Robot Assisted Surgery using HC-05 Bluetooth Module and Android Control Board

Avanti Joshi¹, Juhi Londhekar², Bhagyashree Parde³, Santoshi Pote⁴

Department of Electronics
Maharashtra, India

Abstract:
The field of surgery is coming into a time of nice modification, spurred on by exceptional recent advances in surgical and technology. Robots within the field of surgery have dramatically modified the procedures for the higher. The littleness of the incisions conjointly causes several alternative blessings that build robotic surgery well worth the risk. Besides the rewards given to robotic surgery, it is very essential to include it in the curriculum of medical students in the government hospitals as well as the idea behind this vast technology should reach the rural population. As technology change affects a large amount of urban areas, it has left rural areas unaffected. Taking this into consideration, this project emphasizes on prototype model of the Da Vinci machine. This model includes Robotic Arm which is designed using the Micro-controller 8051 along with, Android robot control using HC-05 Bluetooth module. Procedural training for robotic surgery needs to be carried out in a step wise and systematic manner. Thus, introduction of this new technology can be performed in an efficient and safe way.

Keywords: Da Vinci machine, HC-05 Bluetooth module

I. INTRODUCTION

"An Evolution of surgical technique: from Traditional to Robotics.” A major positive step within the field of surgery was made when a robot was first used in the theatre of surgery about 25 years ago. Robotic surgery is that the latest technological advancement that introduces the robotic technology within the field of surgery. Only recently have robotic systems made their way into the operating rooms as dexterity-enhancing surgical assistance and surgical planners. Robotic surgery could be a form of minimally invasive surgery. "Minimally invasive” implies that rather than operative on patients through massive incisions, we use miniaturized surgical lstruments that fit through a series of quarter-inch incisions. Instead of the flat 2-dimensional image that is obtained through the regular laparoscopic camera, the surgeon receives a 3-dimensional view that enhances depth perception; camera motion is steady and conveniently controlled by the surgeon via voice activated or manual master controls. When performing surgery with the Da Vinci machine worlds most advanced surgical robot these miniaturized instruments are mounted on three separate robotic arms, allowing the surgeon maximum range of motion and precision. The Da Vinci’s fourth arm contains a magnified high-definition 3D camera that guides the physician throughout the procedure. Most advances power-assisted by surgical robots are remote surgery, minimally invasive surgery and unmanned surgery. Due to robotic use, the surgery is finished with exactness, shrinking, smaller incisions; reduced blood loss, less pain, and faster healing time. Articulation on the far side traditional manipulation and three-dimensional magnification facilitate to end in improved applied science. Due to these techniques, there is a reduced duration of hospital stays, blood loss, transfusions, and use of pain medication. The existing open surgery technique has many flaws like limited access to the surgical space, long recovery time, long hours of operation, blood loss, surgical scars, and marks. The above figure shows a picture of the Da Vinci Surgical machine which is used to perform robotic surgery. The arms of this machine are fitted with special instruments called as Endowrist instrument

Figure 1. Da Vinci machine

These instruments are designed to provide surgeons with natural dexterity while operating through small incisions. Most EndoWrist instruments are modeled after the human wrist joint, giving a bigger vary of motion than a human hand. The features of these instruments are:

- 7 degree of freedom
- 90 degree of articulation
- Intuitive motion and finger-tip control
- Motion scaling and tremor reduction

After an instrument is mounted on the Da-Vinci System, the interface is designed to recognize the type of function of the instrument, and display the number of uses. The instruments which are used are forceps, needles, grasper, scissors, etc. These instruments are available in different sizes such as 5mm or 8mm etc. These instruments are designed to be user friendly in all the aspects of the surgery. After an instrument is mounted on the machine, the interface is designed to recognize the type of function of the instrument, and display the number...
of uses. With this unique interface, the Da Vinci system detects when an instrument needs replacing. After an instrument is mounted on the Da Vinci System, the interface is designed to recognize the type of function of the instrument, and display the number of uses. The instruments which are used are forceps, needles, grasper, scissors, etc. These instruments are available in different sizes such as 5mm or 8mm etc. These instruments are designed to be user-friendly in all the aspects of the surgery. After an instrument is mounted on the machine, the interface is designed to recognize the type of function of the instrument, and display the number of uses. With this unique interface, the Da Vinci system detects when an instrument needs replacing.

Figure 2. EndoWrist Instruments

Figure 2 shows various EndoWrist instruments used in the surgery. The da Vinci System has been successfully used in the following procedures:

- Radical prostatectomy, pyeloplasty, cystectomy, nephrectomy and ureteral reimplantation
- Hysterectomy, myomectomy and sacrocolpopexy
- Hiatal hernia repair;
- Internal mammary artery mobilization and cardiac tissue ablation

This paper aims to build a prototype model of the Da Vinci machine. This paper is divided into various sections. Section II describes about the work which has been done in the past. Section III discusses about the problem regarding the unawareness of this concept. Section IV gives the solution to the above problem. We conclude with a discussion of current research issues followed with the future scope of this new technology.

### Table 1. Survey Table

<table>
<thead>
<tr>
<th>Questions asked</th>
<th>Robotic Surgery</th>
<th>Traditional Surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualification of doctors</td>
<td>83% are MS qualified and other equivalent degrees</td>
<td>75% are MS qualified and other equivalent degrees</td>
</tr>
<tr>
<td>Experience in robotic surgery field</td>
<td>10 years and above</td>
<td>20 years and above</td>
</tr>
<tr>
<td>Time taken to perform surgeries</td>
<td>2 hours</td>
<td>More than 3 hours</td>
</tr>
<tr>
<td>Affordibility</td>
<td>Costly</td>
<td>Cheaper</td>
</tr>
<tr>
<td>Healing time</td>
<td>1-3 days</td>
<td>1 week</td>
</tr>
<tr>
<td>Success rate</td>
<td>98 %</td>
<td>85 %</td>
</tr>
<tr>
<td>Blood loss</td>
<td>2 %</td>
<td>70 %</td>
</tr>
</tbody>
</table>

II. RELATED WORK

A systematic literature search was performed regarding the comparative study between traditional (laparoscopic) and robotic surgery. The methodology used was of Qualitative type. A questionnaire was prepared for the survey. It included various questions which were based on the comparative study of traditional and robotic surgery. Table 1 describes the survey questions as well as the comparative study of both the surgeries. The advantages of employing a mechanism system over manual procedures within the laboratory to arrange samples is mentioned, and some of the obstacles are noted. Laparoscopic surgery has bound limitations, such as two-dimensional imaging, restricted range of motion of the instruments, and poor ergonomic positioning of the surgeon. The robotic surgery system was introduced as an answer to attenuate the shortcomings of laproscopy. Improved visual image and bigger sleight area are two major options of robotic-assisted laparoscopic surgery. Laparoscopic surgery is bound to certain limitations which will be a haul once activity complicated minimally invasive operations. Robotic surgery was developed exactly to beat such technical limitations. The question so arises whether or not robotic surgery results in considerable higher results compared with laparoscopic surgery.

III. PROBLEM DISCUSSION

Based on the literature used in this review, robotic surgery system was introduced as a solution to minimize the shortcomings of laparoscopy. In India there are few hospitals which conduct robotic surgery. Besides few doctors this concept is not that familiar in some areas of India. In rural areas for medical students there are no facilities by which the professors could explain this concept to the students. Robotically performed surgery is costly compared with laparoscopic and open approaches. The investment made in acquiring this technology is large, and institutions choosing to adopt it should monitor costs and outcomes to maximize cost-effective use in their centres. To decrease prices, centres may maximize case loads think about keeping the golem operational for extended period, if potential, and use the technology for multiple indications, notably those with bigger potential impact on patient outcomes and institutional cost savings. In order to explain the concept with live demonstration we are building a prototype model of the Da Vinci machine. This will help those students especially studying in government medical colleges.

IV. PROPOSED SYSTEM

The above block diagram represents the proposed system of prototype model. The Robotic Arms are designed using the Microcontroller i.e. 8051, micro-controller using Android application programming. This process works on the principle of interfacing BO motors and 8051 microcontroller using Bluetooth Module HC-05. We have designed Android based application to control the robotic arm. Each arm has three different functions, as well as three Endo-Wrist instruments are used. The first entry instrument does an incision of 5mm in to the patient’s body wherever necessary, also it has a camera and a flash light attached to it which depicts a 360 degree view.
on the interface. Second arm which consists of forceps does the work of holding the flesh. Third arm consists of a needle driver which will be used to guide a suturing needle through tissue. The Database is provided to the application by programming into the PCB for functioning of the arm. Once you give signal (touch the console) through the application the Bluetooth module receives data from the user and feeds to microcontroller which in turn provides output to motor driver to drive the motor and action is performed by the robotic arm. Each application is connected to a Bluetooth module. Robotic arm has been assembled by laser cut parts. End effectors are designed according to the desired output. The above figure shows the actual implementation of the prototype mode of Robotic surgery. Here, in this prototype model we have shown just 3 arms of Da vinci machine. Each arm has separate function. The middle arm carry out the function of the First Entry instrument. The left arm is used as a needle driver and the right arm is used as a forcep. We considered here a case of kidney stone. The prototype model performs the function of removal of kidney stone place at a fixed position. The end effectors are designed in such a way that they can perform the desired task accurately. The end effectors can be modified as the instruments used in different types of surgery. These components are divided into hardware and software

A. Hardware
The hardware components includes BO motors, Android Control Board, robotic arm. The Android Control Board comprises of various components such as 8051 microcontroller which is the heart of the whole board, HC-05 bluetooth module through which the robotic arms are been controlled. It is a 6 pin module mainly used for master slave configuration. It is used for many applications like wireless headset, game controllers, wireless mouse, wireless keyboard and many more consumer applications. It has range up to 100m which depends upon transmitter and receiver, atmosphere, geographic urban conditions. It is IEEE 802.15.1 standardized protocol, through which one can build wireless Personal Area Network (PAN). LM-317 and 7805 Voltage Regulators which an adjustable three-terminal positive-voltage regulator capable of supplying more than 1.5 A over an output-voltage range of 1.25 V to 37 V. L293D Motor Driver which allows DC motor to drive on either direction. L293D may be a 16-pin IC which might management a collection of 2 DC motors at the same time in any direction. It means that you can control two DC motor with a single L293D IC. Potentiometer is used for controlling the speed of the robotic arm. 9V-12V power supply is used. Since there are three robotic arms, there will be three android boards each for each arm and all the arms will be individually controlled by bluetooth module.

B. Software
The software component includes only Bluetooth driven application. App Inventor for Android is an open-source web application originally provided by Google, and now maintained by the Massachusetts Institute of Technology (MIT). It uses a graphical interface, terribly kind of like Scratch and also the StarLogo TNG computer programme, that permits
users to drag-and-drop visual objects to form associate degree application that may run on Android devices. In making App discoverer, Google drew upon significant prior research in educational computing, as well as work done within Google on online development environments. App Inventor and the projects on which it is based are informed by constructionist learning theories, which emphasizes that programming can be a vehicle for engaging powerful ideas through active learning. As such, it’s a part of associate degree in progress movement in computers and education that began with the work of queen Papert and also the MIT emblem cluster within the Nineteen Sixties and has conjointly manifested itself with Mitchel Resnick’s work on Lego Mindstorms and StarLogo. The figure 8 describes about the interfacing of the software as well as the hardware part. The Android application contains all the data of each arm and thus user can interface through the application. For interfacing of hardware and software first, we need to pair the bluetooth device to the bluetooth module. The paired bluetooth modules will be displayed on the application and you can the connect to the desired bluetooth module through “Connect To Bluetooth”. One application can control 3 motors. Thus, here we require 3 application to control 3 arms. The upside and downside arrow will control the motion angle of 1 motor. Likewise, the side arrows and “open” “close” will control other 2 motors. The center RED button is used the stop the motor.

![Application User Interface](http://ijesc.org/)

Figure 8. Application User Interface

The Working of this prototype is show in the figure 9. The application has the data of arm controlling. firstly, Interface the bluetooth to bluetooth module. If the user interface using the application the data is sent to the bluetooth module after which the Android control board receives data. It processes the data. Here, motor drivers are used to connect motors to the bluetooth module. The motors are thus driven by the motor driver circuit installed on the board. The motor driver will control the motors situated on the arm, and thats how the arm will start to move as it will be specified in the program as to which arm will move at what time and in which direction. The motor thus drive the ARM’s movement.

V. CONCLUSION

Robotic surgery is an emerging technology in the robotic field. It gives us even better vision, dexterity and precision than possible with standard minimally invasive surgery. There is a lack of validated training tools for robotic assisted laparoscopic surgery also lack of education regarding it in some parts of India. Hence, the proposed concept of building a prototype model will help the medical students as well as the doctors which will result in enhancement of knowledge. Also, procedural training for robotic surgery can be carried out in a systematic and step wise manner.

FUTURE SCOPE

The possibility of this concept is that which will be in the future is the, where a doctor could make a tiny incision, perhaps through a patients belly-button, and then insert the snake-like arms of the robot through the incision. This concept has become advancement in minimal access surgery because it offers benefits like postoperative pain, less invasive etc. Also, the growth of tele-medicine (where you can operate on someone somewhere else in the world) is the near future. It has been wont to overcome the space barriers and to boost access to medical services that will typically not be systematically obtainable in distant rural communities. It is also used to save lives in critic care and emergency situations.

ACKNOWLEDGEMENT

It is our privilege to mention here our sincerest regards to our project guide Prof.Santoshi Pote who provided us the golden opportunity to undertake this innovative subject project Robot Assisted Surgery using HC-05 Bluetooth Module and Android Control board. We are also thankful to our HOD madam, Dr.Shikha Nema for her valuable timely inputs, guidance, encouragement, wholehearted support and constructive criticism throughout the length of our project. We are also thankful to our parents for their love and constant support.

VI. REFERENCES


learning curves for basic laparoscopic skills. Am J Surg 183:702707


