Motion Tracking in the Operating Theatre 3.0 – Transition to Theatre (MoTOR 3.0)

Study Protocol

Project Team and Responsibilities

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Project Resources

This research project will be conducted with the Monash Children's Hospital Surgical Simulation Centre and Monash University's Virtual and Augmented Reality Services Unit. The project will utilise the HoloLens 2 device, which is a wearable augmented reality interface. The research team involved will be working solely voluntarily and there is no any external funding provided.

Background

Literature Review

Surgical training and education has remained unchanged for many years, whilst always looking for areas to improve in. At present, surgical performance is scored through a subjective method conducted through observation from a more experienced surgeon. With the increasing roles of augmented reality and virtual reality in medicine, there is a growing body of evidence to support the use of the technology in surgical procedures and/or training to create an objective assessment [1].

Eye and hand tracking has been shown in multiple studies to be a potentially powerful tool in the surgical setting [2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13]. The majority of studies focused on the use of the technology in a skills based assessment whereby the surgeons economy of movement, overall dwell time in a single area, gaze paths, and eye fixations were the most significant outcomes of interest.

This study will be building upon the findings of the MoTOR 2 study at Monash Children's Hospital where motion-tracking was used to differentiate surgical skill during a complex simulated surgical procedure. We were able to objectively differentiate the performance of novices and experts during the simulated procedure ($p < 0.0001$). The significant metrics included total path length, average path length, and total time.

Participants also indicated that they would wear the headset whilst operating as part of a research trial (Mean 8.18/10 ± SD 2.67). Feedback on use of the headset for one participant was that the "Motion tracking headset was very unobtrusive and easy to forget."

As such, we aim to build upon the findings from our previous study and utilise the motion-tracking headset to collect data from the live operating theatre environment.

Project Rationale
The HoloLens 2 augmented reality device is one that has the capabilities to track hand movements. The headset has in-built sensors that are able to track the movements of surgeons. There are specific patterns of movement that are associated with increased expertise. It is based on these specific patterns of movement that we aim to utilise to objectively assess surgeons. It has been shown in a previously conducted proof of concept study at Monash Children's Hospital that the HoloLens 2 can sufficiently track these movements and is able to differentiate between varying levels of expertise in simple surgical tasks [14]. We have also demonstrated the ability of the headset to differentiate surgical skill objectively for a complex simulated surgical task. Both studies conducted identified strong acceptability from participants regarding the future benefit of the technology in surgical education and training.

This technology could transform and improve the training of junior doctors by providing objective and measurable markers of performance. We aim to build upon the previously conducted MoTOR 2 study and transition to the live operating theatre environment.

Figure 1. Use of HoloLens 2 in the operating theatre

The project will involve surgical registrars and consultants performing operations as they normally would whilst wearing the motion-tracking headset. A transition to the operating theatre will allow us to further identify whether this headset can be used in a clinical environment and continue to provide objective assessment data. We aim to video tape the procedures to allow for further post-hoc analysis of the footage.

The results from our simulated task showed the following when participants rated statements from (0 = Completely disagree,10 = Completely agree): participants did not find the headset uncomfortable or heavy to wear as noted by mean scores of 3.8/10.0 (SD 2.7) and 3.9/10.0 (SD 2.6), respectively. Participants did not feel that the headset slowed down their operative time, 3.2/10.0 (SD 2.7) nor did it impact their performance 2.7/10.0 (SD 2.2). Lastly, the headset did not interfere with participants visual field as noted by a mean score of 4.1/10.0 (SD 2.5).

Research Questions and Outcomes

AIM:
1. Establish the ability of the HoloLens 2 to accurately track and assess performance in a live operating theatre environment
2. Identify any differences in assessment of surgical performance between the HoloLens 2 device and the traditional Halstedian method.

HYPOTHESIS:
1. There will be a significant difference in surgical performance between junior surgeons and senior surgeons when performing live surgery
2. There will be a difference in rating of surgical performance between the traditional method and the HoloLens 2.

OUTCOMES
1. Path length, total time, and speed of movement are the 3 main metrics of measure
2. User satisfaction with the use of the HoloLens 2 device

Project Design

All participants in the study will be assigned a computer generated randomly assigned candidate ID, which allows for anonymous data collection. The document containing this information will be stored securely by a researcher who is not involved in the recruitment or analysis of results to minimise risk of bias.

The study will involve the use of the HoloLens 2 in the operating room during operations not involving the use of surgical loupes including open inguinal hernia repairs, orchidopexies, hydrocele repairs, circumcisions and others. We aim to collect data from 50 operations. The patient or their parents will be provided with information about the study including details around confidentiality and privacy, the use of the HoloLens 2 device and it's safety, and an emphasis on participation being completely voluntary. Consent will be obtained in Paediatric Surgical Clinic at the time of booking or if additional time is required, this can be obtained on the day of the procedure. The consent can be withdrawn and renegotiated at any time. There will be no patient specific data obtained for this study apart from the name of the scheduled procedure.

Prior to the procedure, the operating surgeon will have an opportunity to get accustomed to the headset. During the procedure, the operating surgeon will be wearing the HoloLens 2, which will

be tracking their hand movements with a focus on path length, total time, and speed of movement to provide an overall gauge of proficiency. A camera that is mounted on the HoloLens will be used to capture video only footage. This will be de-identified and will be from the surgeons point-of-view and will largely capture their hand movements and the operative field.

Upon completion of all 50 operations, we will have the participants complete a post questionnaire assessing their experience with the headset in the operating theatre.

A camera will be mounted on the HoloLens 2 headset to provide a Point-of-View video recording of participants completing the procedure. This would allow for us to perform post-hoc analysis and rate the skill of the participant using the traditional method of assessment.

All data collected including data from the HoloLens 2 device will be de-identified and stored in a secure location at the Surgical Simulation Centre at Monash Children's Hospital for 15 years after that individual reaches 18 years of age. Data will be electronically stored. All data will only be accessible to members of the research team listed on this application. Data will be disposed by wiping of all hard-drives with any project related information.

Adverse events will be reported in line with the NHMRC guidelines. This includes a detailed record of all adverse events and device deficiencies with date tabulations. All fatal or life-threatening AEs must be reported within 7 calendar days with follow-up information provided within 8 calendar days. All other adverse events must be reported within 15 calendar days after the research team has been aware of the event. Significant safety issues should be notified within 72 hours and all other safety issues within 15 calendar days. An annual safety report will be completed.

Results, Outcomes, and Future Plans
The results of this project may be published in a peer reviewed journal. No individual participant data will be published or included in any publication that could identify participants. A standardised text message will be sent to participants containing the publication resulting from this research project. The text message will be sent to the phone number participants provide on the consent form. The data collected in this study may be used in future studies evaluating hand movements of surgeons while performing operations. The data collected may form a database of objective metrics that could be used in future research. There is scope for this study to lead to an objective scoring scale for surgical training for many different surgeries in all specialities.

References:

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