

# Utilisation of Surgical Robots for Minimally Invasive Surgery through Enabling Precise Manipulation of Surgical Instruments beyond Human Ability

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## Abstract

*This article has discussed the utility of surgical robots in minimally invasive surgery. Nowadays surgical robot is one of the biggest innovations that are able to do surgery in a sophisticated manner. Maximum hospitals and doctors try to provide these facilities to their patients. Accordingly, this process has the capability to do subtle surgery on the human body. It is true that doctor has certain boundaries to doing surgical procedures on the human body. Through the help of a surgical robot, they can able to initiate a complex surgical process in humans. On the other hand, minimally invasive surgery through the surgical robot has several kinds of facilities. This process does not require a big area of surgery. Through precision and small instruments can do the surgery. This robot is built with a high-quality sensor and cameras and it helps to check the inside part of the body and also provides a high-resolution and clear picture of the part. This study has focused on several types of robots such as the Da Vinci surgical system that uses artificial intelligence and it has the capability to process surgery by using a small area of the human body. This study has focused on the Contribution of surgical robots in the medical world and it also discusses the various kinds of surgical processes and also elaborates is other parts or instruments. Accordingly, this paper has shone a light on the limitation of surgical robots in minimal surgery. On the other hand, the secondary qualitative process is one of the best processes that help to authentic data on this study paper. It can be said that surgical robot is capable to change the entire concept of medical science.*

## Keywords

*Da Vinci Si, artificial intelligence, CyberKnife, Da Vinci SP, Da Vinci X, Da Vinci Xi, invasive surgery, ROSA, Sensor, surgical robot, TUG, Xenex Germ-Zapping Robot.*

## INTRODUCTION

In the medical sector, surgical robots are an innovative creation, and they change the face of the entire medical world. The human body builds up various subtle things and components. Humans do not have the capability to measure and see those parts of the body. In that case, it is natural that people face issues regarding their health and other major problems that need surgical procedures. As an example, the eye is one of the major parts of the body that consists of three-layer, ciliary muscle, retina, iris, optic nerve, and other components. Doctors cannot hold this component in their hands and surgery on those parts of the body is much more difficult for humans. The surgical robot has the facility to operate those parts of the body easily and it helps to provide the individual to get rid of their complications and difficulties.

This study has discussed several kinds of robots that help to do critical surgery. This is a specialized system that is one of the uniqueness of technologies that includes arms. These arms help to hold medical instruments, magnified screens, cameras, and consoles. Da Vinci system is one of the most common surgical robots by FDA approval. These kinds of robots help doctors to proceed with various kinds of complex

surgery with flexibility, precision, and control. This study will further discuss The Xenex Germ-Zapping Robot, The CyberKnife, and TUG. Hospitals are trying to implement those kinds of robotic systems to provide facilities to the individual. It leads to preventing the disease and accordingly it makes a major impact on people's psychology. This paper will also shed light on some limitations of surgical robots and budget can be considered as a major difficulty due to high maintenance cost. Now days surgical robots provide various kinds of modern facilities such as reducing difficulties of surgery, less blood loss, and decreasing the risk of infection. Those factors change the concept of the surgical process in people's minds. People are also raising interest to adapt the technological facilities. On the other hand, surgical robots also bring super modernization to the medical platform and surgeons also preferred the robotic surgical process due to its high accuracy, and low risk of failure. This is one of the ways that can provide a zero-error operation procedure without harming the body.

## LITERATURE REVIEW

### Contribution of surgical robots in the medical world

An adequate amount of speed and accuracy is achieved by surgeons in the medical world with the help of surgical

robots. The usage of surgical robots is vast and can achieve a proper level of perfection in critical operations and the secure life of humans. The survival chances of patients have increased with surgical robots and developed a proper growth in medical history [1]. The healing process of patients has become faster with the help of surgical robots which are beneficial for the growth of the industry. For patients, surgical robots can offer more mobility, companionship, and proper personalized care by developing appropriate software-regulated processes. After insertion through a small incision in the body surgical robots locks themselves into place which can create a stable platform that can successfully perform surgeries through remote control. Growth in medical history can be achieved with surgical robots as these are ensuring lesser pain and scaring for humans which are also allowing surgeons to perform different critical operations without any hassle []. Robotic gynecologic surgery, robotic kidney surgery, robotic prostate surgery, robotic colorectal surgery, and single-site robotic gallbladder surgery can be performed with the help of surgical robotic systems in recent times [2]. Researchers are developing different new ways to develop surgeries in different areas with robotics.



**Figure 1:** Different use of Surgical robots  
(Source: 3)

Surgical robots are used by different surgeons in various critical operations where the chance of life risk is developed in personalized care for the patients. This has gained ability in the medical sector and helped continuous development. These surgical robots are most useful when any contaminated diseases are developed, then these robots are able to work as an assistant in medical surgeries. Different staffing shortages are easily solved with the help of robots which are also able to assure safety and the goal of life-saving for people. In the future surgical robots are vastly introduced in different other works than surgical operations, these robots are successfully able to complete the major issues in the risk of operations and ensure the life expectancy of patients [3]. These surgical robots are also changing the history of the medical industry with different communicational growth which is achieved with smart computer-based intelligence that is able to predict any difficulties which may develop due to changes in the surgeries. The surgeons are able to take precise decisions which are helpful for gaining major growth in medical history. Robotic nurses are also introduced which are

beneficial for taking care of patients, efficiently remembering all the past medical history of the patients, and providing proper medical assistance accordingly. With the help of AI-based decision-making skills, robotic nurses are able to develop major growth in the medical professions and able to take some critical decisions on behalf of doctors. Before the surgical robots, doctors have to depend on luck for various critical operations which need both perfection and long timing. Easily doctors gained fatigue in different tiring operations which can lead to a major development for creating an issue of unsuccessful operations but different surgical robots are able to overcome the situation and provide growth in the medical industry in a positive way [4]. Different surgeries for cancer are possible with the help of surgical robots and these robots are provided new aid in medical history by providing exact treatment for patients worldwide. Hospitals are willing to develop surgical robots which are able to ensure growth in critical surgeries such as removal or hip replacement, the possibilities with robotic surgeries are incredibly increased with different surgical robots. Scientists are planning to develop different robots which can automatically heal a person from any difficult situation or minor issue. Repetitive and monotonous tasks are able to provide for the patients are helping to gain growth in the industry which is also beneficial for ensuring medical development.

#### **Types of surgical robots of a surgical robot in minimally invasive surgery**

At present, the Da Vinci surgical system is famous and trusted, and used around the world. There are presently four models of Da Vinci robotic surgical systems that are available: Da Vinci X, Da Vinci SP, Da Vinci Xi, and Da Vinci Si. These are designed for different and critical robotic surgeries. Exoskeletons are highly developed in the surgery process in the medical industries which are able to provide major growth in the medical industry. Approximately 6000 da Vinci systems are introduced in operations which performed 8.5 million successful operational development worldwide still now [5]. Zimmer Biomet Robotics is one of the popular surgical robotic systems which can able to perform operations on nervous systems and knees. ROSA is a robotic surgical assistant beneficial for performing different negligible invasive medical operations.



**Figure 2:** Surgical Robot  
(Source: 6)

Da Vinci Xi is the latest surgical robot that was introduced in the market recently. By using AI (artificial intelligence) surgical robots are able to determine different patterns of human anatomy. Robotic surgery is improved with advanced AI and is able to produce errorless surgeries. Real-time data gained with the help of surgical robots are helping to ensure the best performance in surgeries [6]. The surgeons are able to control different surgical robots which are able to gain specific growth in medical history.

#### **Limitation of surgical robots in minimal surgery**

Technicians with vast knowledge of robot-assisted surgery can only perform surgical operations efficiently. These trained surgeons are limited which are leading to a less number of surgeries completed with surgical robots. Surgical robotic surgeries are expensive which normal people cannot afford. Mechanical failure or power cuts can create several issues in the operations and may lead to life threats for the patients [7]. The operations with surgical robots can be critical which develops the chance of human error. The detection with robotic systems can be failed as different components of surgical robots such as mechanical arms, camera are not able to perform accurately. Prolonged surgery can cause some serious issues which are developed at the time of hemorrhage due to laceration.

This can lead to some permanent damage such as blindness. Although the failure rate is very low over complete maintenance charges and others in this surgery are huge and to gain the perfect accuracy the need of patience and proper practice are required. Emotional Support and Development cannot be gained with the help of robots which can improve the condition of patients as they become mentally strong. Privacy and Security cannot always be maintained with the help of surgical robots, the breach in security can be seen in this method so it cannot be trusted blindfolded in surgical operations [8]. The intention and mental condition of the person who is operating the entire system has to be stable otherwise the whole operation can fail miserably. The lack of awareness and also lack of trust for patients can develop a limitation in the complete process of surgery. The lack of creativity can be seen in the surgeries operated with surgical robots which can develop different issues for the patients after the completion of the surgeries. Surgical robots can sometimes increase the complexity of medical operations which can affect the life of the patients.

#### **METHODOLOGY**

In a research paper, the methodology takes an essential role and it provides a constructive structure to the entire research work. All researchers try to maintain a particular research process to get an accurate outcome from the research paper. The methodology is the process that helps to create a concrete framework for the study and it also helps to maintain a pattern of the study. Generally, the methodology part consists of some essential valuable parts such as the research approach, philosophy, study design, data gathering, and

examination or analysis. Every research needs to follow a particular method and process and same as this study also follows a particular pattern that helps to raise the value of the projects. Research philosophy is one of the important things of research work. The research uses philosophy as per their assumption and knowledge of the subject matter [9]. This paper follows the positivism philosophy that is also based on the assumption and it can be effective for the study. Some researchers prefer to take the benefit of deductive approaches and use this approach in their study. From several studies, it has been seen that this approach basically uses for the purpose of testing hypotheses.

This paper has not allowed any kinds of hypotheses and that is why the deductive approach is not suitable for the study. For this reason, this study preferred to use the benefits of the inductive approach. It helps to provide the study to create a relevant and accurate conclusion. On the other hand, this conclusion part is also simple, general, and justified [10]. The study design is one of the major parts of the methodology that also plays a significant role in the research process. It can be said that the entire research structure has dependent on the study design. After analysis of the subject matter, it has been decided that the subject of the research is wide and it is not possible to get the data from a particular source. It needs various sources that can able to provide world-based information or data. That is why this paper has chosen a case study design and this way based on various kinds of information and resource to give an appropriate frame to the study. As per the necessity, all the essential discussion has been explained in this study. After that, the process of data gathering and examination is one of the important parts of the study. The entire value depends on the study and this data is only responsible for the result as well.

This study paper has utilized the facilities of a secondary qualitative study that helps to meet the goal aim and objective of the study. On the other hand, this process gives the provision to extract valuable information from various sources and it also gives permission to expand the area of research. Accordingly, the secondary research process also gives permission to collect the data from google scholar and search engines. There are various kinds of authentic websites that provide extraordinary information for research work. This is the only process that can help to give relevant and similar data for the subject matter and assist to raise the knowledge on the specific subject of study. Accordingly, this is budget friendly and it is not required to pay anything to extract the information from the source. In other words, this method does not allow human involvement in the study, and it assists in reducing the budget naturally. In addition, this process is not taking much time, due to all data available such as journals, books, newspapers, and magazines on the internet source [11]. One of the biggest advantages of using this procedure is these data are collected from open sources, people can access data at any time. This method allows for gaining knowledge on the variety of surgical robots and their use in the invasive surgical process. On the other hand, the

secondary qualitative process also helps to acquire experiences on the surgical instruments and their process of working. This is a wide range of subject matter and there are many variations of surgical robots and instruments. The above factors are more valuable and justified for deciding the secondary qualitative method for this research work.

### DISCUSSION

Robotic surgery or robot-assisted surgery helped doctors to provide a visible advantage in various critical surgeries. This robotic system are providing more flexibility, precision, and control of the environment which is beneficial for saving the lives of people. The need for the robotic assistant is to ensure the success rate of operations which is creating a major opportunity in the field of surgery. Less pain and blood loss in the operation, Shorter hospital stay and fast recovery of the patients, and Smaller, less noticeable scars developed in the operations are achieved with the help of robotic surgeries [12]. The development of high-quality patient care can be achieved with the help of surgical robots which are helping to provide help in different chronic diseases, providing intelligent therapeutics, and social engagement for elderly patients. The healing is faster and less chance of becoming infected is developed in surgeries with the help of surgical robots. The safety of the patients is ensured with surgical robots which are able to provide better growth in the history of the medical industry. The speed in surgeries is gained with the help of surgical robots which are able to ensure the life growth of patients as these robots can easily work for several hours continuously in critical operations without any fatigue compared to humans [13]. From this study, it has been seen that, in the modern era, a surgical robot has the capability to do surgical procedures without the involvement of humans. These kinds of robots are built with various kinds of special chips, sensors, and devices. Those also have an interrelationship with the internet of things and artificial intelligence. These kinds of robots help to sense the temperature and other bodily activities. In the medical sector, there are some robots that are able to continue the surgical procedure through instructions. Sometimes those are also able to provide suggestions to medical professionals. In this context, it can be said that surgical robots can do minimally invasive processes more carefully and better than humans. From this study, it has been seen that nowadays medical professionals also prefer to use robotics surgery in the human body. The Da Vinci surgical system is one of the most famous and trusted robotic systems, and it is generally used all over the world. In this context, There are presently four kinds of models of Da Vinci robotic surgical systems such as Da Vinci X, Da Vinci SP, Da Vinci Xi, and Da Vinci Si. Basically, Those are designed for several critical robotic surgeries. On the other hand, Exoskeletons are a highly developed way in the modern surgery process in the medical industries. It can be said that robotics can also provide growth opportunities of medical industries [14]. In the current time medical industry creates a major position in the business

world. Robotic technology helps to enhance the entire treatment process and expand modernization all over the world.

Accordingly, the robotic system also helps to gain ability in the modern medical sector and assists to continue the development process of the industry as well. These surgical robots are useful when contaminated diseases are developed, and these also work as an assistant to medical professionals. It is able to prevent staffing shortages and also easily solve issues with the help of robots. The robotics process is also able to provide safety and the aim of life-saving for individuals.

From this above-mentioned paper it has been seen that, in the future, surgical robots can be widely introduced in other types of procedures as well as surgical operations. These robots are also able to cure various kinds of major issues and also reduce the high risk of operations. Accordingly, it also can ensure the expectancy of life of patients.

It can be said confidently that these kinds of surgical robots bring revolution in medical history as well as the medical industry with several kinds of commercial and communicational growth. It is also achieved with smart computer-based intelligence that also predicts upcoming difficulties that may develop due to some changes in the surgeries. In that case, surgeons or medical professionals are able to make precise [15]. Robotic nurses have the ability to take care of the patients efficiently and are able to remember all the past medical history and provide proper medication and other essential care to the patient. This is also connected With AI-based decision-making skills and other updated features. In this context, robotic nurses also develop major growth in the medical profession. These robots also take some critical decisions in emergencies on behalf of the medical practitioners [16]. On the other hand, it also has the capability to keep care and do all essential things for the patient, and sometimes it can provide suggestions to the patient for their recovery.

From the history of medical science and industry, it has been known that, before surgical robots, professionals have to depend on luck for critical operations that generally need perfection and long periods, and patience. Sometimes they are not always successful in the procedure and it damages the human body and also hampers the life of patients.

On the other hand, there are Different kinds of critical surgeries for cancer that are only possible to proceed with surgical robots and these robots help to provide new aid and enhance the treatment systems worldwide. Nowadays maximum Hospitals are willing to develop surgical robots that help to provide critical surgery facilities to their patients such as removal or hip replacement, joint replacement, eye replacement, and other advanced facilities [17]. In this case, the major possibilities with robotic surgeries are incredibly increased with different kinds of surgical robots. Technology expertise in trying to invent more innovative robots is not required of any kind for human connectivity.

It has been seen that surgical robots are an innovative

combination of technology and medical sciences. In that case, both take a major position in human psychology. For the surgical procedure people are using this system rather than the manual system due to it can work with zero human error and also decrease the risk of life [18]. On the other hand, robotic surgery is most time-saving and it also helps people a mental satisfaction that helps to recover the patient earlier.

### CONCLUSION

From this study, it can be concluded that in the modern era, surgical robots help medical professionals to handle some critical issues in a protective manner. From this study, it has been seen that surgical robots make a major and effective impact on medical science. Nowadays doctors are recommended and prefer to do the surgical process by helping surgical robots. Accordingly, it has been seen that nowadays people are so much more health conscious and they try to solve the issues regarding their health. In that case, medical practitioners are provided with the suggestion to go for robotic surgery. These surgical process helps to move the individual to continue their regular life earlier. On the other hand, this process of surgery is the most time saving and cost-saving as well.

This study has shed light on the Contribution of surgical robots in the medical world. The human body builds up with several kinds of subtle parts and tissues which are well understood by the surgical robots and respond accordingly to the issues of critical surgeries. The contribution of surgical robots is so vast that a wider group of people are able to achieve success with these systems and able to gain growth in the industry. To understand different contributions in the medical history of surgical robots a secondary qualitative methodology is used to complete the research which is beneficial for gaining proper growth in the industry as different previous articles, newspapers, and research are helpful for gaining growth to overcome different issues and understand the knowledge which is developed positiveness in the compilation of research work. These methods of study assist in knowing the limitations of surgical robots and also provide information about several kinds of robots. That makes a major impact on the world medical platform and also raises the values of the modern medical treatment process. At last, it can be said that those innovative robots are blessings for future medical treatment processes and studies.

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