Literary Review sketch pad

Applications in Learning

Applications in Practice

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How is virtual reality being used in the medical field?

Abstract

Keyword: [Medical education](https://search.proquest.com/pqrlscitech/indexinglinkhandler/sng/if/Medical+education/$N?accountid=4488); [Virtual reality](https://search.proquest.com/pqrlscitech/indexinglinkhandler/sng/if/Virtual+reality/$N?accountid=4488); Anatomy Virtual reality Serious games Natural interfaces Medical operators training

Mainly education

Introduction

Zajtchuk and Satava (1997) claimed “Virtual reality is being used to enhance medicine in four main areas: education and training; medical disaster planning and casualty care; virtual prototyping; and rehabilitation and psychiatric therapy.”

**Medical Education**

Zajtchuk and Satava (1997

an exceptional program run by Helene Hoffman of the University of California at San Diego combines an established multimedia computer-based education program with virtual reality [3, 4]. This program helps students learn about anatomy, pathology, radiology, and case studies

Zajtchuk and Satava (1997

medical curriculum can be available from any place, by anyone, at any time. The power of education is now convenient and at the disposal of the student, no longer limited by schedule, place, or time.

Salsabeel et al. (2018) reasoned that medical students need to develop clinical skills before dealing with real people.  Students can develop skills without the risk of harming a patient by working with artificial models. However, the current models need to be updated due to the changing complexities of Medical knowledge and student demand for modern teaching methods.  Virtual reality is a model that can be used and has already been being used to enhance medical education.

Salsabeel ect al. (2018) explained that minimizing errors in medical learning is crucial for patient safety.  Virtual reality provides a way to measure learning outcomes to ensure students are ready to perform on real patients.

Salsabeel ect al. (2018) explained that their Virtual Reality system can be used all over the world because it’s user friendly,

*Anatomy*

Jan-Maarten, Vorstenbosch, and Kooloos (2017)

For the study of human anatomy, this promises extraordinary versatility and flexibility in the presentation and exploration of anatomical objects, at a fraction of the cost of maintaining dissection facilities [2-4]. However, full VR is technologically challenging and has not yet been implemented. The ongoing development of virtual reality is reflected in the lack of consensus in the literature as to the effectiveness of digital 3D representations for human anatomy learning.

Salsabeel ect al. (2018) study allowed students to interact with a realistic looking three-dimensional model of a heart in virtual reality. Students are able to dissect and explore different parts of the heart and access description about those parts.  These student also used the traditional method for learning about the heart so they would be able to compare the experience.

Salsabeel ect al. (2018) anatomy descriptions can be modified, and it can be accessed through the internet.

Salsabeel ect al. (2018) experimented by having students use their virtual reality system to identify structures of the heart, dissect the heart, see anatomical relations, and view information about each element of the heart.  After the student finished the run through, they were given a questionnaire to assess their experience. Twenty three of the questions asked the student to assess their experience with the physical model and twenty three other questions asked them to assess their experience with the virtual model.

Salsabeel ect al. (2018) concluded from their experiment that students felt like they learned more and preferred using the virtual reality model over the physical model.  This means that virtual reality is a efficient teaching tool

Jan-Maarten, Vorstenbosch, and Kooloos (2017)

Older studies often report ambiguous or negative findings (e.g., [5, 6]). These studies however do not utilize the full potential of virtual reality, using 3D computer models in a "desktop VR" setting. In desktop VR, sources of spatial information such as physical size and tactile/force feedback are lost, and there is no direct interaction or sense of sharing space with virtual anatomical objects.

Other areas

Jan-Maarten, Vorstenbosch, and Kooloos (2017)

we created a virtual anatomy learning environment to study the anatomy of the neck. both virtual anatomy groups would outperform the nonanatomical control condition.

Jan-Maarten, Vorstenbosch, and Kooloos (2017)

we created a test that asks the participant to localize a cross section of the studied anatomy on a frontal view of that same anatomy. The student can do this by clicking one of a number of horizontal lines drawn over this frontal view.

being relevant for learning to apply anatomical knowledge in a clinical setting, for example, to interpret cross-sectional material resulting from radiological or histological imaging.

Jan-Maarten, Vorstenbosch, and Kooloos (2017)

The*study phase* differed for each experimental condition, except for duration, which was 150 seconds. This duration was based on previous research [17] and a three-person pilot. We found that around the two-minute mark participants start losing focus, which led us to believe a study phase exceeding 150 seconds would not lead to more learning. Participants were alerted to the time left for exploring the study phase environment at the thirty-second, one-minute, and two-minute mark. Students were randomly distributed over the following three conditions.

Jan-Maarten, Vorstenbosch, and Kooloos (2017)

*1) The Stereoptic Condition* . Participants in this group studied a 3D reconstruction of anatomical objects of the deep neck wearing the Oculus

*(2) The Nonstereoptic Condition* . This condition was identical to the stereoptic condition, with the exception of the virtual objects being offered such that both eyes were presented with the exact same visual perspective.

*(3) The Control Condition* . Participants in this condition did wear the Oculus Rift headset for 150 seconds and only got to explore a virtual sea world instead of test-related human anatomy.

Jan-Maarten, Vorstenbosch, and Kooloos (2017)

Overall, for participants this results in 30 percent (3 answers) correct as performance at chance level. Answers came in at a mean of 2.8 correct,

Jan-Maarten, Vorstenbosch, and Kooloos (2017)

Confirming earlier research in this area, visuospatial ability positively impacted anatomical learning [7, 14]. In contrast, we were not able to confirm earlier research that suggests stereopsis in digital learning environments can positively influence learning [17]. We did in fact not find an effect for either of our experimental conditions compared to each other, or to the control condition.

*Surgical Training*

Zajtchuk and Satava (1997) explained that virtual reality allows surgeons to train on difficult procedures by performing the procedure on an virtual organ that move, behave and feel like real organs.  They only say that they do not currently look like real organs. Also further testing is needed to determine if this method improves learning.

*Manufacturing Medical devices*

Ho et al. (2018)

the assembly of hybrid medical devices is considered to be a highly complex and time-consuming process. Furthermore, the working environment has to be free from contamination throughout the fabrication and preparation process [[18](https://link-springer-com.erl.lib.byu.edu/article/10.1007/s11042-018-6216-x#CR18), [31](https://link-springer-com.erl.lib.byu.edu/article/10.1007/s11042-018-6216-x#CR31)]

Ho et al. (2018)

Traditional, existing training methods for manual assembly include mentoring and attending lectures in classrooms. However, these methods pose many problems such as difficulty in transferring tacit skill/knowledge to the trainees and the requirement of intensive guidance by qualified manager or supervisor [[33](https://link-springer-com.erl.lib.byu.edu/article/10.1007/s11042-018-6216-x#CR33)]. This training process also gives rise to other underlying issues such as long training period, high skill and experience requirements of operators, and high training costs [[25](https://link-springer-com.erl.lib.byu.edu/article/10.1007/s11042-018-6216-x#CR25)]. Moreover, the training is likely to be executed within a shared workcell among other existing operators due to the high costs involved in purchasing, constructing and/or maintaining the equipment and the cleanroom [[19](https://link-springer-com.erl.lib.byu.edu/article/10.1007/s11042-018-6216-x#CR19)]. In such case, the training process may lead to an increase in contamination and safety risks, which is not desirable for hybrid medical device fabrication [[2](https://link-springer-com.erl.lib.byu.edu/article/10.1007/s11042-018-6216-x#CR2), [41](https://link-springer-com.erl.lib.byu.edu/article/10.1007/s11042-018-6216-x#CR41)]. In order to solve these underlying issues, a risk-free, low cost and efficient assembly guidance training system has to be introduced.

Ho et al. (2018)

VR training systems also face another challenge, which is to customise the training to suit individual learning patterns. This customisation process conventionally involves human supervision that is time consuming and costly.

Ho et al. (2018)

VR can be used to (a) create effective virtual environments that are not available or easily accessible in the real world, (b) provide a safe, low-cost training method with no harm/risk for patients in the medical industry, (c) support active learning and repeated task practices.

Ho et al. (2018)

Inspired by popular first-person game concepts, the VRAGTS is an intelligent, VR and game based assembly training system. The motivation of this system is to promote real-time effective guidance, interaction and fun for trainees during the training process. It aims to solve the underlying training issues for hybrid medical device assembly by providing trainees with effective, efficient, risk-free and low cost training.

Ho et al. (2018)

The Virtual Environment allows both the assembly operator and the VR supervisor (a programmed virtual supervisor that will be explained in detail in the next section) to be readily updated of these virtual activities and interactions; the assembly operator will be updated via a physical display set (e.g. computer monitor, projector screen, VR headset) while the VR supervisor, being part of the Virtual Environment programme, is constantly updated with the generated data.

Ho et al. (2018)

Interactive Channel is the communication bridge between the assembly operator and the VR supervisor, where the operator can send special request commands (e.g. request for hints, fast forward time, restart) and the VR supervisor can give assembly training step guidance to the operator when requested and/or when the operator repeatedly perform the wrong assembly training step action (e.g. word instructions, virtual animations of the required assembly training step action, visual directions to the equipment/materials/items involved in the assembly training step)

Ho et al. (2018)

Tutorial, practice and assessment phases are implemented to prepare trainees and/or test trainees if they are ready for the real-life tasks. The proposed training system can be used as an effective learning platform not only for new operators but also for existing operators who want to revise on the assembly steps [[33](https://link-springer-com.erl.lib.byu.edu/article/10.1007/s11042-018-6216-x#CR33), [56](https://link-springer-com.erl.lib.byu.edu/article/10.1007/s11042-018-6216-x#CR56)].

Ho et al. (2018)

All tutorials, practices and assessments are operated within the virtual environment workspace under the VRAGTS. The trainees are required to pass each game assessment test based a minimum score requirement to move on to the next stage, else they are required to start their training from the beginning of the stage that they are currently in. At any point of time during any assessment test, the trainees can request for hints from the VR supervisor. However, they will be penalized for each hint request they make. The trainees will be deemed fit to proceed on to the real-life training phase by the system when they pass all the game assessment tests. The game-learning process overall flowchart of the proposed training system is summarize

Ho et al. (2018)

we can observe that the average training time taken per participant is the lowest for Method A, followed by Method B, and then Method C.

Ho et al. (2018)

we can observe that the average assessment score per participant is the highest for Method A, followed by Method B, and then Method C. The average assessment score for Method A is 32.

Ho et al. (2018)

The effectiveness of the various training methods are further evaluated and analysed using the qualitative ratings based on the participants’ subjective responses. Figure [20](https://link-springer-com.erl.lib.byu.edu/article/10.1007/s11042-018-6216-x#Fig20) summarizes the comparisons of the average ratings for the different qualitative metrics (i.e. effectiveness, confidence, enjoyment, comfort) among the various training methods. Referring to Fig. [20](https://link-springer-com.erl.lib.byu.edu/article/10.1007/s11042-018-6216-x#Fig20), we can observe that for every qualitative metric, the average ratings per participant is the highest for Method A, followed by Method B, and then Method C.

Ho et al. (2018)

it can be observed that 90% of Method A’s participants felt ready to proceed to the next training level (i.e. physical training in the lab), whereas only 40% of Method B’s participants and 30% of Method C’s participants felt ready.

Ho et al. (2018)

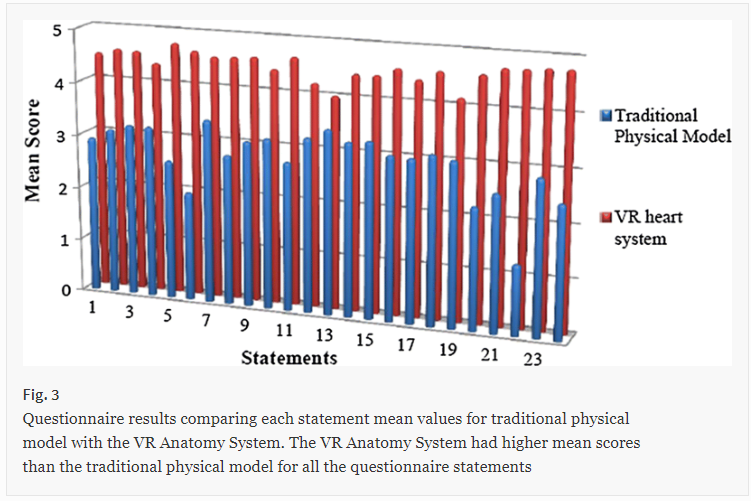
Thirdly, Method A’s participants on average felt that the proposed VR training system was significantly enjoyable, Method B’s participants on average felt that the common VR training system was moderately enjoyable, and Method C’s participants on average felt that the conventional training system was not enjoyable.

**Therapy**

Zajtchuk and Satava (1997

and creation of threatening environments, such as tall buildings or bridges, for psychiatric therapy

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Zajtchuk and Satava (1997)

“The value of these simulators is principally in teaching cognitive and manual skills. Due to their increasing complexity, simulators will eventually provide the same value in medical testing and certification as flight simulators do.”

Zajtchuk and Satava (1997) explained that real patient data can be stored in libraries and then rendered in three-dimensions for medical student studies.

Zajtchuk and Satava (1997)

Another application of virtual reality is medical planning, such as that needed to deal with disasters and combat casualty care.  such as an earthquake zone or a battlefield

Jan-Maarten, Vorstenbosch, and Kooloos (2017)

Ho et al. (2018)

Ferracani, Pezzatini, Seidenari, and Del Bimbo (2015) Feracani et al. (2015)

Ferracani, Pezzatini, Seidenari, and Del Bimbo (2015) Feracani et al. (2015)

Simulation is a key training method used to train medical personnel. There are many types of simulations but virtual reality allows for a setup of many different situations for a low cost. Many risky environment and situations can be simulated. Manikins can cost from 20 – 80$ k and finding free ground to enact risky environment can be hard to find.

Ferracani, Pezzatini, Seidenari, and Del Bimbo (2015) Feracani et al. (2015)

Results showed that the overall set-up cost for facilities and equipment was $876,485, fixed costs per year amounted at a total of $361,425, while variable costs for session training and teaching totalled $311 per course hour. adoption of the EMERGENZA system cannot be precisely quantified but it would certainly relieve the expenses for equipment, simulation scenarios setup, courses and teaching staff.

Ferracani, Pezzatini, Seidenari, and Del Bimbo (2015) Feracani et al. (2015)

Of course the use of a virtual environment may decrease the realism of the simulation, since it would be complicated to deliver the tactile information that a physical mannequin can, and it offers substantial advantages: it both allows to decrease the cost of the simulation and to increase the simulation complexity.

Ferracani, Pezzatini, Seidenari, and Del Bimbo (2015) Feracani et al. (2015)

. A second point is to increase the amount of patients in need of assistance with no cost at all.

Ferracani, Pezzatini, Seidenari, and Del Bimbo (2015) Feracani et al. (2015)

Gas leak situation, the assistant indicates smell of gas, player can make decision what to do. 1. Secure environment 2. Patient state 3. Action on patient. Time taken and player errors are assessed. Trainings can be recorded for debriefings.

Ferracani, Pezzatini, Seidenari, and Del Bimbo (2015) Feracani et al. (2015)

only limitation of the standard KinectTM SDK was the lack of a hand pose recognition algorithm. The recognition of the hand pose allows a system to recognize on/off actions such as activating, grabbing or manipulating an object in the 3D world. This limitation was often handled with the use of persistence, i.e. a user must keep his/her arm still for a not so short amount of time (3 s)

Ferracani, Pezzatini, Seidenari, and Del Bimbo (2015) Feracani et al. (2015)

The detection is really fast but sometimes not very accurate.

Ferracani, Pezzatini, Seidenari, and Del Bimbo (2015) Feracani et al. (2015)

To improve the system robustness, the classifier is cascaded with a temporal Kalman filter [30] that outputs a smooth estimate of the hand state. The filter helped increase accuracy to basically 100%.

Ferracani, Pezzatini, Seidenari, and Del Bimbo (2015) Feracani et al. (2015)

Ten evaluators (6 of them researchers in the field of interactive systems and 4 medical operators in the field of emergency medicine) were asked to interact with the virtual environment. Evaluators were instructed how to interact with the system, and the task they were supposed to accomplish was described to them. In particular, the correct medical BLSD procedure was explained and they were asked to perform it in the virtual environment. Eventually, evaluators were asked to fill a questionnaire based on the proposed heuristics. The questionnaire consisted of 10 declarative statements, each one of those related to one of the heuristics. Evaluators rated these statements using a 5-point Likert scale

Ferracani, Pezzatini, Seidenari, and Del Bimbo (2015) Feracani et al. (2015)

The results show that the users were highly engaged in the virtual reality experience (H3b, H5, H6a), even if there are still some issues related to gesture understanding and tasks accomplishment due probably to the prototypal state of the system (H2, H3a).

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