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Medical Robotics For Minimally Invasive Surgery

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Abstract
The learning curve for advanced laparoscopic surgery is significantly more challenging compared to open surgery. Laparoscopic surgeons rely on a distant monitor that offers a two-dimensional view, which alters the typical hand-eye coordination. This two-dimensional perspective results in a diminished sense of depth perception, necessitating the surgeon to make compensatory adjustments. Additionally, since an assistant holds the camera, the surgeon's visual control is limited, leading to potential fatigue and an unstable visual field. Both the surgeon and the assistant might get far less fatigued as a result of these challenges thanks to the da Vinci surgical robot. In contrast to the rigid, four-degree-of-motion usual laparoscopic equipment, the surgical robot has seven degrees of mobility, which is comparable to the human wrist in open surgery. Additionally, during laparoscopic surgeries, the abdominal wall creates a "Fulcrum effect" that reverses the surgeon's movements.
Keywords: *Robotic surgery, da Vinci surgery, laparoscopically*

1. INTRODUCTION

The Czech word 'robota', meaning forced labour, is where the name 'robot' comes from. After the first AESOP prototype robot, a voice-controlled camera holder, was used in a clinical setting in 1993, the first robots in surgery were introduced in 1994. In 1994, the US FDA began marketing this robot as the first surgical robot. The SRI Green Telepresence Surgery system was reengineered by Intuitive Surgery, Inc [1]. (previously Integrated Surgical Systems) to create the Da Vinci Surgical System®, a master-slave surgical system. Highlights of this system include true 3-D viewing and Endo Wrist technology [2]. It received FDA approval in July 2000 for use in general laparoscopic procedures and in November 2002 for use in surgery to repair the mitral valve [9]. The da Vinci robot is being used in several medical specialties, such as urology, general surgery, gynecology, cardiothoracic, pediatric, and ENT surgery. Compared to traditional laparoscopy, it has many advantages, including tremor filtration, motion scaling, three-dimensional vision, intuitive movements, and improved visual immersion [12]. Experienced surgeons may now undertake more complex and sophisticated reconstructions because to the development of robotic technology, which has also made it easier for new laparoscopic surgeons to adopt minimally invasive surgical techniques [14].

This is a problem that robotic surgery resolves, much like open surgery [3]. Consequently, tasks such as ligation and suturing become considerably more intricate in conventional laparoscopy. These issues contribute to a long and challenging learning curve for laparoscopic colorectal surgery [4]. However, the benefits of minimally invasive surgery are now well proven in terms of oncological safety, survival rates, and recurrence rates for malignant disorders [10]. Thus, by carefully choosing the right indications, the surgical robot can let patients benefit from minimally invasive colorectal surgery without having to deal with the disadvantages of traditional laparoscopy [13].

2. MATERIALS AND METHOD

Four wheels on the instrument's head are attached to a wire system that controls the wrist. As a result, the robot can move in unison and create a sophisticated motion that resembles the movement of a human wrist. Position detection, which happens about 1500 times each second, effectively reduces human tremors [4]. The instrument itself provides a seventh degree of freedom (e.g., gripping or cutting), while the instrument tip allows six degrees of mobility. Each instrument can only be used 10 times before needing to be discarded and replaced due to the system that counts the number of sessions. The instruments are sterilizable and can be used more than once in a single surgical session. However, the instrument cord could still fail and become inoperable before the ten sessions are up [5].

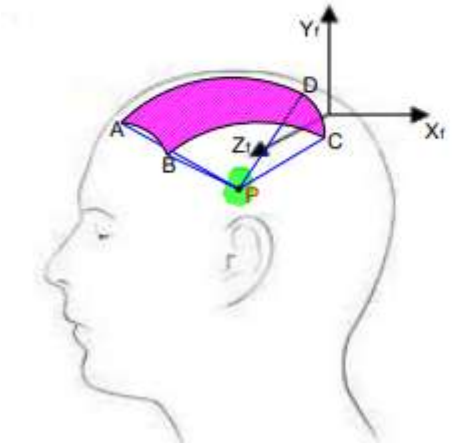

Figure 1: fiducial frame

With its twin optical channels and two three-chip cameras, this sophisticated endoscope has high-resolution capabilities that, when viewed through a binocular viewer, create distinct images for each eye [11]. To operate jawed instruments, the thumb and index finger of each hand slip into movable loops that are connected to the master controllers [6]. With their ability to move freely in all directions, the multi-joint master controls make it easy to manipulate the camera and the instruments. Five-foot pedals are also available. The first pedal on the left, the clutch pedal, keeps the instruments and controllers apart so that the controllers can be manipulated easily without affecting the instruments' position [7]. Pressing the second pedal, located on the right, activates the camera and disconnects the tools from the masters. The surgeon can then make any necessary adjustments. The third foot switch is used to focus the telescope vision prior to treatment, the fourth pedal is for bipolar coagulation, and the fifth is for monopolar cautery [8].

3. RESULT AND DISCUSSION

The camera, endoscopic calibration, and motion scaling controls are on the left panel, while the start control, emergency stop, and standby buttons are on the right panel, which is positioned on either side of the surgeon [15].

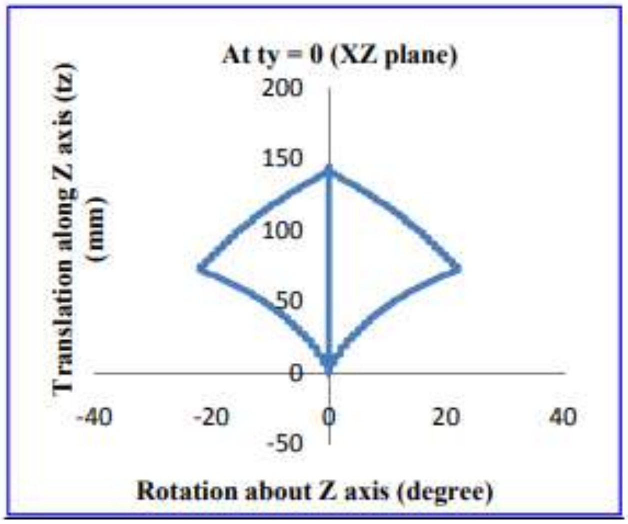

Figure 2: Rotational work place

pushing the fault override button is the sole way to restart the master controllers after pushing the emergency stop button, which instantly disengages them [8]. The system can be quickly put in standby mode if a switch to open surgery is required. This will enable the cart to be rolled out of the operating field after the instruments are taken out and the arms are freed from the ports.

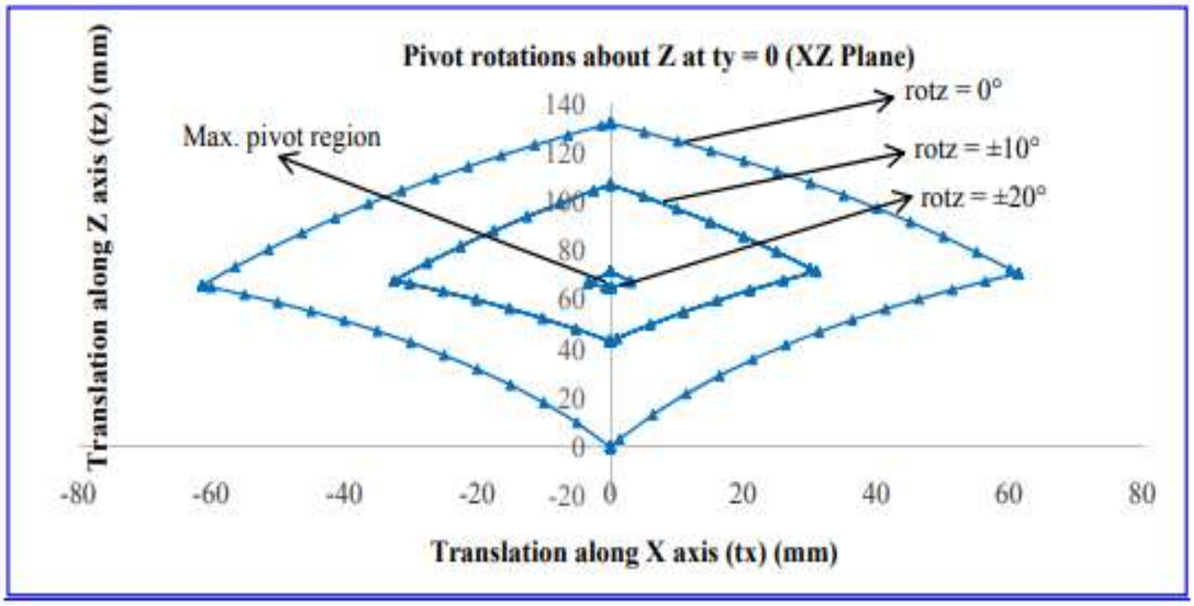

Figure 3: Pivot rotation

This procedure may normally be finished in two to four minutes by trained staff. Operating from a console, the surgeon places their forehead against a second padded bar, rests their elbows on a padded bar, and aligns their eyes comfortably with the adjustable binocular viewer.

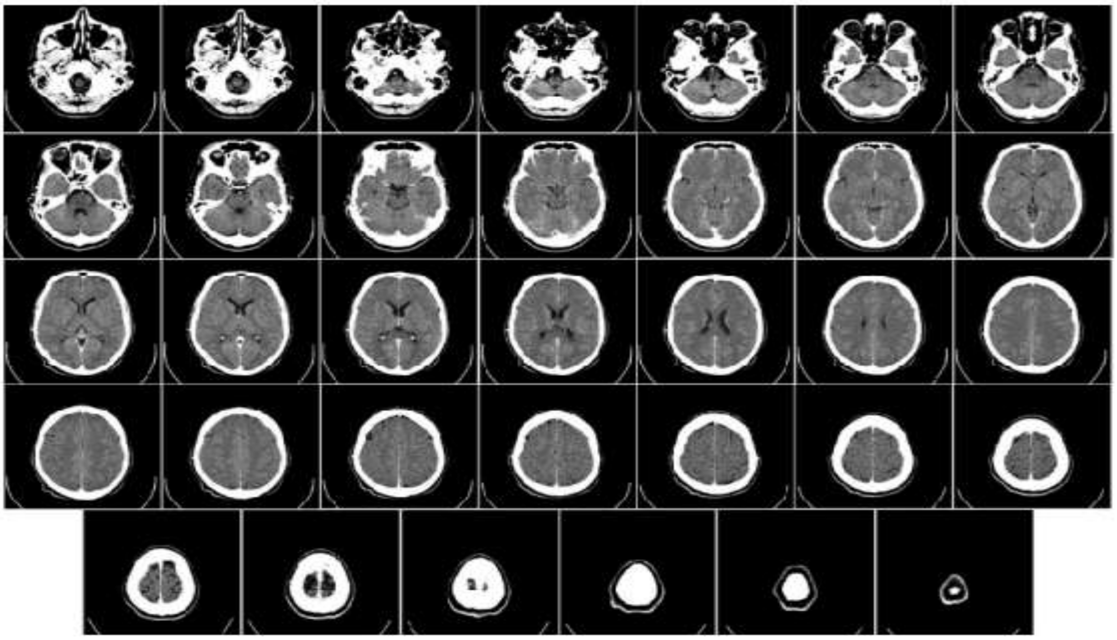

Figure 4: CT DICOM images of human brain, from base of the skull to top

While keeping the previously mentioned hand and finger positioning, the intraocular distance can be changed to meet particular needs. Throughout the treatment, the surgeon can maintain the ideal hand placements by adjusting their arms and hands using the clutch pedal.

4. CONCLUSION

Robot and automation systems composed of networked components have been developed as a result of the recent ten years' technological developments in robotics, computing, and communications. Examples of this include automobiles, sensors, actuators, and communication equipment. These engineers and researchers are now able to design new items because of breakthroughs. communication-capable robot systems that can interact with both people and other robots. Due to time restrictions, the Robot Operating System was primarily created with protection as its primary (if not main) component. Robot and automation systems composed of networked components have been developed as a result of the recent ten years' technological developments in robotics, computing, and communications. Examples of this include automobiles, sensors, actuators, and communication equipment. These engineers and researchers are now able to design new items because of breakthroughs. communication-capable robot systems that can interact with both people and other robots. Due to time restrictions, the Robot Operating System was primarily created with protection as its primary (if not main) component.

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