Poster #158: Data Requirements for the Use of VR Platforms for the Practical Assessment of Medical Imaging

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Note: QR codes in this poster link to additional references, handouts, and resources.

Project Rationale

Though Virtual Reality (VR) technology has improved significantly over the past few years, touch-sense displays and data (i.e., haptics) has lagged behind visual and auditory progress (Wang et al., 2019). However, the anticipated use of VR in both medical imaging education and assessments has only grown in the past several years (e.g., Makary, 2020; Shah, 2019; Tang et al., 2018; Uppot et al., 2019). Consequently, it behooves medical imaging educators and assessors to evaluate both the current capabilities of VR technology and the data streams needed to validate the authenticity of this medium for real world applications. The current study will be conducted in two parts: 1) evaluate the current capabilities of haptics in VR technology and the authenticity of dynamic "touch" processes as compared to real world simulation tasks, and 2) evaluate the data streams needed to validate the authenticity of VR tasks compared to real-world practice assessment tasks.

Virtual Reality (VR) Headsets

Modern **VR Headsets** and controllers consist of a **head-mounted display** that is wired or wireless and one **controller for each hand**. Some of the most popular VR Sets include the **Oculus Quest 2**, **Valve Index VR Kit**, and the **Oculus Quest Pro**. Due to the comparatively lower cost, the Oculus Quest 2 is already being **used in the hospitality and medical industries** to train and provide assessments for medical professionals and patients (Vaughan et al., 2016). Cost and lack of software development often are the biggest barrier to entry.

Data Sources in VR

- **Headset** - **Position** (x,y,z coordinates), **rotation** (x, y, z orientations), **audio recordings** (mp3, WAV, etc), **image/video recording** (mp4, MOV, F47), and **time**.
- **Controller** - **Haptic** (frequency & amplitude), **position** (x, y, z coordinates), **rotation** (x, y, z orientations), **button press** (time & true/false), **joystick movement** (x and y positions, as well as true or false button clicks/touches), **trackpad** (x and y positions, as well as true or false button clicks/touches), and **time**.
- **User** - User **provided data** (gender, age, job, experience usually in a CSV or JSON file) and user **generated data** from completing steps and evaluations in VR (CSV, JSON, or Matrix).
- **Extrapolated** - **Interactions** with the **virtual** environment, **velocity** and angular velocity, **acceleration** and angular acceleration, **poking**, **grabbing**, **pointing**, and other **hand movements/positions**, **interactions** with **real world objects** in a virtual environment.

Sonography Tasks in VR

Task Specifications Should…

- Provide all learners with an equal opportunity to demonstrate their knowledge
- Represent the types of tasks a learner would encounter in practice (e.g., common sonography tasks)
- Include clearly defined expectations and directions
- Be free from distractions and construct-irrelevant variance (e.g., hard to use software or hardware)

Formative Assessment of Skills

For medical sonographers, VR offers a flexible framework for performing tasks and receiving formative feedback (e.g., skill-level diagnostic feedback). Both **process data** and **outcomes data** can be collected and scored to provide learners with feedback.

Operationalizing Tasks and Feedback

Process vs Outcomes Data

- ***Process Data*** - Steps, actions, and sequences performed by the learner to perform a specified task
- ***Outcomes Data*** - the end result or product from the task (e.g., the desired sonography image)

Scoring and Feedback to Learner

Process Mining can be used to collect robust data on a cohort of experts. This data can then be used to create a profile to which the process data from the learner can be compared. Deviations from the expert processes can be flagged and may result in opportunities for learner feedback and improvement.

Image Similarity Indexing can be used to compare the final image taken during the task to those captured by experts.

VR EQUIPMENT FOR EDUCATION AND ASSESSMENT

META QUEST 2

PROS FOR EDUCATION AND ASSESSMENT

- Lower cost of entry
- Head, body, hand, and finger tracking
- Proven use in hospitality, mental health, and neuropsychologic assessments
- Software Development Kits are widely available for engineering medical assessments in VR
- High resolution
- Wireless/Standalone

CONS FOR EDUCATION AND ASSESSMENT

- Not the most accurate position tracking
- No eye/gaze tracking
- Hand and finger tracking not as advanced as the Meta Quest Pro
- Smaller field of vision, less immersive

USE CASE AT HILTON HOTELS

META QUEST PRO

MORE INFO AND DETAILS

PROS FOR EDUCATION AND ASSESSMENT

- Augmented Reality available
- Head, Eye/Gaze, Body, Hand, Finger Tracking
- Faster Internal Processor
- Each controller has its own processor
- High Resolution

CONS FOR EDUCATION AND ASSESSMENT

- Priciest out of modern commercially available options
- Better position tracking, still not the best
- Smaller field of vision, less immersive, better than Meta Quest 2

VALVE INDEX

PROS FOR EDUCATION AND ASSESSMENT

- Best for position tracking
- Head, eye/gaze (with add on), body, hand, finger tracking
- Semi-modular for upgrades
- Best field of vision
- Steam development tools
- Highest image refresh rate of 144Hz

CONS FOR EDUCATION AND ASSESSMENT

- Still somewhat pricey, but cheaper than the Meta Quest Pro
- Require a higher end PC due to no internal processor
- Wired
- Limited mobility, meant to be a more stationary gaming experience

MORE INFO AND DETAILS

OTHERS

VIVE PRO 2

HP REVERB G2

Virtual Reality kits are available from a large number of manufacturers, but those listed above have been tested, have high quality images, and have tracking capabilities largely built in. For a more comprehensive breakdown on available VR kits please check out the QR code to the right.

FULL SUMMARY OF VR KITS

Conclusions and Current Limitations

Why VR Tasks?

- Experiential learning is more impactful than classroom in many situations (Kolb, 2015, Morris, 2018, Roberts, 2018)
- VR provides a low-stakes environment for practicing skills
- The controlled environment allows learners to focus on specific tasks and skills, and receive detailed feedback
- Increase opportunities for global standards in medical imaging and medical imaging assessment

Limitations for using VR for Education and Assessment in the field of sonography include that the software takes time and resources to develop and access to headsets might be limited. Validity research studies will also be needed to evaluate the generalizability of tasks from VR to real life scenarios.

References

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VR headsets can gather so-called biometric data, including "really sensitive, really intimate data about your body posture, your eye gaze, what you're looking at, your pupil dilation, what you're not looking at, your gestures, what you're touching, what you're interacting with, what you're saying, even as specific as minute variations in skin color or blushing." EdWeek.org