Robotic Surgery and Remote Surgery- A Review

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Abstract-*Paper discusses the developments in Robotics surgery and a review of remote surgery, robotic arm used for the remote surgery, applications and limitations of remote surgery. Robotic surgery is a robotically assisted surgery or computer assisted surgery uses robotic system to perform the surgery. Robotic surgery came into picture two decades ago to overcome the human or manual errors while performing operations. And one advantage of robotic surgery is that the surgeon does not have to present in operation room, but can be anywhere in the world and performs the surgery is called Remote surgery or Telesurgery. The first telesurgery is Operation Lindbergh.*

Keywords-Robotically assisted surgery, remote surgery, Operation Lindbergh.

I. INTRODUCTION

The word Robot was named by Karel Capek. It was derived from the Czech word. Originally it was Robota which means "Forced Labor" [3][4]. Robot is a machine which capable to do work automatically programmed by computer.

Robotic Surgery Evolution:

In recent years Robotic technology advances and Robotic machine entered in medical field. And now days it is easy to conduct surgery for surgeons. The Robotic surgery evolution is as shown in Figure 1.

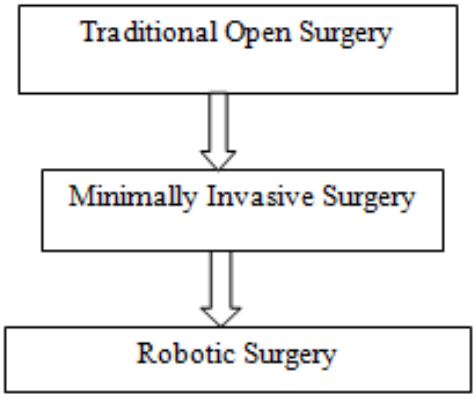

Figure 1. Robotic surgery evolution

Traditional Surgery as shown in Figure 2 [3], it is an open surgery in which a surgical cut or incision is made using a scalpel. Then surgeons insert the medical instruments and perform the operation. Because of open surgery larger mark left on the skin or body. Weakness in abdominal muscle and increases chronic pain [5], to overcome this problem minimally invasive surgery was developed.

Minimally Invasive Surgery (MIS), in this technique the surgical cut which is made during operation is reduces or in some cases there is no any surgical cuts. It is a surgery, where surgeons perform surgery laparoscopically [3]. Also there is some limitations of minimally invasive surgery that the surgeons face difficulty to control instruments while watching in 2D image.

The Robotic Surgery was developed to reduce minimally invasive surgery drawbacks, now by robotic surgery a surgeon gets the enlarged 3D image of a body and conduct surgery with fewer surgeons. In Robotic Surgery method, perform surgery using small tools which is attached to Robotic arm. With the help of computer system surgeons controls the robotic arm. Robotic surgical system average cost ranges from 0.5 million to 15 million Dollar [6].

There are three main systems of Robotic Surgical system. Supervisory controlled system, Telesurgical system or Remote surgery system and Shared control system [3]. This paper deals with the study of Remote surgery system.

II. REMOTE SURGERY

Remote Surgery also called as Telesurgery. It is the ability for a surgeon to conduct surgery even though they are not present physically in the operation theatre. the technology described here shows that we now have ability to remove distance barriers from surgery [1]. The specialized surgeons from worldwide can perform surgery without the need for patients to travel beyond their local hospital.

Remote surgery generally consists of Surgeon's console or master console at surgeon side, a patient side robot and it requires the high speed data connection. Remote surgical system has been developed from the first telesurgery

system ZEUS to the da Vinci Surgical system. The general block diagram of Telesurgical system is as shown in Figure 2.

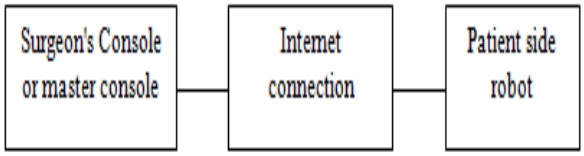

Figure 2. The general block diagram of Telesurgical system.

Remote surgery is automated surgery but that doesn't mean the surgery can only conduct by robots or computer systems without the help of human or surgeons. Surgeon must do the extensive work with patient before surgery then robots operate.

ZEUS Robotic Surgical System:

The ZEUS Robotic surgical system is a remote surgery system which uses Zeus robot; it is well suited to telesurgery because it is already in mater-slave configuration that naturally and clearly separates into two different parts [1].

The Surgeon's Console or master console: The surgeon comfortably sits at a master console located at a distance from the patient with eyes focused down toward the operation site mirroring an open surgical technique [4]. It include high quality video monitor to display view from the endoscope and a touch screen panel for setting various option and interacting with central control computer [1]. A set of sensors are used and the output of sensors sends to the patient side robot. Figure 3(a) shows Surgeon's Console [1].

Patient Side Robot: Patient side there are three robotic arm mounted on the table which perform surgical task. One is AESOP (Automated endoscopic System for optimal positioning) by this surgeon can see inside the body of a patient and other two arms are for positioning the instruments. One instrument driver/controller to manage the control of graspers, scissors, or other instruments. Figure 3(b) shows Patient side robots [1].

Figure 3(a). Surgeon's Console [1].

Figure 3(b). Patient side robots [1]

The da Vinci Surgical System:

The da Vinci surgical system allows surgeons to conduct complex and delicate operation through a few small cuts on a body or skin. The de Vinci surgical system consists of surgeon console, Patient side cart, Robotic arm, Endowrist instruments and 3D HD vision system.

Surgeon console: Surgeon operates the mater console and conducts surgery. The system translates the surgeon's hand, wrist and fingers movements into precise, real time movement of surgical instruments [8].

Patient side cart: It includes three or four robotic arm that follows the surgeon's commands.

Endowrist instruments: These instruments are designed with seven degree of motion, each instrument performs the specific tasks like clamping, cutting, coagulating, dissecting, suturing and manipulating tissues [8].

Vision system: Remote surgical system has high definition, 3D endoscope (flexible tube with a camera and light at the tip) and image processing equipment that gives the real HD images of the patient's body [8].

Network Protocol for Remote Surgery:

In remote surgery the real time data must be exchange between the patient and surgeon's console. The communication on network layer and transmission layer decides the exchange process [7]. Data exchange between computers by using TCP (Transmission Control Protocol). It handles the error automatically and safe delivery of data. But it require more time for arrival of data. This can be overcome by UDP (User Datagram Protocol), it is used in transmitting control signal, video and audio stream. It does not require any acknowledge message because of this UDP does not guarantee data delivery. TCP cannot be used to transmit large packages in a real time application like video and audio therefore UDP is used in telesurgery [7]. Before the operation it is necessary to monitoring and analysis of network.

III. OPERATION LINDBERGH

A team of French surgeons from New York perform the first telesurgical operation which is "Operation Lindbergh" on a patient in Strasbourg, France using Zeus surgical robot. Operation Lindbergh was staged on September 7, 2001.The 54min operation on 68 year old female patient over more than 4,300 miles if distance [1].

IV. APPLICATIONS OF REMOTE SURGERY

People from the rural areas can also access the quality healthcare by specialized surgeons around the globe. The surgeon is seated comfortably on the robotic control console, an arrangement that reduces the surgeon's physical burden [2].

Instead of 2 dimensional images that are obtained through regular laparoscopic camera, the surgeons receive a 3 dimensional view [2]. For Treating injured soldiers on or near the battlefield and Improves the range of motion of robotic arm allows surgeon to perform more complex surgical movements.

V. LIMITATIONS OF REMOTE SURGERY

Everyone is not aware of remote surgery. It is not widespread technology because it does not have sponsorship by governments. Question of safety arises because it needs very high speed of internet connection. The cost of Remote surgery is very high or expensive.

VI. CONCLUSION

After researching about Remote surgery, I have discovered that there are a lot of benefits, a lot more than I had predicted. Even though there are a few disadvantages to remote surgery, such as high costs, I think that the main focus should be on the safety and success of the operations. Remote surgery may be expensive, but it greatly increases the safety and the likelihood of success of the operations. With the minimal invasive surgery method, the small incisions minimize blood loss, reduce any harm to the body, decrease the risk of an infection, and reduce the recovery period. During surgery, the robots allow better visualization and greater dexterity with fewer tremors. The flexible arms allow surgeons to do many things at once. These aspects of robotic surgery all contribute to the safety and success of the operations as well as the comfort of the patients post-surgery. There is no doubt about the benefits of robotic surgery and remote surgery.

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