AN AUGMENTED REALITY ENVIRONMENT FOR ENHANCING CLINICAL TRAINING EXPERIENCE: STROKE ASSESSMENT SIMULATION

Stroke Assessment Simulation

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Abstract

The development of virtual, augmented, and mixed reality in recent years is opening doors for using VR, AR and MR devices in education. The purpose of this study was to test the use of augmented reality in teaching healthcare practitioners. To conduct our research, a simulation application was developed for the HoloLens that projects a face displaying facial drooping (a symptom of stroke) onto a training mannequin. Students at the nursing school were then placed in a clinical simulation wherein they wore the Microsoft HoloLens and performed an assessment of their mannequin patient. The students participated in a survey following their simulations and provided feedback on the devices and the quality of their experience. The results of the study show that most students enjoyed the simulation and felt that VR and AR would be a very useful educational tool in the near future. Further development of the program and device is underway, and future tests will be conducted. The results from this study will be helpful in further progressing the development of mixed reality, and the use of these devices in healthcare training.

Stroke is one of the major causes of death and long-term disability in the United States. On average every 40 seconds, someone in the country suffers from stroke (American Heart Association, 2017). Several studies show that the stroke treatment provided in an acute stroke unit is able to improve the patient's functional ability and decrease the length of stay (Aebersold, Kocan, Tschannen, & Michaels, 2011; Chang, Llinas, Chen, Llinas, & Marsh, 2018; Roquer et al., 2008; Saposnik et al., 2009; Terént et al., 2009). Early detection and intervention is the best way to minimize the permanent damage to the patient who is experiencing a stroke (Cavallini, Micieli, Marcheselli, & Quaglini, 2003; Jauch et al., 2013).

While much work has been done to increase awareness in the community and training for first responders and emergency room staff to recognize and respond to patients with stroke, there is still work that needs to be done to train nursing staff on the inpatient units in our hospitals. Strokes can and do occur when patients are hospitalized for other conditions such as hip fractures, heart conditions or respiratory illnesses. Nurses need to be prepared to quickly recognize and respond to a patient having a stroke. Bunch, Nunziato and Labovitz (2012) found that patients who were already in the hospital being treated for something else and experienced a stroke were not always able to get tPA, a medication that can lessen the impact of an ischemic stroke. In their single site study, they found

only 10/24 patients who could have received tPA were able to receive it. The largest modifiable reason they did not receive it was because their symptoms were not recognized within the required three-hour window. This could be addressed by training staff (most likely nurses) to recognize and quickly and correctly respond to stroke symptoms.

Mixed Reality for education

Mixed reality (MR) is one of the methods which can enhance the learning experience, due to its ability to provide an immersive learning experience as well as an interactive learning experience for students (Freitas & Neumann, 2009; Pan, Cheok, Yang, Zhu, & Shi, 2006). Mixed reality provides natural interactions with the real world and virtual objects (Azuma, 1997; Mann, Furness, Yuan, Iorio, & Wang, 2018), which extends and enhances the Virtual Reality (Hung, Liu, Liang, & Kang, 2016; Talmaki & Kamat, 2014) and Augmented Reality (Akula et al., 2013; Behzadan, Iqbal, & Kamat, 2011; Behzadan & Kamat, 2006, 2009, 2011; Kamat & Behzadan, 2006). Much experience-based knowledge, such as hospital patient room design (Dunston, Arns, Mcglothlin, Lasker, & Kushner, 2011) or evidence-based practice guidelines in healthcare (Aebersold, 2011), are more accessible to deliver through the application of MR. The virtual environment, e.g., Second Life® (Linden Lab, 2018)—a three-dimensional, online, multiplayer, interactive virtual environment, has been broadly used in nursing education (Aebersold, Tschannen, Stephens, Anderson, & Lei, 2012; Aebersold et al., 2015; Caylor, Aebersold, Lapham, & Carlson, 2015). On the other hand, the experience of the team collaboration or multi-professional learning can also be practiced in the MR environment (Caylor et al., 2015; Dong, Behzadan, Feng, & Kamat, 2013; Wu et al., 2017).

The recent growth of the augmented reality (AR) and virtual reality (VR) headset commercialization and the demand expedites the application of MR in healthcare (Kobayashi, Zhang, Collins, Karim, & Merck, 2018; Shirer, Mainelli, & Ubrani, 2018). The use of the headset such as the HTC Vive, Oculus Rift, Samsung Gear, or Microsoft HoloLens to provide education to healthcare education and medical personnel has become widespread (Zhu, Hadadgar, Masiello, & Zary, 2014). One of the primary advantages of MR simulation is to imitate the real world medical situation without putting actual patients at risk (Aebersold et al., 2011).

This pilot introduces new technology, using the HoloLens (Microsoft) to project an animated face onto a computerized mannequin (SimMan3G-Laerdal) in order to help nursing students recognize early stroke warning signs in patients who are not admitted for a stroke but who suddenly development one. The research questions in this pilot are:

1. Is the HoloLens an acceptable technology for the nursing students to use in simulation?
2. Were the nursing students able to complete the care of their patient including recognizing the stroke and completing a stroke screen (FAST)?

Methods

In this research, the AR simulation is applied to project the stroke animation on the head and face of the mannequin patient. When nursing students wear the AR device, they will see the animated face/head model on the mannequin patient. The stroke animation will be triggered after a predefined time for students to assess. The student's action can be evaluated by the instructor, as the simulation unfolds.

Device and Application

Microsoft HoloLens was utilized as the AR device in our simulation. The HoloLens is capable of projecting a 3D model into an open space or onto the desired location. The users can look or walk around, and the model will still be mounted at the same location. The HoloLens also includes some predefined gestures and voice control allowing users to interact with the model, as shown in Figure 1. To assign the projecting location, the AprilTag (Olson, 2011) was used as the AR sticker for the HoloLens to track the location. The AprilTag was placed on the head of the mannequin patient, as shown in Figure 2, and the HoloLens projected the 3D animated model based on the location of the AprilTag. An AR refining algorithm, KEG algorithm (Feng & Kamat, 2013), was applied to stabilize the model. After the model was placed at the correct location, it can be secured by the gesture control.

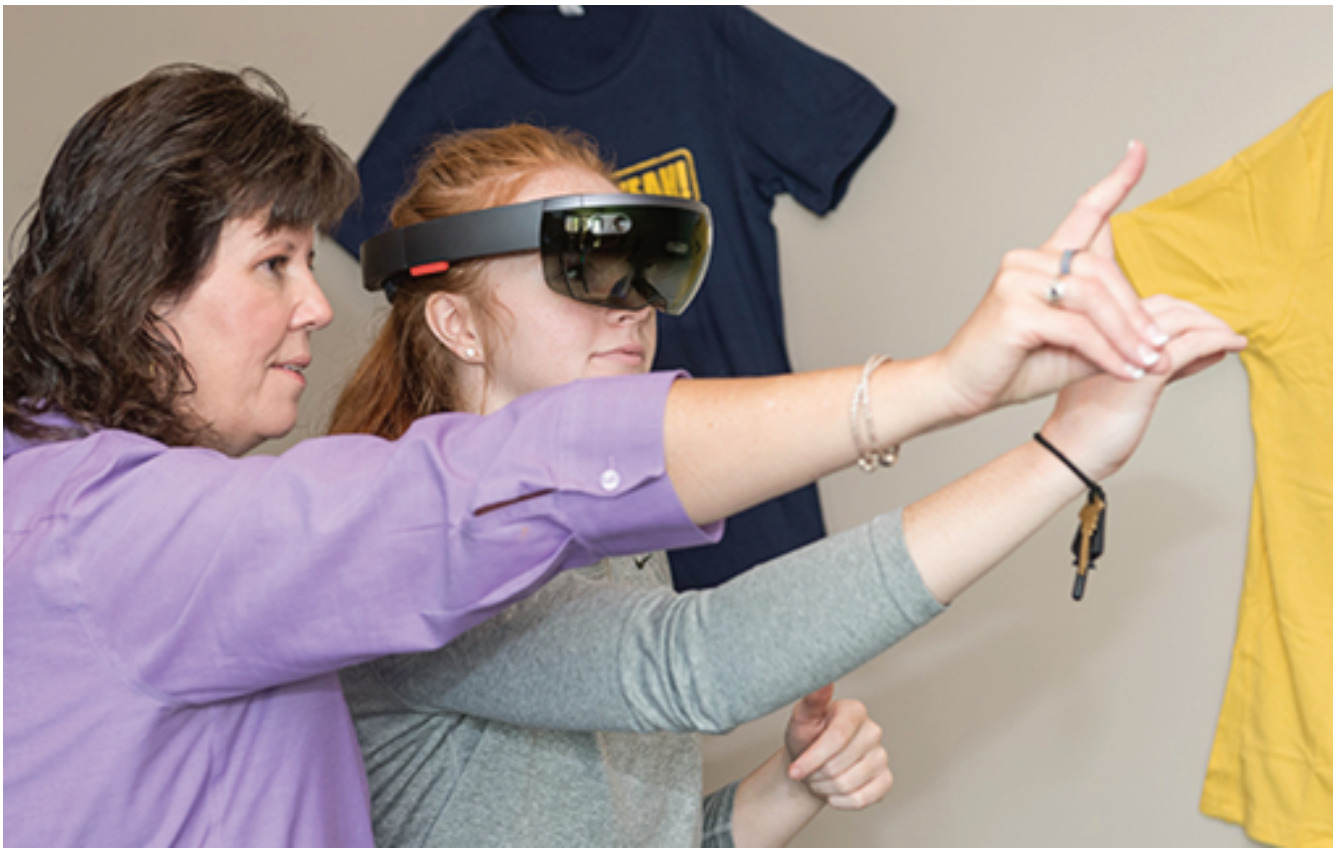

Figure 1: HoloLens using gesture control by a nursing student

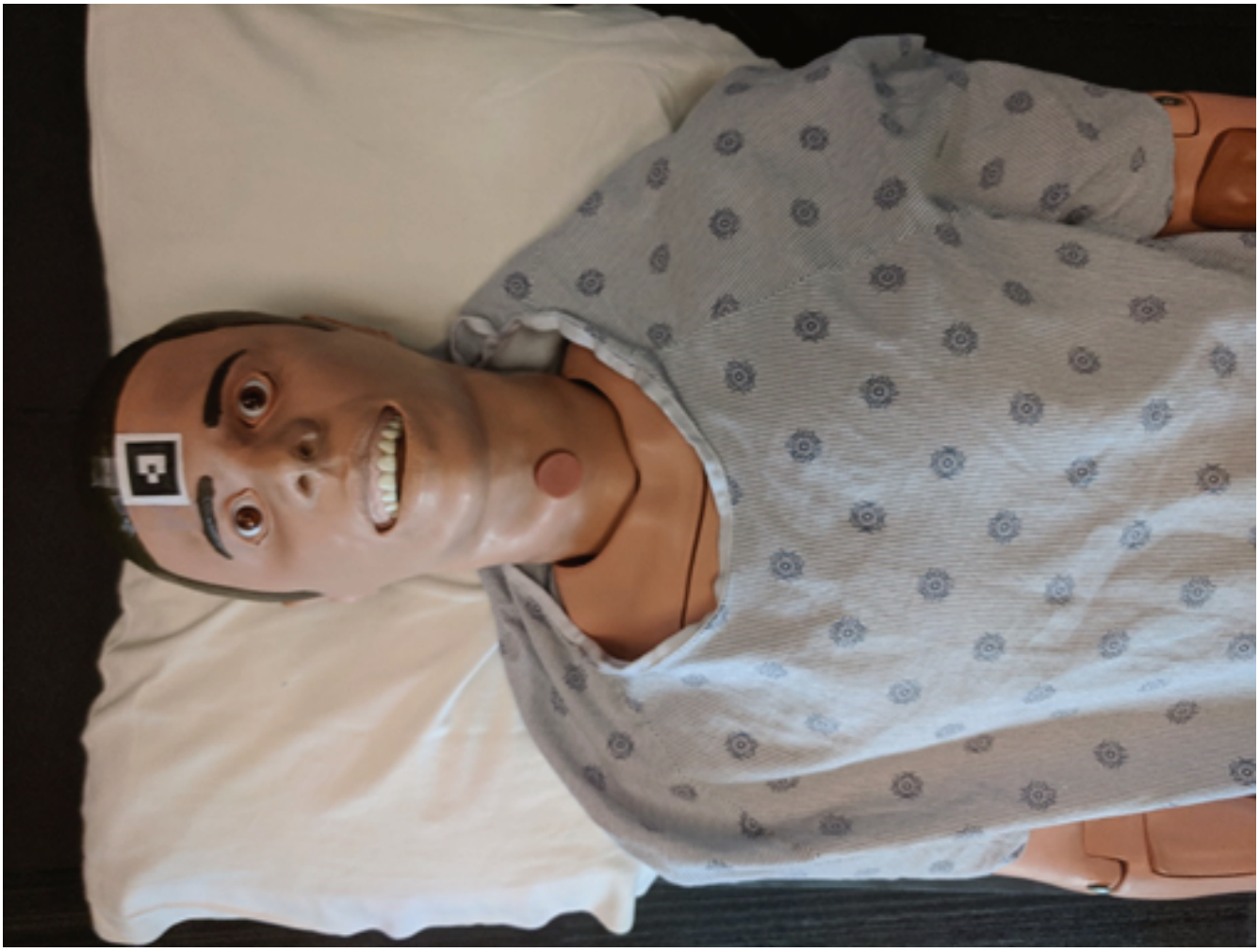

Figure 2: The AR sticker (AprilTag) was attached to the mannequin patient

Stroke Simulation

The stroke simulation was designed for nursing students to evaluate their ability to recognize the patient was having stroke-like signs and to then perform the FAST stroke assessment (American Heart Association, 2018; Harbison et al., 2003). One scenario was developed for the simulation. After obtaining institutional review board (IRB) approval groups of 2–3 students participated in the simulation. At the beginning of the scenario, the patient said they felt uncomfortable, then stated, "something wasn't right' and their speech was garbled. The student nurse needed to identify symptoms, conduct the FAST assessment (check for the facial drooping, arm weakness, speech difficulties, and recognize time was important to verify that the patient is having a stroke) and proceed with the correct procedure (contact the stroke team or rapid response team).

The whole scenario took about 5–10 minutes and would end once the student finished all the required assessments and reacted accordingly or after 15 minutes. The facial drooping animation was triggered one minute after starting the simulation scenario when the student began her/his basic assessment stopped 30 seconds later. The animation could also be triggered by gesture control. Therefore, the instructor could decide when to trigger the change based on the student's action.

Evaluation

An evaluation survey of the stroke simulation was conducted following each simulation. A total of 33 questions were listed in the survey. The students rated their experience on devices and the quality of the simulation using a five-point Likert scale (strongly agree, agree, neither agree nor disagree, disagree, strongly disagree). The students were also asked to provide their familiarity with VR, AR, and MR.

Results

The simulations were conducted between November 2017 and March 2018 in the simulation center. Eighty-five nursing students participated in the stroke simulation. Table 1 illustrated the detailed perceptions of the AR stroke simulation. Among the experience with VR/AR, 88.2% (n=75) of the students had heard of the two before, but 76.5% (n=65) of them could not explain the difference between the two. Only 3 out of 85 students had used VR/AR in their healthcare training prior to the stroke simulation. For the opinion on using the HoloLens in learning, 82.4% (n=70) of them agreed that the 3D animated facial model could help them assess the patient and recognized stroke symptoms, and 91.8% (n=78) of them were able to find the stroke symptoms themselves. In addition, 68.2% (n=58) of them felt they could assess a real patient following the stroke simulation. The most common responses for what people liked best about the HoloLens were that it was a new and exciting way to learn and that it made the simulation more realistic. On the other hand, the most common responses for what people liked least about the HoloLens were that it was heavy or uncomfortable, especially for the glasses wearers. They also suggested including the whole-body 3D model, instead of the head-only model.

For the perception of the HoloLens, 54.1% (n=46) of the students thought the HoloLens was comfortable to wear, but 27.1% of them disagreed, and 24.7% (n=21) of them felt impaired. Only 6 out of 85 students felt dizzy when wearing the HoloLens. Regarding the technical part, 61.2% (n=52) of the students found the facial model to be stable, and 80% of them found the model to be clear.

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
Prior experience with VR/AR					
Heard of VR/AR before	88.2%				11.8%
Could explain the difference	4.7%	18.8%	14.1%	47.0%	15.4%
Played VR game before	24.7%				75.3%
Used VR device before	23.5%				76.5%
Played AR game before	35.7%				64.3%
Used AR device before	4.7%				95.3%
Participated in training simulation before	89.4%				10.6%
Perception of HoloLens					
Felt itchy	1.2%	4.7%	11.8%	50.6%	31.7%
Felt pain	1.2%	14.1%	9.4%	47.1%	28.2%
Felt dizzy	1.2%	5.9%	8.2%	51.8%	32.9%
Felt heavy	8.2%	44.7%	10.6%	22.4%	14.1%
Saw clearly	7.1%	60.0%	16.5%	15.3%	1.1%
Felt impaired	2.4%	22.4%	21.2%	49.4%	4.6%
Facial model stable	7.1%	54.1%	11.8%	21.2%	5.8%
Facial model clear	12.9%	67.1%	9.4%	8.2%	2.4%
Facial drooping clear	37.6%	56.5%	1.2%	4.7%	0%
Found the stroke symptoms	35.3%	56.5%	4.7%	3.5%	0%
Opinion on using the HoloLens in learning					
Novel features for learning	7.0%	69.4%	18.8%	3.5%	1.3%
Help them assess patient	11.7%	67.1%	11.8%	9.4%	0%
Recognize stroke symptoms	11.8%	70.6%	10.6%	7.0%	0%
Could assess a real patient	14.1%	54.1%	20.0%	9.4%	2.4%
Closer to a real person	20.0%	56.5%	10.6%	12.9%	0%
Help them learn about stroke	15.3%	62.4%	9.4%	12.9%	0%
A useful simulation tool	17.7%	56.5%	15.3%	8.2%	2.3%

Table 1: Overall perception of the AR stroke simulation (n=85)

Conclusion

In a clinic simulation learning environment, it is difficult to portray stroke symptoms using a computerized mannequin because there is no way to alter the facial features to show facial droop or asymmetry. Using the mix of augmented reality and simulation mannequins allows educators to provide more realism in their simulation experiences. The feedback from the students demonstrating their agreement that this was an exciting way to learn and adds to the realism. The future works of this research are first to continue to perfect the animation model, that is, making it more stable as well as different types of facial expression. Second, the method of eliminating the need for placing the fiducial marker on the forehead of the mannequin will be explored, for example, object recognition algorithm (Liang, Kamat, & Menassa, 2018) or pose estimation method (Liang, Lundeen, et al., 2018).

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