Undergraduate Thesis Prospectus

Improving the Efficiency of Beverage Refill Rates in Restaurants

(technical research project in Electrical and Computer Engineering)

The Viability of Mixed Reality as a Medical Tool

(STS research project)

by

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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General Research Problem

How are skills best learned?

Virtual and augmented reality can be a powerful tool for educating medical students. It immerses them in simulated scenarios that closely mimic real-life ones. However, some contend VR/AR is no substitute for working with real patients. Preece et al. (2013) found that medical students learned much better from physical models than from 3D computer-generated models. VR/AR can make use of both.

Beverage refills can entail similar tradeoffs. Customers can flag down a nearby waiter, rely on a coaster to measure their drink's weight, or wait for a robot to come by to refill their beverage. Ryu et al. (2012) found that good customer service improves the chance a customer will return to a restaurant. Hence the tradeoffs in medical training are analogous.

Improving the Efficiency of Beverage Refill Rates in Restaurants

How can restaurants refill diner's beverages more efficiently?

Professor Harry Powell of the Electrical and Computer Engineering Department will advise Daniel Ayoub, William Define, James Garcia-Otero, Taylor Kramer, and me on this capstone research project. Among food quality and the dining environment, customer service establishes the perceived value of a restaurant, which has a strong correlation with a customer's intent to revisit (Ryu et al. 2012). Beverage refills are the most frequent interaction between a customer and server. Therefore, by improving the efficiency of beverage refills, customers will be more satisfied and inclined to return. We seek to design a scalable system that will improve the consistency of restaurant beverage refills and reduce the effort of waiters and customers. The

system must be easy to use, implementable in any restaurant, use an embedded processor, and contain a printed circuit board of our own design.

There are currently a few methods for receiving a beverage refill. Either a waiter can observe a diner's glass and deliver a refill or a customer can flag down a waiter. These interactions yield an inconsistent amount of effort from both sides, and therefore a customer's satisfaction will vary. Technological innovations have attempted to make this process smoother. Some restaurants have a system where diners can press a button at their table to alert a waiter. Students from Saarland University of Germany developed a beer mat that uses pressure sensors to detect empty beverages. It incorporates accelerometers such that diners can flip the mats to cast votes in bar games (Butz & Schmitz, 2005). Students at the University of Virginia developed an automatic drink refilling robot. It housed a robotic arm to deliver a refill and used computer vision to identify empty beverages (Hutchinson et al., 2019).

We will develop a coaster that can sense the weight of a customer's beverage, detect an empty beverage vessel, and alert a waiter over a local area network. The coaster will feature induction charging, wireless communication, and force sensing all in a small form factor. This removes the effort from the customer's side of the interaction and makes it easier for a waiter to supply a refill when one is needed. This system improves on prior design by taking into account scalability, recharging, and ethical concerns regarding image processing and a waiter's job. At the end of this project, we will have a system that makes the customer to waiter interaction more efficient, yielding higher customer return rates. Furthermore, our findings can provide a framework for other methods to improve a customer's satisfaction.

The Viability of Mixed Reality as a Medical Tool

How are advocates & critics of high-tech medical education techniques competing to shape medical education?

According to Wu et al. (2018), while AR promotes engagement, contextualization, and authenticity in education, users can incur cognitive overload from complex tasks. Some MDs, such as Verghese (2011), fear that VR and other high-tech medical training is displacing other important techniques, such as shadowing and other direct experiences with real patients. However, because AR can elicit real emotion, such as fear or sense of threat, it can be useful in research and clinical applications (Chessa et al., 2019). There are two opposing perspectives towards this problem: high-tech medical training can simulate experiences that would otherwise be difficult to obtain or repeat, but reliance on these techniques can be overwhelming and divert students from real human interaction.

Shadowing offers students experience in the operating room and requires no special technology. It values human interaction and puts no technology between the doctor and patient.

Some institutions, such as the University of Virginia, use VR to train students. One approach is filming surgeries with 360° cameras and adding additional visuals that were critical for the operation. Students then immerse themselves as if they were the shadow, observing and interacting with the virtual environment (UVA School of Medicine, 2018). This type of training places VR between the doctor and patient.

The Association of American Medical Colleges, the American Hospital Association, the VR/AR Association, the XR Association, the Society for Science Based Medicine, and advocates for experiential learning are all participants in this problem. The Association of American Medical Colleges claims it strives for health equity by transforming medical education, medical

research, and patient care. AAMC sponsors students and institutions and promotes VR, for example through conferences at medical colleges. An AAMC spokesperson says “if I can rehearse the surgery ahead of time [in VR], when I get there it’s not a surprise. It’s as if I’ve been there before” (Breining, 2018).

The American Hospital Association values quality and affordability in health care. According to AHA: “Low-tech solutions can be as straightforward as building time into patient visits… 80 percent of diagnoses can be made just based on the patient story alone” (Bathija, 2019). It warns that high-tech medical care can be expensive and unscalable. AHA wants doctors to visit patients and interact with them directly.

The VR/AR Association promotes this technology. It hosts monthly podcasts, offers training sessions for developers and managers, and rents equipment (Yeomans, 2019). VRARA works with schools, VR development companies, and others to promote medical VR, for medical training, for rehab, and for patient education. According to VRARA’s Global Executive Director, Kolo (2018): “VR/AR is helping in training, providing services, and of course, education.”

The XR Association seeks standards to protect VR practitioners and to make VR/AR more immersive and realistic (XRA, 2018).

The Society for Science-Based Medicine promotes scientific validation of medical treatments and products, including medical AR. According to its Founder and Executive Editor, Novella (2018): “As a profession we struggle to integrate the human warm-and-fuzzy aspects of medicine with the advantages that modern technology bring.” It holds the doctor-patient relationship as vitals with or without AR.

Advocates of experiential learning contend that it is a more effective means of education. To them, VR/AR tech is an experiential learning tool (Bequiri, 2018). It can “guide students on a

path from novice to expert, a path that is difficult to traverse until they are faced with real-life experiences" (Drescher et al., 2018). VR/AR can help students prepare for difficult situations so that the real emergency is not their first encounter.

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