Virtual Endoscopy Using an Oculus Quest 2 Controller

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Clinical Problem

- With over **250 million endoscopies** performed annually worldwide, effective doctor training remains paramount to ensure safe and accurate execution of this essential procedure.
- Typical training methods include the Apprenticeship Model and Simulation-Based Model.

Figure 1. Picture of Endoscope with Tube

Models	Apprenticeship	Simulation-Based
Background	• Current Standard of Care • Training under experienced endoscopists via dummy or pig model or real patients	• Supplemental to apprenticeship training • Utilizes Virtual Reality software to simulate endoscopy procedure
Pros	• Clinical Exposure • Immediate feedback from mentor	• Cheap and easy to use • Can be practiced anywhere • Patient risk-free
Cons	• Risk of injury to patient • Limited doctor or endoscopy availability • Equipment costs $10,000 +	• Lack of Realism • Lack of accurate training procedures

Table 1. Apprenticeship and Simulation Training Model

Figure 2. Virtual Simulation of Endoscopy

Figure 3. Dummy Model used in Apprenticeship Model

Figure 4. Doctor using the Oculus Virtual

Current Simulation System:

- This system uses an endoscopy simulation training on the virtual reality system, Oculus Quest 2

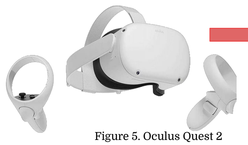

Figure 5. Oculus Quest 2

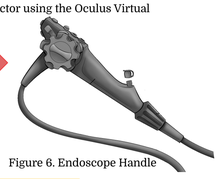

Figure 6. Endoscope Handle

Our Goal: *Design a controller that replicates an endoscope handle while integrating to the Oculus endoscopy software as a supplement to Apprenticeship training*

Design Criteria

Component	Specification	Reason
Weight	0.75 lbs +/- 0.15	Weight of typical endoscope
Device Length	9.5 in +/- 1	General shape of endoscope
Handle Length	3.1 in +/- 0.25	Ergonomic feel

Table 2. Design Criteria

Buttons will be tested by checking if, when a button is pressed, there is a reaction in software. Additionally, **accurate tracking** of the controller in the software will be tested comparing movements to an original controller.

Our Process

Disassembly of Oculus

- Multi Layered PCB
- Mechanically Attached Button

Electrical Connections

- Button is soldered to circuit
- Joystick is attached by ribbon cable

Elementary Testing

- Buttons accurately register as outputs
- Infrared tracking is inconsistent

Final Corrections

- Integrity of original tracking ring is required for accurate tracking

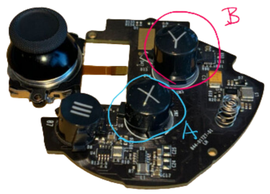

Figure 7. Circuit Board Disassembled

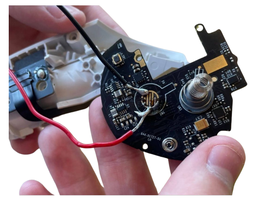

Figure 8. Circuit Board with Soldered Wires

Figure 9. Connected Wires with Buttons

Figure 10. Final Design

Final Design

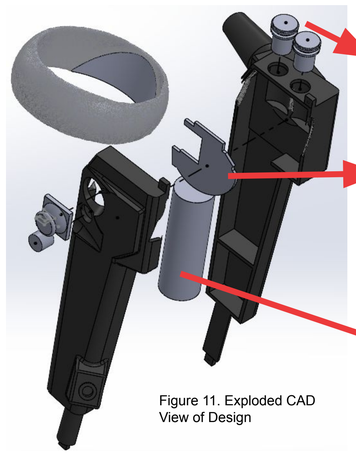

Figure 11. Exploded CAD View of Design

Figure 12: Button

Buttons: Soldered to the Circuit to respond to X and Y inputs

Fig 14. Internal Side View of RIght Side of Design

Oculus Motherboard: Original circuit from the left controller

Figure 13.: Oculus Circuit

Adhesive Weights: Used to increase the weight of endoscope controller

Fig 15. SIngular Weight

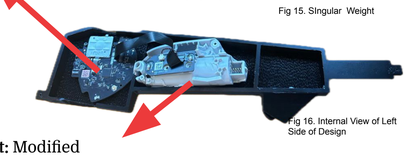

Fig 16. Internal View of Left Side of Design

Battery Compartment: Modified Battery Compartment from Left Controller

Fig 17. Battery Component

Tracking Ring: determines the location of controller in Oculus simulation

Joystick: Allows rotational movement in Oculus VR Software

Menu Button: Enables User to control the Menu in Oculus VR software

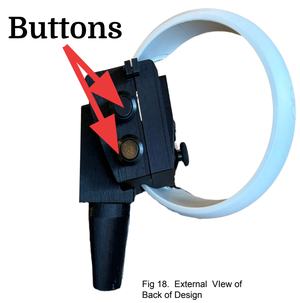

Fig 18. External View of Back of Design

Fig 19. External View of Right Side of Design

Fig 20 External View of Left Side of Design

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Testing

Weight Testing:
To ensure the feel of the endoscope, the weight of the device is measured using a scale and compared to the weight of real endoscopes.

Dimensions Testing:
Device length refers to the entire length of endoscope. This dimension is relevant to replicate shape and size of real endoscopes. The handle length refers to the length of where the hand grips the endoscope. This dimension is important to ensure comfortability of the users hand.

	Magnitude of Prototype	Magnitude of Real Device	Accuracy Percentage
Weight	0.660 lbs	0.750 lbs	88%
Device Length	9.625 in	9.5 in	98.7%
Handle Length	3.5 in	3.1 in	87.1%

Table 3. Dimension and Weight Testing

Button Testing:
This criteria tests if the buttons correspond with the Oculus Virtual Reality system. This test involves us pressing the buttons and seeing the impact on the software simulation.

Button Input	Oculus Output	Accuracy

Table 4. Button Testing

Oculus Tracking:
Movement of the new controller is compared to a preexisting Oculus controller measuring the distances moved in real life compared to the distanced moved in Virtual Reality.

Distance Moved	Average Distance Tracked	Accuracy

Table 5. Tracking Testing

Future Work

Some things we wish to add to our design in the future include other features on the endoscope remote that we were not able to implement such as:

- Other Buttons
- Dial inputs
- Biopsy Valve

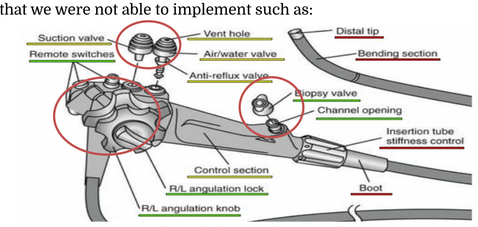

Figure 21. Diagram of Endoscopy Features

Ethical Considerations

Preclinical Testing: Not required due to it's virtual nature, but recommended to understand efficiency

Potential Testing Plan:

- Controlled trial comparing traditional apprenticeship with and without VR supplement
- Trainees split into control and intervention groups
- Standardized Skill assessments measure time and ability for mastery
- **Aim**: Improve training mastery + decrease animal use in training

This device is not designed to replace the pre-existing training methods but is meant to be a low-cost, risk-free, and portable **supplement** to help with training

Beneficiaries:

- Doctors learning to perform endoscopies
- Patients receiving an endoscopy