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Medical applications of virtual reality

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Abstract:

[Virtual reality](http://go.galegroup.com.erl.lib.byu.edu/ps/retrieve.do?tabID=T002&resultListType=RESULT_LIST&searchResultsType=SingleTab&searchType=AdvancedSearchForm&currentPosition=1&docId=GALE%7CA20378504&docType=Article&sort=RELEVANCE&contentSegment=&prodId=AONE&contentSet=GALE%7CA20378504&searchId=R2&userGroupName=byuprovo&inPS=true) continues to advance in [medical education](http://go.galegroup.com.erl.lib.byu.edu/ps/retrieve.do?tabID=T002&resultListType=RESULT_LIST&searchResultsType=SingleTab&searchType=AdvancedSearchForm&currentPosition=1&docId=GALE%7CA20378504&docType=Article&sort=RELEVANCE&contentSegment=&prodId=AONE&contentSet=GALE%7CA20378504&searchId=R2&userGroupName=byuprovo&inPS=true), training and therapy. Browsing on the [Internet](http://go.galegroup.com.erl.lib.byu.edu/ps/retrieve.do?tabID=T002&resultListType=RESULT_LIST&searchResultsType=SingleTab&searchType=AdvancedSearchForm&currentPosition=1&docId=GALE%7CA20378504&docType=Article&sort=RELEVANCE&contentSegment=&prodId=AONE&contentSet=GALE%7CA20378504&searchId=R2&userGroupName=byuprovo&inPS=true), medical students enjoy the surgical simulators delivered by the National Library of [Medicine](http://go.galegroup.com.erl.lib.byu.edu/ps/retrieve.do?tabID=T002&resultListType=RESULT_LIST&searchResultsType=SingleTab&searchType=AdvancedSearchForm&currentPosition=1&docId=GALE%7CA20378504&docType=Article&sort=RELEVANCE&contentSegment=&prodId=AONE&contentSet=GALE%7CA20378504&searchId=R2&userGroupName=byuprovo&inPS=true" \o "Related articles for'Medicine')in Washington, D.C. There are also virtual disaster and combat environments designed for planning and casualty care training. [Rehabilitation](http://go.galegroup.com.erl.lib.byu.edu/ps/retrieve.do?tabID=T002&resultListType=RESULT_LIST&searchResultsType=SingleTab&searchType=AdvancedSearchForm&currentPosition=1&docId=GALE%7CA20378504&docType=Article&sort=RELEVANCE&contentSegment=&prodId=AONE&contentSet=GALE%7CA20378504&searchId=R2&userGroupName=byuprovo&inPS=true) and psychiatric therapy may likewise be availed online.

Full Text:

How virtual reality is helping improve [patient care](http://go.galegroup.com.erl.lib.byu.edu/ps/retrieve.do?tabID=T002&resultListType=RESULT_LIST&searchResultsType=SingleTab&searchType=AdvancedSearchForm&currentPosition=1&docId=GALE%7CA20378504&docType=Article&sort=RELEVANCE&contentSegment=&prodId=AONE&contentSet=GALE%7CA20378504&searchId=R2&userGroupName=byuprovo&inPS=true) in the form of advanced educational tools and therapeutic options.

It has been 12 years since a team of NASA scientists and engineers at Ames Research Center in Palo Alto, Calif., first put on head-mounted displays and "flew" through the Martian countryside, marking the beginning of virtual reality for scientific visualization. Medicine has only recently discovered the power of virtual environments for enhancing patient care through medical education and therapy. 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.

The field of medical education was the first medical discipline to exploit the power of virtual reality because it could directly leverage the long history of simulated environments for aviation training. Flight simulators are an appropriate analogy for advanced training in medical and surgical procedure. 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](http://go.galegroup.com.erl.lib.byu.edu/ps/retrieve.do?tabID=T002&resultListType=RESULT_LIST&searchResultsType=SingleTab&searchType=AdvancedSearchForm&currentPosition=1&docId=GALE%7CA20378504&docType=Article&sort=RELEVANCE&contentSegment=&prodId=AONE&contentSet=GALE%7CA20378504&searchId=R2&userGroupName=byuprovo&inPS=true) as flight simulators do. There are already numerous first- and second-generation surgical simulators in ophthalmologic, biliary, urologic, laparoscopic, orthopedic, arthroscopic, and neurologic [surgery](http://go.galegroup.com.erl.lib.byu.edu/ps/retrieve.do?tabID=T002&resultListType=RESULT_LIST&searchResultsType=SingleTab&searchType=AdvancedSearchForm&currentPosition=1&docId=GALE%7CA20378504&docType=Article&sort=RELEVANCE&contentSegment=&prodId=AONE&contentSet=GALE%7CA20378504&searchId=R2&userGroupName=byuprovo&inPS=true), and the third generation will follow soon.

The virtual organs displayed in these systems are derived from actual patient data, such as the Visible Human dataset of the National Library of Medicine in Washington, D.C. [2]. They are rendered in three dimensions and can be explored by "flying" inside and around them. If surgical training is the goal, an operative procedure (like laparoscopic cholecystectomy, or gall bladder removal with a scope and instruments inserted through holes rather than an incision) can be performed. Although the organs lack full visual fidelity, they behave like real organs in response to movements of the handles of the simulator instruments, and medical students can see the effects of the instruments on the organs and even feel the forces in their fingers [5]. it will soon be possible to reproduce bleeding and other [physiology](http://go.galegroup.com.erl.lib.byu.edu/ps/retrieve.do?tabID=T002&resultListType=RESULT_LIST&searchResultsType=SingleTab&searchType=AdvancedSearchForm&currentPosition=1&docId=GALE%7CA20378504&docType=Article&sort=RELEVANCE&contentSegment=&prodId=AONE&contentSet=GALE%7CA20378504&searchId=R2&userGroupName=byuprovo&inPS=true) in these simulators. At the same time, testing and evaluating protocols am being developed to determine how the simulators can contribute to surgical education. For example, unless it can be shown that there is an improvement--measured. through outcomes analysis showing, for example, shorter surgical time, shorter training periods to become an independent surgeon, or lower complication rates--the value of the simulators will be in question.

In addition to adapting flight simulators, the educators designing medical curricula am using virtual reality to reinvent medical education. In the area of learning the basic medical sciences, 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](http://go.galegroup.com.erl.lib.byu.edu/ps/retrieve.do?tabID=T002&resultListType=RESULT_LIST&searchResultsType=SingleTab&searchType=AdvancedSearchForm&currentPosition=1&docId=GALE%7CA20378504&docType=Article&sort=RELEVANCE&contentSegment=&prodId=AONE&contentSet=GALE%7CA20378504&searchId=R2&userGroupName=byuprovo&inPS=true), pathology, radiology, and case studies. The same virtual anatomy can be exported to simulators for practicing surgeries and other medical procedures (see Figure 1).

Moreover, because such an education system can be networked throughout a medical center and a university's computing facilities, the medical curriculum can be available from any place, by anyone, at any time. This type of system can tap many large medical databases (such as the Index Medicus) through the facilities of the National Library of Medicine via the Internet. The power of education is now convenient and at the disposal of the student, no longer limited by schedule, place, or time.

Another application of virtual reality is medical planning, such as that needed to deal with disasters and combat casualty care. There is a new generation Of individual simulators that, like a video game, place an individual student or physician in an imaginary place, such as an earthquake zone or a battlefield [7]. The student, medic, or surgeon can then practice triage or emergency first aid and coordinate planning and training. The student can "walk" through the environment, seeing the disaster and its human casualties, interacting and practicing casualty triage in the simulated environment.

Virtual reality is also being used to create prototype medical buildings, equipment, and instruments. Engineers creating non-medical instruments have been able to fashion their products in computer-aided-design (CAD) programs, then test and validate them before actually fabricating the first one; medical professionals can now use CAD to design medical equipment and instruments as well. Today, for example, a number of ambitious projects are building the operating environment of the future, including a complete operating room based on advanced materials, equipment, and technology in order to totally rethink the way surgical (or procedure) suites should be designed RL These projects are based on new requirements--"smart" materials, systems integration, and information flow--for the future, not today's traditional architectural and engineering techniques. The room and equipment will then be "virtually" tested and evaluated (walking around, moving equipment, and adding or taking away virtual objects) by all who will use or influence it, from [physicians](http://go.galegroup.com.erl.lib.byu.edu/ps/retrieve.do?tabID=T002&resultListType=RESULT_LIST&searchResultsType=SingleTab&searchType=AdvancedSearchForm&currentPosition=1&docId=GALE%7CA20378504&docType=Article&sort=RELEVANCE&contentSegment=&prodId=AONE&contentSet=GALE%7CA20378504&searchId=R2&userGroupName=byuprovo&inPS=true) and nurses to administrators, materiel managers, clerks, and janitors, in order to recruit the best ideas and derive the optimal plan. Once everyone has had a chance to "experience" the room and offer their opinions, the iterative process will be completed and the room will be built.

Virtual reality for rehabilitation and psychiatry has also experienced dramatic developments, resulting in annual conferences covering virtual reality and rehabilitation. Notable applications include virtual environments that can be explored in wheelchairs; eye-tracker devices for quadriplegic children, providing the opportunity to interact with the outside world before the disability causes the child to become too introverted to communicate [6]; and creation of threatening environments, such as tall buildings or bridges, for psychiatric therapy.

Medical treatment and training is on the threshold of benefiting from more than a decade of virtual reality as a scientific visualization and training tool. These technologies can be optimized for medical applications, significantly enhancing total patient care through advanced educational tools and therapeutic options.

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Brig. Gen. Russ Zajtchuk, M.D., (bg\_russ\_zajtchuk@ftdetrck-ccmail.army.mil) is Commander of the U.S. Army [Medical Research](http://go.galegroup.com.erl.lib.byu.edu/ps/retrieve.do?tabID=T002&resultListType=RESULT_LIST&searchResultsType=SingleTab&searchType=AdvancedSearchForm&currentPosition=1&docId=GALE%7CA20378504&docType=Article&sort=RELEVANCE&contentSegment=&prodId=AONE&contentSet=GALE%7CA20378504&searchId=R2&userGroupName=byuprovo&inPS=true) and Materiel Command in Fort Detrick, Frederick, Md.

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