Seminar Review:
Augmented Reality as a Telemedicine Platform for Remote Procedural Training

Project:
Semi-Automatic Content Generation & HMD-Based Eye-Gaze Analysis

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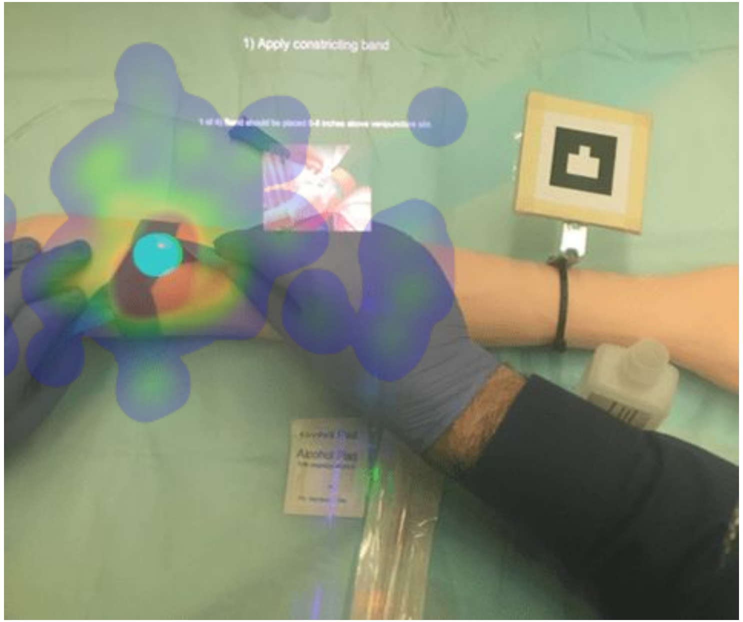
Project Review

- Goal: Create a HMD-based software tool that allows the user to create medical tutorials and collect eye gaze tracking data to evaluate performance
- Devices: Microsoft HoloLens and Pupil Labs eye gaze tracker



Paper Relevance

- Using augmented reality HMDs in a medical educational setting is a relatively new concept
- What has been explored?
- What are the expectations and goals of users?

Paper Background

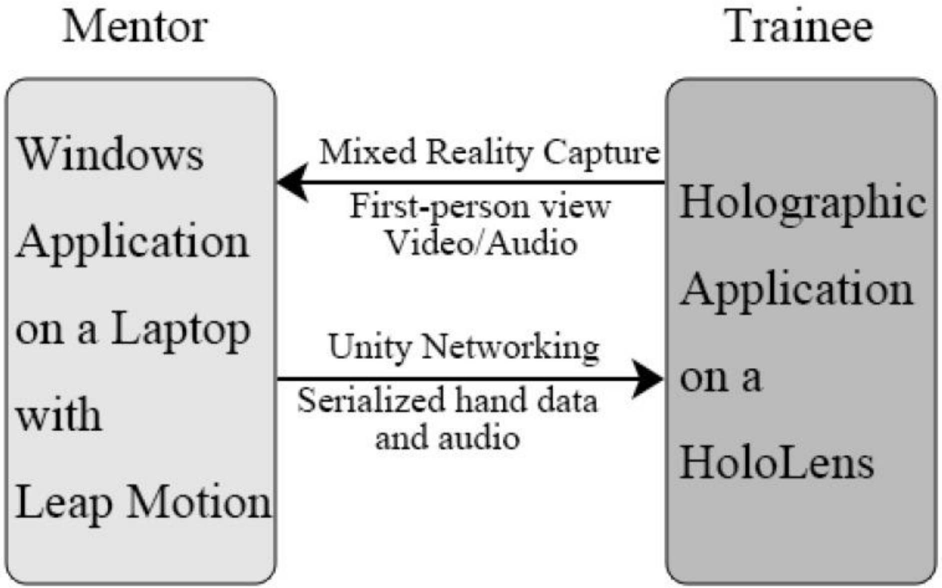
- Past applications of AR in telemedicine have proved to be cumbersome and expensive
- Many systems require significant setup or technical support
- How does a modern solution compare to these traditional telemedicine solutions?

Paper Background

- Google Glass still too technically limited
- HoloLens confers many advantages
  - Untethered operation
  - Non-occluding
  - First-person camera
  - Depth-sensing and relocation ability

Design

- Prototypes:
    - Gyroscope-controlled probe
    - Video conferencing
    - AR view in VR
- Final:
    - Leap Motion sensor
    - HoloLens
    - Mixed reality capture
    - Hand models



Experimental Methods

- Point of Care Ultrasound (PoCUS)
  - Focused Assessment using Sonography in Trauma (FAST)
- 24 trainees: 12 on HoloLens, 12 on “full telemedicine setup” (control)
- “Full telemedicine setup”:
  - Overhead camera
  - Patient view camera
  - Sonography screen
- GRS scoring of trainee performance
- Likert survey and open-ended questionnaire for mentor and trainees

Results

Table 1

Trainee’s opinions on the efficacy and difficulty of the HoloLens and Full Telemedicine Set-Up.

	HoloLens Score Out of 5 (Standard Deviation)	Full Telemedicine Set-Up Score Out of 5 (Standard Deviation)	*p*-Value	*t*-Value	Degree of Freedom
The technology was easy to setup and use	4.08(0.90)	4.67(0.49)	0.065	1.969	17.039
The technology enhanced my ability to generate a suitable ultrasound image	4.50(0.67)	4.58(0.51)	0.737	0.340	22
The technology was overly complex	1.92(0.79)	1.42(0.51)	0.081	−1.832	22

Table 2

Mentor’s opinions on the efficacy and real-life application of the HoloLens and Full Telemedicine Set-Up.

	HoloLens Score Out of 5 (Standard Deviation)	Full Telemedicine Set-Up Score Out of 5 (Standard Deviation)	*p*-Value	*t*-Value	Degree of Freedom
I was able to telementor the student effectively	2.92(1.00)	3.67(0.65)	0.04	2.183	22
The technology was effective in enhancing remote ultrasound training	2.50(1.17)	3.75(0.45)	0.004	3.458	14.227
I would be able to mentor a trainee in a real-life stressful situation with this technology	2.25(1.14)	3.42(0.67)	0.007	3.062	17.783

Results

Table 3

Global Rating Scale for right upper quadrant exam of the HoloLens and Full Telemedicine Set-Up.

	HoloLens Score Out of 5 (Standard Deviation)	**Full Telemedicine Set-Up Score Out of 5 (Standard Deviation)**	***p*-Value**	***t*-Value**	**Degree of Freedom**
Preparation for Procedure	2.92(0.79)	3.00(0.60)	0.775	0.290	22
Patient Interaction	3.00(0.43)	3.08(0.51)	0.670	0.432	22
Image Optimization	3.00(0.60)	3.08(0.51)	0.719	0.364	22
Probe Technique	2.83(0.58)	2.83(0.72)	1.000	0.000	22
Overall Performance	2.75(0.62)	2.91(0.67)	0.534	0.632	22

Results

- Completion time: 536.00 seconds (HoloLens) vs. 382.25 seconds (full set-up)
- Mental effort and task difficulty scores were slightly lower for HoloLens

Discussion & Conclusions

- Downsides of the HoloLens system
  - System had network problems
  - Heavy
  - Some users could not fit the headband properly
  - Limited FOV
  - Mentor may lose sense of depth
  - Limited battery life
- Upsides of the HoloLens system
  - Non-occluding system
  - Less dizziness inducing

Discussion & Conclusions

- No significant difference in trainee performances
- HoloLens was rated lower in teaching effectiveness by the mentor
- Frequent malfunctions and connection issues
- System is viable when compared to a more costly setup
  - Includes many “new” technologies
  - Meaningful to future development

Paper Evaluation

- Strengths
  - Provided multitude of background information
  - Focused on many qualitative aspects of using an AR-based HMD
- Weaknesses
  - Only one mentor
  - No details on hand position data collection
  - No details on system development
  - Did not fix networking issues

References

1. Wang, S., Parsons, M., Stone-McLean, J., Rogers, P., Boyd, S., Hoover, K., ... Smith, A. (2017). Augmented Reality as a Telemedicine Platform for Remote Procedural Training. Sensors (Basel, Switzerland), 17(10), 2294. https://doi.org/10.3390/s17102294
2. Carbone M., Freschi C., Mascioli S., Ferrari V., Ferrari M. A Wearable Augmented Reality Platform for Telemedicine; Proceedings of the International Conference on Virtual, Augmented and Mixed Reality; Toronto, ON, Canada. 17–22 July 2016; pp. 92–100.
3. Cui N., Kharel P., Gruev V. Augmented reality with Microsoft HoloLens Holograms for Near Infrared Fluorescence Based Image Guided Surgery. Proc. SPIE. 2017;10049 doi: 10.1117/12.2251625.