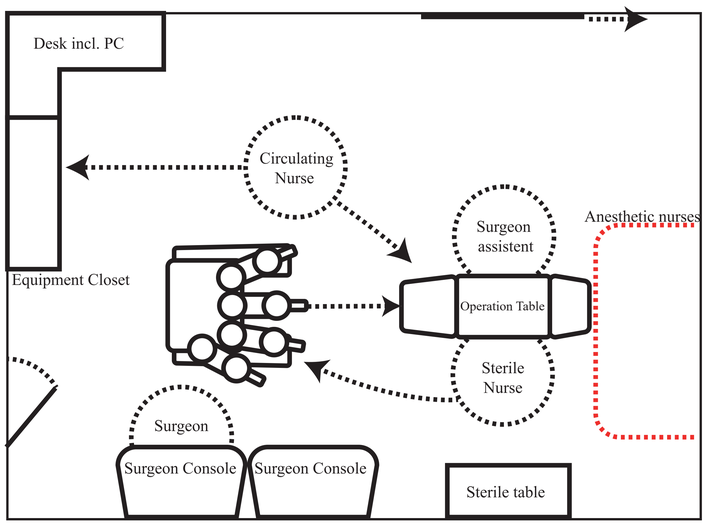
1 Introduction

Surgical robotics has evolved quickly since the 1980's and will continue to do so in the future [1]. Although robot assisted minimally invasive surgery (RAMIS) is at worst as effective and at best lowers injury, complication, and death rates significantly compared to conventional surgery, errors still occur [2]. Alemzadeh et al. found that around 17.4% of deaths during RAMIS occurred during the operation, and 7% were due to staff mistakes [3]. The majority of injuries were caused by device malfunction, but a not insignificant amount were due to staff errors. Training of robot surgery staff have proven beneficial in this regard as more experienced surgeons are less prone to errors. This paper hypothesizes that virtual reality (VR) can simulate this team training with sufficient accuracy, thereby increasing accessibility of training.

2 Context Study

Active observations of RAMIS surgeon and team training for were needed to assess the implementation requirements whereas semi-structured interviews with Jane Petersson, First Nurse Assistant, and Johan Poulsen, Head Surgeon, from Minimal Invasiv UdviklningsCenter's (MIUC) informed the design. From the observations and later confirmed in the interviews, it was made clear that correct positioning of the robot arms and surgical ports is important and exercised repeatedly during team training. Another important aspect is the trainer-trainee interaction that occurs during the sessions, any questions or mistakes that arise are used for learning purposes.

During RAMIS there are usually two nurses present, one surgeon, one surgeon assistant, and one anaesthetic nurse or doctor.



3 Methods

An operating room was created in Unreal Engine 4 using the Proteus VR multiplayer template to simulate a real operating environment in order to show the capabilities of VR and its potential use in RAMIS training.

To evaluate the operating room created, an expert review with Johan Poulsen and Jane Petersson was conducted which consisted of a test using the described system followed by an interview. The results from this review were used to determine the viability of the concept. The purpose was to identify the features, scenarios, and key considerations needed for such a system to be fully implemented in institutions such as MIUC, to allow VR training instead of, or as an addition to, regular training.

Expert review pic

4 Results

Jane Petersson and Johan Poulsen were both able to test the system. The following interview revealed that the system at present was satisfactory at simulating the scenario, but was not comprehensive enough to warrant implementation with them. They believed the interaction was sufficient, and that trainees didn't require additional features, however they both stated that several features should be available to the instructors, such as scene change and reset, interacting with procedures and progress, as well as changing the rules during play (for example by introducing emergencies).

One key point throughout the interview was realism. This was brought up many times, and the consensus was that the closer the simulation was to total realism, both with controls, models, and textures, the more it could replace or improve upon current training standards. This meant that, for example, the robot should have multiple end effectors to allow more realistic movement.

Johan Poulsen stated that there were limitations, but that systems such as this could be a must-have for the future of RAMIS. He talked about fully integrating the system with current simulators such as RAMIS surgeon console simulators and anaesthetic nurse simulators.

5 Conclusion

The concept of introducing VR training in established RAMIS training sessions seems feasible, however with some caveats. Currently, the system is too basic to warrant implementation at MIUC, but could serve other purposes such as introducing medical students to RAMIS. Experts stated that the system would require a high level of realism to accurately show the procedure and be useful in RAMIS training. This means that key considerations for future implementations would be the introduction of multiple control points on the da Vinci robot's arms, followed by a comparison of inverse kinematic methods to simulate their movement. This would also require a fully modelled and rigged robot with all the joints of the real one. The robot's interaction with important tools such as surgery ports will be similarly important. We suggest a usability study with such a system, followed by a longitudinal study to determine the effects of extending RAMIS training to VR.

Real/rendered robot pic

6 Acknowledgements

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7 Litterature

[1] R. H. Taylor, "Medical Robotics and Computer-Integrated Surgery." IEEE, 2008, pp. 1.

[2] A. A. Razmaria et. al, "Does robot-assisted laparoscopic ileocystoplasty (RALI) reduce peritoneal adhesions compared with open surgery?: Adhesion formation after cystoplasty in a porcine model," BJU International, vol. 113, no. 3, pp. 468–475, Mar. 2014

[3] H. Alemzadeh et. al, "Adverse Events in Robotic Surgery: A Retrospective Study of 14 Years of FDA Data," PLOS ONE, vol. 11, no. 4, Apr. 2016.

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