Introducing VR Training for IEEE Conferences

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***Abstract*—The abstract goes here.**

I. Introduction

Surgical robotics has evolved quickly since the 1980's and will continue to do so in the future [cite taylor medical 2008]. In some areas, it has even become an essential technology [cite sivaraman robotics 2015]. 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 [cite razmaria does 2014, punnen how 2013, sung oncologic 2016, raza long-term 2015]. Alemzadeh et al found that around 17.4% of deaths during RAMIS occurred during the operation, and 7% were due to staff mistakes. The majority of injuries were caused by device malfunction, but a not insignificant amount were due to staff errors (see Figure I) [cite alemzadeh adverse 2016].

Injury Reports (Total = 410)	
Example Causes	**Number of Reports (%)**
Device malfunctions	254 (62.0%)
Surgeon/staff mistake	29 (7.1%)
Improper positioning of the patient	17 (4.1%)
Inherent risks of surgery and patient history	16 (3.9%)
Burning of tissues near port incisions	9 (2.2%)
Possible passing of currents through instruments	6 (1.5%)
Surgeon felt shocking at the surgeon-side console	2 (0.5%)
N/A	77 (18.8%)

TABLE I
THE MOST COMMON SOURCES OF INJURY[CITE ALEMZADEH ADVERSE 2016]

According to Alemzadeh et al, one key area of RAMIS that may be improved is the "human-machine interfaces and surgical simulators that train surgical teams for handling technical problems". Other researchers suggest a variety of methods to reduce injury numbers, such as dry lab training, simulated emergency handling, including in virtual reality (VR), and even a complete remodeling of operating theaters [cite liberman training 2011, huser simulated 2014, ahmad ambulatory 2016, abelson virtual 2015]. These all suggest that more training is beneficial to reduce error rates.

During an interview with, and observation of, Jane Petersson, First Nurse Assistant and Nurse Specialist in Robotic Surgery at Aalborg University Hospital and MinimalInvasiv UdviklingsCenter (Minimally Invasive Education Centre, MIUC), she stated that some of the most important aspects of RAMIS are routine and training, especially as part of a team. This claim is substantiated by several studies [cite moorthy qualitative 2004, chandra comparison 2010], showing clear improvements for experienced surgeons, but also a significant learning curve.

We, together with Jane Petersson, believe this can be extended to team training in VR as shown by Abelson et al in conventional surgery [cite abelson again] and Huser et al simulating full surgery teams doing emergency fibrillation. VR training has the benefits of being cost-effective compared to regular RAMIS training (which costs 6,000-8,000 DKK per person), at the cost of reduced accuracy, as well as enabling concurrent multi-user functionality in different locations. This would allow surgeons and nurses to train certain scenarios at their work or at home instead of travelling to certified institutions.

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II. Method

Two types of tests were performed, namely a usability test and an expert review with Jane Petersson and Johan Poulsen. A system was designed to improve training options for RAMIS nurses and surgeons by introducing a VR environment that allowed them to train communication during calibration and emergency undocking, described in detail in this section. The procedure is listed below:

- Participants are introduced to the system and the project
- The usability participants are split up in different rooms
- The participants perform the required tasks together
- Usability test participants fill out questionnaires
- A short exit interview was held

The VR environment allowed participants to interact with a virtual robot modelled after the da Vinci Si, see Figure XX. They were able to move the arms and fit it with tools. Additionally, they were able to interact with items such as scrubs found in the room, which was modelled after the AUH robotic operating room, see Figure XX.

The scenario simulated was chosen based on interviews with Jane Petersson. It tasked participants with calibrating the robot arms by moving the tools to the ”patient's” body. Afterwards, they were tasked with performing an emergency undocking together, going to open surgery. An overview of roles and tasks during emergency undocking is shown in Figure XX. This scenario was chosen since it enables training vital procedures that can be relatively accurately represented in VR. According to Jane Petersson, these are the most important tasks to train since they are what trainees undergoing team training at MIUC usually struggle the most with. Additionally, it would allow trainees to practice emergency procedures in a safe environment. Each participant was randomly assigned a role matching one shown in Figure XX, and informed of their tasks as the scenario progressed through a graphical user interface (GUI).

The participants used three HTC Vive head mounted displays (HMDs) connected to a server hosted on computer A. Computer C was located in a separate room from computer A and B. The specifications of these computers are shown in Table II.

	Computer A	*Computer B*	*Computer C*
CPU	Intel Core i7-6700K	Intel Core i7-4770	x
GPU	Nvidia GTX 1080	Nvidia GTX 980	Nvidia GTX 980Ti
Motherboard	x	x	x

TABLE II
SPECIFICATIONS OF THE COMPUTERS USED

Prior to the test participants were informed of the two actions they could perform, namely grabbing (using the HTC Vive controller's trigger) and teleporting (using the touchpad on the controller). Teleporting is important in VR since there is limited space to move around in the real world, and thus participants were also cautioned not to move outside the bounds shown in the world by poles. They were also informed about the possibility of VR sickness [cite XX] and that should it happen, they were to inform the observers and disengage from the system.

After the test, participants were given a questionnaire. The questionnaires used in the usability test contain rating scales that rates different measures of the system complying to the System Usability Scale (SUS). These are shown in appendix XX. It also contained additional questions about the participants age, gender, familiarity with VR, and XX. Following that, a short interview was held to ensure their experience matched the expectations of the test, primarily to ensure they understood the tasks.

An expert review was held after the usability test to assess the utility of the system qualitatively. This review is also done to determine if there are critical errors in the simulation. Jane Petersson and Johan Poulsen both participated in this interview after observing and trying the system themselves. The review followed a simple structure with a facilitator, an observer and audio recorder. The script and transcript for the interview is shown in appendix XX.

III. Results

What did we find out

This is discussion

None of the participants in the usability test were trained in the medical field, which affects the validity of the results. This is an acceptable risk given that this is a usability test and not a utility focused test.

IV. Conclusion

What does it mean

Acknowledgment

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References

[1] H. Kopka and P. W. Daly, *A Guide to LaTeX*, 3rd ed. Harlow, England: Addison-Wesley, 1999.