

TELEPRESENCE IN MEDICINE - AN OVER VIEW

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Abstract

Telepresence is a set of technologies which allow a person to feel as if they were present, to give the appearance of being present, or to have an effect, via telerobotics, at a place other than their true location. From the telepresence, Telemedicine is one of the latest technologies that provide an efficient way of performing surgery from a different location. Using this idea, it is applied to the medical field in order to help the doctors / surgeons perform surgeries effectively. This type of surgery allows the surgeon to perform a "virtual" operation on the patient. This is accomplished by a surgeon console and a remote surgical unit, which consists of two computer-controlled by robot arms. Using telemedicine, most of the surgeries can be performed by using minimally invasive surgical techniques, in which there is only small incision site for instrument entry. As a result, this causes less pain to the patients and there will be less tissue trauma, thus reducing hospitalization time and enhancing recovery. Extending the above idea, surgery can actually be operated by a surgeon from large distances. For example, a surgeon in the USA can perform a heart surgery on a patient in India. This is called Remote Operation. The physician can simply look at the electronic video image and remove the internal organs without actually touching them. Again, this technique can be applied in the military area in which the surgeons can perform operations on the injured soldiers without endangering their own lives. With the ever developing computer technology, in future, with better and more high tech remote operation technique, surgeons can effectively perform surgery on people all over the world, especially in the backward and remote places, where a telerobot can ensure the patients to undergo operation without flying to, or the surgeons flying from the other part of the world.

Introduction

The medical sector is under consistent pressure to provide better care for more people, while keeping costs to acceptable levels. Traditionally, experts in the medical field were few and far between. With the arrival of telemedicine, however, this is set to change. Telemedicine differs from "conventional" medicine in that the doctor must not necessarily be in the same physical location as the patient. Instead, the doctor operates from a remote location, possibly in real-time consultation with other specialists around the world.

Tele consulting

Despite the relatively new terminology, teleconsulting has been around for many years. Technically, even calling a doctor on the phone for advice is encompassed in the teleconsulting sphere. In the last years, however, this has been further extended, with doctors taking part in live teleconferences or participating as viewers in a surgical table. In simple cases, the telephone network is used for voice, fax, and data transmissions, while in more complicated situations Ethernet networks are the usual preference.

Tele Diagnosis

Telediagnosis involves the doctor making an assessment without physical examination, but rather based on data transmitted from a remote location. This can be simple X-rays, MRI and CT scans, or more advanced computer data fused with real-time video. An example of the latter is the Advanced Real Time Motion Analysis (ARTMA) project, which involves the integration of live video data with overlaid virtual data (such as bone structure, for example). The virtual data is computed and generated 60 times per second, seamlessly merging with the video footage. The composite image or video can aid the surgeon by providing more than simple visual cues that would otherwise be the only source of information. This also allows the surgeon to prescribe treatments to patients who cannot be visited (for example, in under-developed countries).

Cooperative Telesurgery

Taking one step further, cooperative telesurgery involves a medical assistant local to the patient, and a doctor in a remote location. The medical assistant lacks the experience and expertise of the doctor, but has the advantage of physical access to the patient and immediate feedback. The doctor, using vocal and visual instructions, guides the assistant, who simply follows instructions. This combines the best of both worlds, and can be very helpful in the battlefield, where rapid assessment and immediate action can save up to 90% of the lives.

Telepresence Surgery

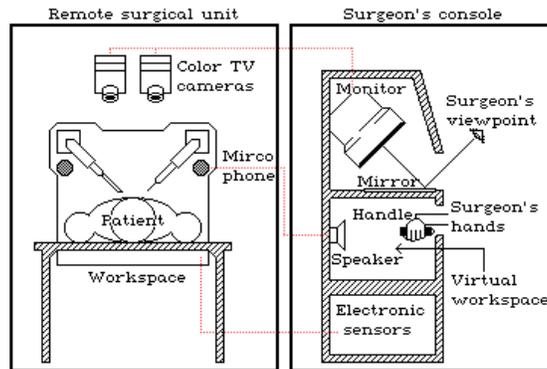


The most advanced form of telemedicine is telepresence surgery. As the name suggests, telepresence surgery allows the surgeon to perform a "virtual" operation on the patient. This is accomplished by a surgeon console and a remote surgical unit, which consists of two computer-controlled robot arms.

Computer-controlled robot arm

The scheme is similar to that used for the handling of radioactive materials. Visual and acoustical data from the remote operating room is transmitted to the surgeon's console to create a "virtual workspace" in which the surgeon operates.

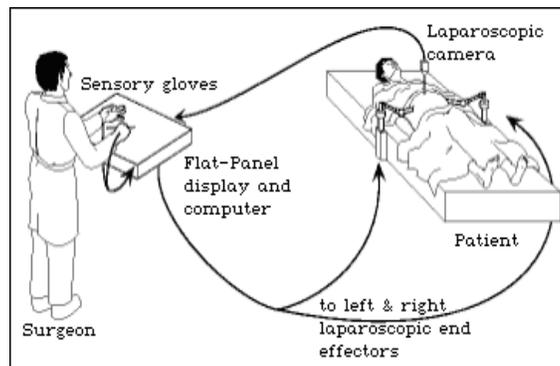
The hand movement is precisely sensed and transmitted to the remote location, where the remote surgical unit mimics it. The surgeon operates using two handles, onto which the currently used instrument blade is virtually superimposed. That is, to their eyes, the handle in the console and the end blade at the remote location move as one rigid entity. This, along with force and resistance feedback greatly enhances the immersion feeling, and therefore the speed and ease of operation.



Schematic representation of the telepresence surgery setup

Telepresence in Closed Surgery

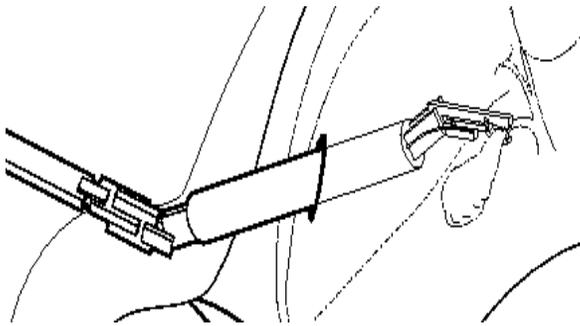
Closed surgery like *laparoscopy* is already being used for gall bladder removal, appendectomies, gynecological procedures and other operations. The advantages of this method are lower costs, shorter hospital stays, quicker rehabilitation, less infection and less cosmetic damage. However, it has some problems, the most notable of which are the "*fulcrum effect*" and the dependence of the instrument-hand movement relationship on the insertion extent. These problems, coupled with the fact that the location of the instrument must be viewed on a monitor screen across the operating table and the lack of force feedback, make movements unnatural and hand-eye coordination extremely difficult.



Laparoscopy using telepresence surgery techniques

Telepresence surgery solves many of these problems, while providing even more sophisticated advantages. For a start, the surgeon is no longer spatially constrained. The tip

of the instrument is equipped with lens to relay visual information. The surgeon's hands are effectively inside the body, situated at the tip of the probe. This makes the process much more intuitive and therefore requires far less training. Also, telepresence can be invaluable in cases where extreme precision is required, such as in eye surgery. The surgeon is now viewing a magnified image, his hand movements being scaled down appropriately. This allows effective hand precision of a few microns, previously impossible using conventional techniques.



Laparoscopy using a robot arm

Even further, the possibility of definition of computer-controlled exclusion zones exists. These zones restrict movement to a particular area, therefore eliminating the chance of accidental damage to nearby tissue when working near sensitive areas.

Limitations

Telemedicine relies heavily on the transmission of data between two locations. As the distance between these two locations increases, time lag is introduced. This increases feedback latency and, after a point, renders real-time surgery impossible. Tests so far have been constrained to cable links, although there is intense research towards increasing range using satellite links. The advent of broadband ATM networks will further speed up the process.

Another important limitation is that the remote surgical unit's movement must not be allowed to deviate from or become misaligned with the hand movement. In practice, this means complicated feedback control and continuous monitoring of specific reference points. Finally, high prototype costs and bureaucratic governmental medical regulations do their part to slow down the wide-scale use of this technology.

Conclusion

Telemedicine is a rapidly changing area. Experiments involving ever larger distances are continuously conducted. Effort is put into conveying even more information across the link, such as smell and texture. Also, the remote surgical unit is continuously enhanced as well. Among the attributes that are developed are better accuracy, more degrees of freedom, smaller volume and faster response. The remote unit does not only copy the surgeon's actions, but augments them as well. Down-scaling and exclusion areas

are just two of the possibilities, others being databases and anatomical atlases linked to live video.

One day, technology will allow robots to operate on a patient completely unsupervised. Until that time, however, telemedicine represents the leading edge of the surgical field, combining human skill and information technology in ways never before thought possible. Undoubtedly, telemedicine provides surgeons with a much more effective way of performing surgery.

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