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A Survey: Virtual Reality Model for Medical Diagnosis

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Virtual reality is a new and a very revolutionizing concept and its progress in the field of medical diagnosis is taking this technology to another level. Simulators of virtual reality give essential aptitude for preparing in a controlled domain, operating patients free of pressure without supervision. These skills acquired can then be utilized in the training room. In medical applications virtual reality can be utilized for better picture control, enhanced picture understanding, enhanced quantitative correlations, and better planning of surgery. Not only has the virtual environment provided in the virtual reality helped the patients to cope with stress associated before the surgery but also helped in the reduction of pain. In this paper we have mainly focused on incorporating Virtual Reality in treatment of three diseases-breast cancers, colon cancer and Alzheimer's. Also, we have made a comparison of the traditional methods, which already exist to treat the above diseases with the methods incorporating virtual reality. Finally we have stated the benefits of using virtual reality over traditional methods.

Keywords: Virtual reality, medical diagnosis, breast cancer, colon cancer, Alzheimer's disease.

Virtual Reality is the basis used to define a novel human-PC interface that empowers users to collaborate with PCs in a fundamentally extraordinary manner. Virtual reality is the combination of computer-generated environment[15] and interface that enables the users to explore the environment, communicate with various other objects present in the environment and inundate themselves into the environment. It is compelling to enter into this field of Virtual Reality[32]. The basic requirements for entering into the virtual world by means of artificial intelligence is by wearing a cap (helmet) that contains head mounted show (HMD) that consolidates a sensor to track the user's actions and location. Along with this, user can also put on sensor consisting clothing that does the same work. The sensors impart position and area information to a central computer, which refreshes the picture of the virtual world as required. By utilizing this attire, the client "gets through" the PC screen and turns out to be into this multi-dimensional virtual world. Hence, by this any user can stroll through a virtual house, drive a virtual auto, or run a marathon in a recreation centre all inside a computer, that is Virtually. Late advances in PC processor speed and designs make it feasible for even work stations to make exceptionally reasonable situations. The viable applications are expansive.

Medical science is rapidly accepting and acknowledging the findings of virtual reality. Every researcher and pysician is aware of the advantages of the virtual reality in medicine. A few advanced

researches have by far proved that the virtual reality has better performance in detection and treatments of various diseases usingVR imaging and planning techniques. The utilization of VR in therapeutic applications accommodates better picture control, enhanced understanding of the image repots, enhanced examinations[14], and systematic planning of the surgeries[9]. Medicinal utilization of intuitive 3D advancements is wide. Until now, the virtual realtiy has proven to be extensivly successful in surgical planning and training, surgeries conducted through computer systems.

In this paper we will be mainly focusing on incorporating Virtual Reality in treatment of three diseases-breast cancers, colon cancer and Alzheimer's. Breast cancer treatment using conventional methods leads to a lot of pain and stress. Thus in the next section we have explained how using VR we can reduce the pain and stress the patient goes through, improve the drug design process for the treatment of breast cancer and make the screening process of breasts harmless. Colonoscopy is used to detect the early stages of colorectal cancer. It has various demerits and causes discomfort to patients and needs an expertise to conduct the process skillfully. Hence we bring in Virtual colonoscopy[3] that eliminates all the cons of the traditional method and makes it easier for both patients ans doctors. Alzheimer's disease is the impairment in cognitive abilities and memory loss. The patients suffering from AD find it difficult to recognize things in everyday life. The conventional methods for the treatment of AD leads to nausea, diarrhea, and muscular weakness, significant weight loss on occasion etc. and do not guarantee the cure of the disease. We can use virtual reality to reduce these side effects and make the life easier by making the patients recognize their surroundings.

Comparison of Traditional Methods wit Virtual Reality in Medical Diagnosis

Breast cancer

Diagnosis of disease using VR

When cells in the breast mutate and go on reproducing it leads to breast cancer. The presence of breast cancer is indicated by existence of lump, discharge of blood from nipple and modifications in the texture or the shape of the breast or the nipple. Depending on the stage of the cancer its treatments are given. It might comprise of chemotherapy, radiation, hormone treatment and surgery. How or why this harm happens isn't completely comprehended. A few changes may grow haphazardly after some time, while others are acquired or might be the aftereffects of ecological exposures or way of life factors. This affects mostly ladies over the age of 50. Nonetheless, a great value of false positive rate found while the normal investigation worsens the issue. The total hazard for false positive results in mammography has a value in the range of 21% to 49%[20] after investigating ten mammography cases. The absence of visualization

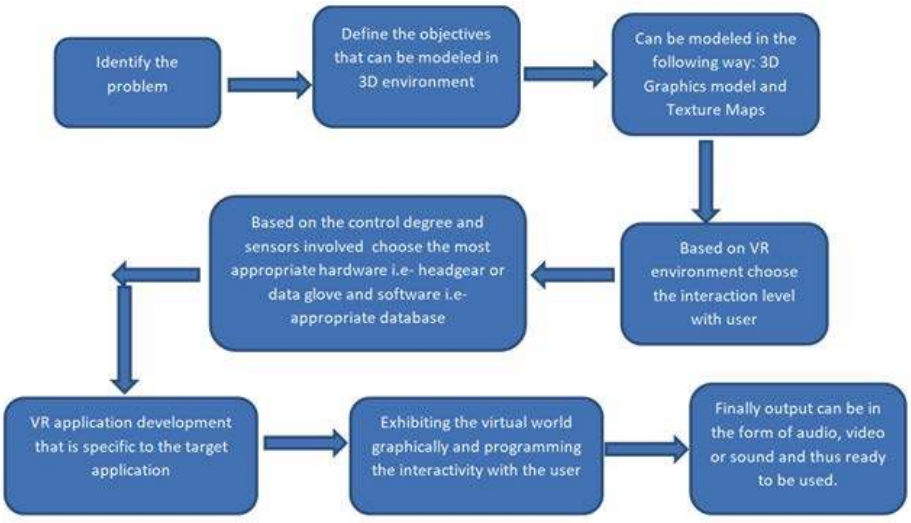

Fig. 1. Architecture

of tumor causes this error. The lives of many people have been revolutionized due to the advancement in the visualization process. Thus using virtual reality, the processes can be studied by the doctors on a really large sale. This will not only help them see the tumor properly and come up with better treatments but also help them come up with better designs of drugs.

Before explaining how virtual reality can be incorporated into the treatment of breast cancer we would like to list out the problems associated with the conventional methods already in use. While screening of breasts for detection of the presence of the tumor, patients are exposed to radiations, which are very harmful for them. Also this gives rise to increase in anxiety faced by the patient, pain and the medicines given to the patient for the reduction of pain.

Virtual reality can be used to solve the above problems in the following ways:

Using VR for stress management techniques

The process of breast cancer treatment is very painful and the very thought of going into a surgery is very stressful. Thus a virtual reality headset can be provided to the patient just before the surgery where he is shown some videos thus helping the patients to get accustomed to situations involving stress and pain, providing them information which can be easily understood by them and thus making them feel comfortable and composed. For instance below are some statistical results of patients who made use of VR provided by OnComfort – Patients who used OnComfort 15 minutes prior to getting operated observed the following:

- 50 % decrease in the nervousness experienced before surgery
- 40 % decrease in pain
- 80 % reduction in medication given to reduce pain
- 50 % decrease in time taken for recovery of patient

The above results provide benefits to both the patients as well as people involved in providing healthcare who continuously strive for improvement and decrease in the time period that patient stays.

Using VR for improving process of drug design

The physicists and cell scientists can put on a virtual-reality headset and show signs of improvement feel for the little situations they are exploring and building. For example, they can view the virtual reproductions of the diverse manners by which nanoparticle drugs are eaten up by malignancy cells, possibly supporting the medication configuration process.

Using VR for harmless screening of breasts

As VR is immersive and interactive the doctor can easily incorporate this while performing the surgery. From MRI data obtained from the breast cancer a 3D model is displayed. This helps the technologists as well as the doctors performing biopsy to become proficient and confident as this visualization makes their task easy. This also prevents patients from getting exposed to harmful radiations. Douglas *et al* in[25] after conducting an experiment using a head display unit and joystick control concluded that they got a better view of the shape as well as the margins of the breast as they were in a 3D environment. They thus established a view that this method is superior to the traditional 2D methods.

Statistical Analysis

Susan *et al* in[20] conducted an experiment with old aged women who were 50 or more. This experiment analyzed the impacts of virtual reality diversion mediation on chemotherapy-related manifestation distress stages in 16 ladies. Cohen's effective size in State Anxiety Inventory for the manifestation was found to be 0.44. This partially bolstered the fact that VR help in reduction of stress.

Yobelli *et al* in[23] also conducted an experiment on two groups and finally observed that scores that were obtained in the group who were exposed to virtual environment ($p<0.5$) were more significant. They thus concluded that VR helps to reduce anxiety in patients.

Colorectal Cancer

Diagnosis of disease using VR and comparing it with traditional method

One of the leading most cancers across the globe in both men and women these days is the Colorectal Cancer[4]. According to various sources and researches, there are about 1.3 million new cases that have been reported every year. With the mortality rate being 51%, it is the second most common cancer among women.

In the initial stages of colon cancer, polyps are formed in the inner lining[4] of the

surface of colon. A gastroenterologist visualizes the colon lining by an optical colonoscopy. Through colonoscopy, the early stages of colorectal cancer can be easily detected and treatment is possible. Along with early detection, cancer can also be prevented using colonoscopy. A colonscope consists of a video camera and light sources are attached to a very thin flexible tube. Cleaning and distending of colon is carried out via pumping carbon dioxide into the colon before its examination. We can get visuals on the video monitor when a colonscope so inserted in anus for examining the colon surface[3]. On observing any malignant polyps, special tools in a colonscope are used to remove them.

On account of the numerous elements that may influence performance of the manual inspection in colonoscopy[6], it gets difficult to efficiently assess the performance in live colonoscopy. So the alternative is the utilization of virtual simulation. There is a possibility of impartially and consequently evaluating a large number of factors relevant to an efficient inspection assessing on the basis of standard cases. There is an availability of various types of VR colonoscopy simulators which have the capability to report scope of information that can portray performance factors like, level of mucosa visualized, rate of polyp detection, withdrawal time and time in 'red-out'[2].

Virtual Simulators for virtual colonoscopy

Virtual colonoscopy is rising as another option to replace optical colonoscopy. In virtual colonoscopy, we use a thin-area[3], computed tomography (CT) for the production of 2D, high-resolution axial images. Although, the precision of virtual colonoscopy stays obscure, studies propose that this method might be an appealing contrasting option to existing screening tests for colorectal cancer due to its high safety and minimum invasion.

In virtual colonoscopy, we can visualize 3D model to a human anatomy and navigate through the tubular structures of intestines using the means of virtual camera, eliminating the need to insert any physical device into the body. Virtual colonoscopy has applications in detecting various abnormalities in the body along with the detection and diagnosis of early stage cancer. It is much faster and highly comfortable in comparison to traditional[1] techniques. Although, similar to conventional colonoscopy, virtual colonoscopy also requires the cleaning and distending of colon for better vision. Perception of the outer surface alongside the inward surface is the principle advantage over traditional techniques

Virtual simulator systems give protective and real situations for learners to take in the aptitude of colonoscopy. They can comprehend 3D connections between anatomical structures in the colon and build up the haptic control and artfulness required to work the colonscope. Moreover, it is convenient to assess the progress of trainees of number of parameters that include, ratio of mucosa observed, caecal intubation time, how much the patient is uncomfortable and number of errors. Simulator systems may likewise offer the open door for endoscopists to practice colonoscopy methods with understanding particular information keeping in mind the end goal to predict any potential difficulties amid the genuine colonoscopy.

Gaps in current practices and solutions

Dissimilar to traditional colonoscopy, which takes a long time for the procedure to complete, virtual colonoscopy merely takes about 15 minutes. Along with less time taken, it does not cause much discomfort to the patient[4]

The traditional methods used medial lines for the computation of path, which endured the risk of leaving various portions on the surface unchecked, whereas, the main function of the virtual colonoscopy is the self-computation of the path. This procedure makes sure that there is no undetected portion left along with keeping the path optimum[2]

The standard method to visualize the inner lining of intestines for various abnormalities has always been the Traditional Colonoscopy.

Various parts of the body remain unchecked due to the fact that there are numerous body areas which are not available because of impeding tumors [8] or not suitable for optical endoscopy

- There might be a possibility that the polyp is undetected by the doctor even after it comes on screen.
- There is a high requirement for skilled endoscopists to carry out procedures as it is of high discomfort for the patients.
- Patients who cannot bare sedations cannot undergo traditional endoscopy.
- Thorough gut planning, requirement

for sedation and obtrusiveness are significant preventions in receiving colonoscopy as a screening strategy.

Virtual Environment

- Virtual colonoscopy is speedier and offers less discomfort to the patient. An obtrusive strategy is essential only if suspicious polyps are recognized.
- Virtual products packaged with restorative imaging workstations are restrictive in nature, firmly combined with the framework equipment and don't trade the pictures in standard arrangements[4] They additionally include high permitting and repeating costs.
- Business medicinal imaging workstations include high beginning venture and consequent yearly support costs[4]

Statistical Analysis

According to the survey conducted[1] the evaluation form was filled by experienced gastroenterologists on various evaluation criterion for VR such as Visual Effect, real-time interaction, Haptic experrience, rotation of colonoscope, bend effect etc. and more than 80% of these doctors approved the system and gave an "Excellent" review for the same.

Previous investigations on CT colonography reports "excellent" outcomes. In various journals[12] it was conceivable to show in survey that CT colonography has the required affectability and specificity to be utilized for examination purposes in a generally safe environment.

Around 1333 patients were analyzed at nearly same time in a multi focus survey using differne to types of colonoscopy.The affectability of CT for polyps more than 9 mm in estimate was nearly 94.8%; for polyps which were more than 7 mm it was 92.3%, and further more, for polyps more than 5 mm it was 87.7%. Also, in other survey reports[14] it was showon to have distributed correspondingly great outcomes (at any rate for polyps > 9 mm).

Also according to present study and recent reserches in other references[2] it was observed that in a patient colonoscopy, simulator trained learners have performed exceedingly well than non-simulater trained learners[1,2]

Alzheimer's disease

Alzheimer's is a disease, which destroys memory, thinking skills and the ability to do simple daily tasks slowly and progressively[31] Alzheimer's is the most common cause of dementia, which is a common term for the disorders affecting brain, and include loss of memory, difficulty in thinking, language or solving problems symptoms contained in a set. People with this disease tend to forget and misplace things and have minor short term memory loss. This disease is most commonly diagnosed in the people at the age of 65 and older. Heart issues, depression, diabetes and high blood pressure pose a higher risk of causing Alzheimer's disease. In the risk of developing Alzheimer's disease genetic factors play a very crucial role. There is a severe loss of cholinergic neurons in some brain areas causing AD even though the causes of AD are not understood clearly. In this disease in the brain proteins build up to form structures called plaques, which are the abnormal clumps in the brain, and tangles which are the bundles of fibers in the brain. This leads to loss of brain tissue, nerve cells connections and lead to death of nerve cells. In their brain there is some shortage of chemicals. These chemical messengers around the brain help to transmit signals whose shortage causes the signals to not transmit effectively.

This disease cannot be cured but temporary reduction in some symptoms or slowing down the progression of the condition in people can be done by some medication available. These medications may or may not be effective and can pose various other problems.

- The use of the combination of drugs alpha-tocopherol and selegiline[40] may delay functional deterioration in patients that are clinically important at a mild level but studies have shown that in cognitive test scores there was no improvement when patients were more severely impaired.
- Pharmaceutical therapy: Cholinesterase inhibitors are used which increase acetylcholine activity in the nervous system. This leads to the side effects such as nausea, gastrointestina upset, diarrhea, muscular weakness, syncope, and significant weight loss on occasion. Moreover they are expensive.
- Great potential for the treatment of AD is by medical herbs. These include polyphenols, HuperzineA, Ginkgo biloba etc which protect neuron membranes, slow down cell generation and

control neurotransmitters by their antioxidant and antiflammatory properties. These pose problems like low bioavailability, need more human trials appear to work for AD but do not lessen the risk of getting AD and mild cognitive impairment.

• To facilitate cognitive functioning cognitive training, socialization and physical exercise are recommended. For a healthy brain they increase the supply of blood to the brain and control chemicals that are necessary. These therapies are not proved by any research. It may work on some people and not on others.

Virtual Reality can be used in the following ways for the detection and the treatment of AD and gives solutions to various above problems mentioned.

• Virtual reality environment[38] can be used to train the patient to target in a symmetric virtual building with no landmark. The patient's skill to navigate while he is driving improves considerably and enjoys improvement in cognition at home in his day to day life.

• A virtual reality[31] platform which is dual-modal has been developed especially for training in cooking activities in AD and establish its value as a tool for training in day to day activities in these patients. Within a virtual kitchen two everyday tasks and two reductions in the error learning methods have been implemented. Error reduction learning methods which are implemented in virtual environments which could be profitably used in such populations of people suffering from AD.

• For early diagnosis and recovery of patients with suspected AD virtual reality is better suited than current traditional memory tools.

• VR make more self-pertinent and multi-sensorial states than laboratory conditions. It can also be used to reproduce or construct a large amount of environments with different varieties, such as the place where patient lives, creating highly ergonomic situations for the rehabilitations of these patients. It is easy to investigate the memory of the patient for specific events of AD patients.

• VR offers the chance to detect subtle deficits in early stages of AD. Alzheimer's disease can be detected before the start by using a virtual reality maze test in which the people aged 18 to 30 are made to direct through virtual maze so that the function of certain cells of the brain can be tested.

Statistical Analysis

• According to the test conducted[30] it was concluded that a strong effect of population on the amount of recalled items ($F(3,57) = 78.9$, $p < .002$, $2p = .75$), indicating that recalls of the patients with AD and aMCI were impaired compared to healthy ANCOVA based control participants on which scores. In addition to this after demonstrating the sensitivity of the test to episodic reference memory measures in healthy younger and older groups VR test seems to be well-suited to characterize amnesic differences between normal aging and pathological aging.

• According to the test conducted[33] there was the calculation of correlation between the VR-RMT, VRMT and neuropsychological tests which was proposed to the members participating in the test before to the phase of the test. The results of VR-MT in correlation with the Mini Mental State Examination (Pearson's .687, $p < .002$), Manikin Test (Pearson's .752, $p < .002$) , Corsi's span (Pearson's .516, $p < .001$), Corsi's supra-span (Pearson's.803, $p < .001$) and Trial Making Test (Pearson's .488, $p < .039$). A decreasing capacity in VR-MRT performance exists in AD based on performance analysis.

• The test was conducted [38] in which the viability of a VR-based spatial navigation practice was tested. In this exercise a simple case study was conducted in which a 74 year old man was examined at the beginning of AD and it was suggested by the evidence that there might be benefits related to cognition to VR navigational learning. A quantitative change was appeared in the patient over a time period of 7 weeks.

Benefits of Virtual Reality in Medical Diagnosis

Cognitive rehabilitation

Patients with mind damage from injury or ailment, for example, stroke, regularly battle with the ordinary undertakings that we underestimate, for example, shopping or making arrangements for the end of the week. Reproducing these assignments inside virtual conditions and enabling patients to work on them at expanding levels of many-sided quality can accelerate complexity and enable patients to recover a more elevated amount of psychological capacity. Along with patients, doctors can also use virtual environments for assessing and observing patients who suffer

Table 1. Future scope

Disease	Recent Technology	Future Scope
Breast Cancer	Depending on the stage of the cancer, treatments of breast cancer are given. It might comprise of chemotherapy, radiation, hormone treatment and surgery. As these traditional methods have few side effects Virtual Reality is being adopted mainly for reducing the pain and stress the patient goes through, improving the drug design process for the treatment of breast cancer and making the screening process of breasts harmless.	For future scope, breast imaging tries to incorporate methods to enhance screening affectability and specification of women who has no signs of cancer with greater progress in mammographic technology. Also, uses of ultrasound in the both the screening and demonstrative setting. There might be a role in future screening of breast with a few more advancements that uses molecular imaging and CT of breasts.
Colorectal Cancer	Due to great advancements in the technology of CT scanners and new techniques in 3D image processing, colonoscopy has been highly benefitted.It can examine in large volumes, small layers and least possible time. It also enables us with sight behind intestinal folds.	Stool DNA tests and virtual colonoscopy are the future evolving technologies. Throughout the following couple of years, CRC screening will be commanded by colonoscopy, while it is expected that the FOBT technology utilization keeps on declining. Expected progressions in colonoscopy, particularly with enhanced sedation with better patient acknowledgment, will strengthen this drift. Due to the extreme low sensitivity of neoplasm, CT and MR colonography currently are restrictive.
Alzheimer's	It improves the skills of the patient in driving and cognitive improvement in his daily life. It is used for the early diagnosis of patients prone to AD. It provides more self-relevant situations that can be used to build a variety of environments for the patients.	Comfortable VR interfaces should be designed for patients and future experiments should be performed upon more subjects with more training.In the future it is necessary to introduce an assessment based on neuropsychological that should have some similarity to our daily life demands. Moreover it is also necessary to design VR interfaces that are comfortable for the patients.

from various diseases that includes memory loss, problems in decision makingnand many more.

Management of pain

The pain can be made less severe by incorporating virtual reality. The logical proof for the previous statement is that the insula and the somatosensory cortex, which are the parts of the mind that are connected to pain, are less dynamic when a patient is inundated in virtual reality. It can be observed in a few instances that individuals can endure therapeutic techniques using virtual reality that are generally extremely painful.

Training nurses and doctors

Virtual reality, obviously, is not only for patients. It likewise offers advantages to human services experts. Preparing specialists and medical attendants to complete routine methodology is tedious, and mostly professionals who are required to train them are busy as well as expensive. However, virtual reality is progressively being utilized to learn life structures, rehearse tasks and show contamination control.

Being inundated in a sensible simulation of a method and rehearsing the means and procedures is much better preparing than viewing a video, or learning from an expert standing in a crowd full of other learners. With VR hardware that is low of cost, controllable, repeatable

situations and immediate feedback we have an intense new instructing device that achieves well past the classroom. Seymour et.al in[40] have done a comparison on how training under VR simulation is preferred for training the surgeons.

Physical Therapy

In physical therapy VR can be used efficiently by following the movements of the body allowing patients to use the movements of their therapy exercises as interaction in a game of virtual reality. It is better to do practice in virtual reality than it is in a gym, so individuals are more motivated to train.

Fears and phobias

The established forms of medical virtual reality treatment are fear and phobia. Graded-exposure therapy is used to treat phobias in which the patients are moderately familiarized with their fear by the specialist. Virtual reality can be precisely adapted according to every patient's needs and this can be done in the office of the specialist or at home. Various kinds of fears can be treated by VR and can help people to recover from post-traumatic stress disorder.

Future Scope

We have summarized the recent technology already in use and the future scope in each disease separately in the table given below:

CONCLUSION

We have observed a rapid increase in the techniques and tools of virtual reality in field of scientic research, engineering and medical areas. This innovation has straightforwardly influenced therapeutic practice. It gives the liberty to pysicians and doctors to perform surgical operations in a simulated virtual environment where errors can be perceived and amended instantly by the computer. Methodology can be looked into from new viewpoints that are unrealistic in reality.

The trendsetters in medical VR will be entitled to refining technical efficiency and increasing physical and psychological comfort and capability, while keeping an eye to reducing costs for healthcare. Besides this the possibilities are very exciting. In this paper we have mainly focused on incorporating Virtual Reality in treatment of three diseases-breast cancers, colon cancer and Alzheimer's. Also, we have made a comparison of the traditional methods, which already exist to treat the above diseases with the methods incorporating virtual reality. Finally we have stated the benefits of using virtual reality over traditional methods. While the potential outcomes and the need for medical VR are gigantic, methodologies and arrangements utilizing new VR-based applications require industrious, agreeable endeavors among innovation engineers, therapeutic professionals and consumers of medicine to set up where future prerequisites and request will lie

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