



Internet of Robotic Things in Cardiac Surgery: An Innovative Approach

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Abstract- It is possible that the application of the Internet of Robotic Things in cardiac surgery may bring about a revolution in the field of medicine and a significant improvement in the outcomes for patients. It is possible for IoRT to aid surgeons in carrying out difficult surgeries with enhanced accuracy and efficiency thanks to its cutting-edge technology, precision, and enhanced visualization capabilities. As this technology progresses more and further now, we may anticipate seeing even more advancements in the field of cardiac surgery, which will make the procedure safer and more accessible to patients all around the world. There is a possibility that the Internet of Robotic Things will bring about a revolution in the field of cardiac surgery. Internet of Things (IoRT) is a promising technology for the future of healthcare because of its capacity to improve precision, decrease the amount of time needed for recovery, and improve patient outcomes. Nevertheless, in order to guarantee that its adoption will be both secure and effective, it is necessary to address the difficulties and worries that are linked with utilizing it. IoRT has the potential to transform the way cardiac procedures are performed, which would result in improved outcomes for patients all around the world if additional developments and research are applied to it.

Keywords – Internet of Robotic Things (IoRT), Cardiac Surgery, Robotics, Heart Issue,

1. Introduction-

The life-saving operation known as cardiac surgery has completely changed the way heart illnesses are treated. It entails surgery to replace or repair malfunctioning cardiac components, including the muscles, arteries, and valves. Since its founding, this extremely specialized area of medicine has advanced significantly, with improvements in patient outcomes and quality of life resulting from new methods and technological developments.

When alternative treatments, such medication or lifestyle modifications, are not successful in improving a patient's health, heart surgery becomes necessary. Numerous cardiac conditions shown in Figure 1, like heart failure, coronary artery disease, and congenital heart defects, are frequently treated with it. Heart surgery is an essential therapeutic option for many disorders because untreated cases can be fatal.

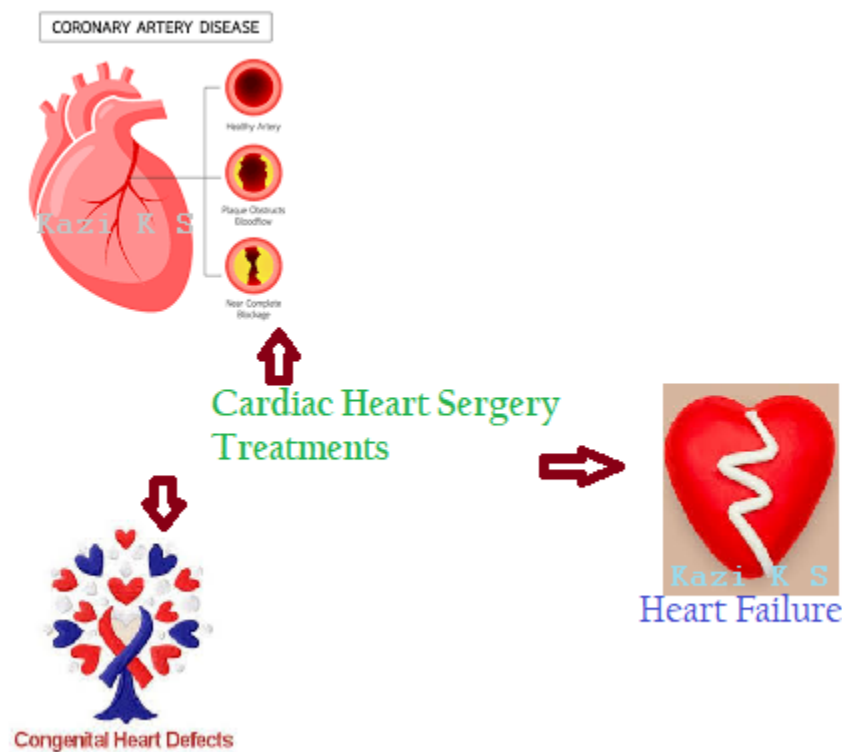


Figure 1- Cardiac conditions treatments

The advent of less invasive treatments has been one of the biggest advancements in heart surgery. By using small incisions rather than a massive chest cut, these procedures can speed up recovery and lower the risk of infection and problems. These days, valve replacement or repair, coronary artery bypass surgery, and other cardiac treatments are frequently performed using minimally invasive techniques.

The application of robotic surgery is a noteworthy development in cardiac surgery. In order to carry out delicate procedures with more precision, a surgeon can control a robotic arm equipped with surgical equipment. It has been discovered that robotic surgery shortens the recovery period for patients and lowers the dangers connected with conventional open heart surgery.

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The field of cardiac surgery has also significantly advanced with the use of artificial hearts and heart support devices. Patients who are not eligible for a heart transplant can utilize these devices as a permanent solution or as a stopgap to maintain a failing heart. Numerous lives have been saved by artificial hearts, and patients with end-stage heart failure now enjoy far higher quality of life.

Like any surgical treatment, cardiac surgery entails certain risk and the possibility of complications. But because to improvements in methods and technology, the hazards are now substantially lower, making this a far safer choice. Heart surgery success rates have also increased dramatically, with most patients reporting extended survival times and higher quality of life.

Cardiac surgery has not only been essential in treating heart conditions but also in understanding and researching the heart. It has made it possible for medical professionals to comprehend the anatomy and physiology of the heart better, which has resulted in the development of novel heart disease medicines.

To sum up, cardiac surgery has advanced significantly since its inception and has been instrumental in saving many lives. It will remain a crucial therapeutic option for heart disorders due to ongoing technological and procedural developments. But as they say, prevention is always preferable to treatment, therefore leading a healthy lifestyle is essential to lowering your chance of heart disease. Maintaining a balanced diet, quitting smoking, and limiting alcohol intake can all help to maintain our hearts in good condition.

When non-surgical methods, such lifestyle modifications or medication, fail to control heart issues, cardiac surgery becomes necessary. For those with heart problems, cardiac surgery is frequently an essential and life-saving treatment, despite the fact that it may feel intimidating and intrusive. Treating coronary artery disease is one of the primary reasons cardiac surgery is required. This disorder develops when the heart's blood supply arteries narrow or obstruct, which lowers the heart's blood flow. It can cause a heart attack, which can be lethal if untreated. The best course of action in these situations to repair the heart's blood supply and stop additional harm is cardiac surgery.

The replacement or repair of damaged heart valves is another frequent cause for cardiac surgery. Four heart valves control blood flow, and when they are ill or injured, they can lead to life-threatening consequences. For example, an excessively thin valve may impede blood flow, and a leaking valve may cause blood to flow in the incorrect direction. Heart failure may result from the heart having to pump blood harder in either scenario. In certain cases, surgery could be required to replace or repair the damaged valve and get blood flowing normally again.

Moreover, the treatment of congenital cardiac abnormalities also requires cardiac surgery. These heart issues are structural in nature and exist from birth. Certain malformations have the potential to be fatal, and their correction may necessitate prompt surgical intervention. For example, a heart valve deformity or hole in the heart can seriously harm the heart and its ability to pump blood. Often, surgery is the sole option to fix these flaws and restore the heart's normal function.

Moreover, heart failure treatment may potentially require cardiac surgery. This disease manifests itself when the heart is unable to pump sufficient blood to satisfy the requirements of the body.

Heart attacks, hypertension, coronary artery disease, and other cardiovascular conditions and issues with the heart valves are some of the causes of heart failure. Surgery can be required to replace or repair damaged heart tissue and enhance heart function, even while lifestyle modifications and medicines can assist manage heart failure.

Apart from the above mentioned causes, other cardiac disorders such as aneurysms, arrhythmias, and heart tumors may also require cardiac surgery. A blood vessel bulge known as an aneurysm has the potential to rupture and result in potentially fatal bleeding. In order to fix the aneurysm and stop it from rupturing, surgery might be required. Similar to this, surgery is a viable treatment for some arrhythmias, or irregular heart rhythms. Despite being uncommon, heart tumors may need to be surgically removed in order to stop them from impairing the heart's ability to function.

To sum up, cardiac surgery is an essential and required medical operation for people who have heart issues. It can stop more problems, enhance heart health, and save lives. Despite its intimidating appearance, heart surgery is now safer and more successful than ever thanks to technological developments. It is important to remember, though, that not all cardiac diseases call for surgery, and that doctors will only suggest it in the last resort. Consequently, the optimal course of treatment for any heart issue must be determined by consulting a physician and according to his or her suggestions.

2. Internet of Robotic Things(IoRT)-

With the advent of Internet of Things-IoT, a new era of connectivity has emerged. And now, the latest addition to this technological revolution is the Internet of Robotic Things (IoRT). IoRT is a concept that combines the power of the internet with robotics, creating a network of connected robots that are capable of communicating with one another as well as with other tools. There is a possibility that this technology will completely transform the way in which we engage with machines along with the environment that surrounds us.

The term 'Internet of Robotic Things' was first coined by the research firm Gartner in 2013. It refers to the connection of robots and devices to the internet, allowing them to share data and perform tasks autonomously. This technology has the potential to create a highly efficient and interconnected network of intelligent machines, leading to a more advanced and automated world. Figure 2 illustrates the wide range of applications that can be achieved through the implementation of IoRT. One of its main uses is in industrial settings, where it is possible to connect robots with internet and control them from a remote location. This allows for more precise and efficient operations, reducing human error and increasing productivity. For instance, in a manufacturing unit, robots can be connected to the internet and receive real-time data from sensors on the factory floor. This enables them to adjust their movements and actions accordingly, resulting in faster and more accurate production.

Another major application of IoRT is in the field of healthcare. With an aging population, there is a growing demand for assistive technology to help the elderly and disabled. IoRT may have a significant part that, in this by connecting robotic devices, such as exoskeletons or prosthetics, to

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the internet. This can enable users to control these devices remotely, improving their mobility and quality of life.

IoRT also has the potential to transform the transportation industry. With the rise of autonomous vehicles, the need for a connected network of vehicles and infrastructure has become crucial. IoRT can provide this connectivity, allowing for real-time communication between vehicles, traffic signals, and other infrastructure. Accidents and congestion can be reduced as a result of this, which can lead to transportation systems that are safer and more efficient.

Apart from these major applications, IoRT is also being used in various other fields, such as agriculture, logistics, and even in our homes. For example, smart homes can be equipped with robotic devices connected to the internet, allowing for automated tasks such as cleaning and maintenance.

However, as with any new technology, there are also concerns and challenges surrounding IoRT. The possible eradication of jobs that could occur as a result of the automation of operations that were previously carried out by humans is one of the primary cause for concern. There are also concerns about security and privacy, as the vast amount of data collected by these connected devices can be vulnerable to hacking and misuse.

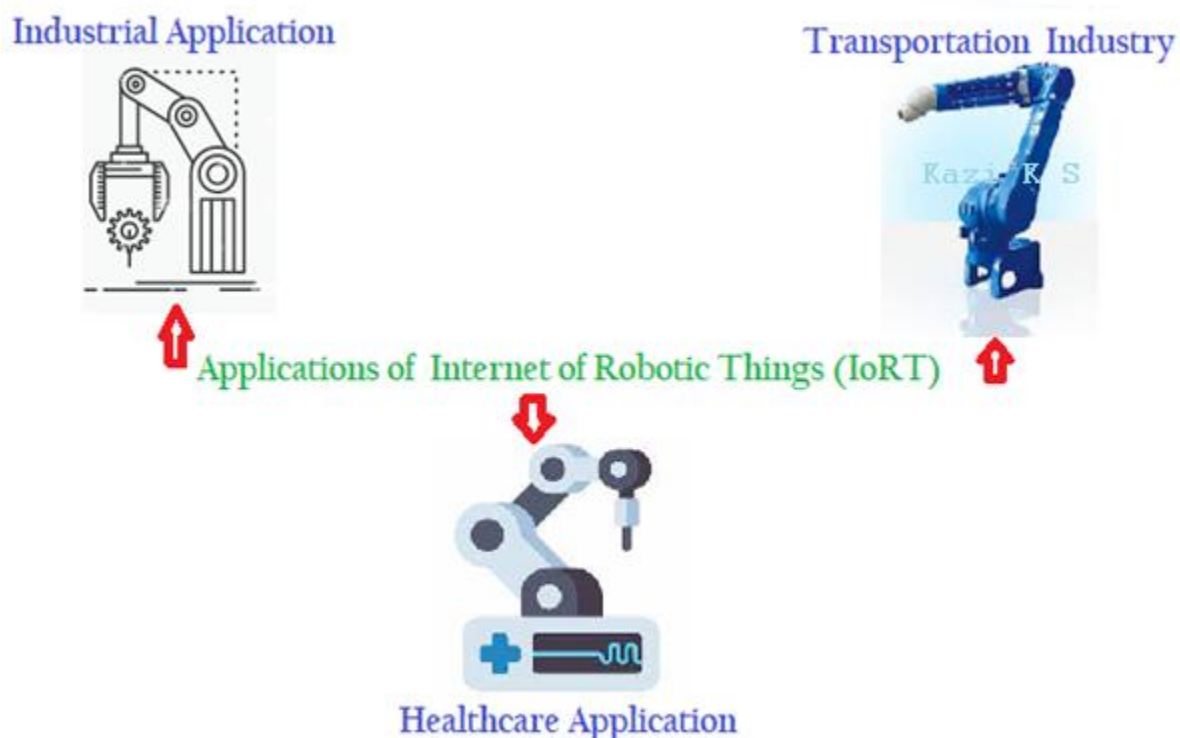


Figure 2- IoRT Applications

To address these concerns, it is crucial to have proper regulations and guidelines in place. Companies working on IoRT must prioritize data security and privacy, and governments should

enforce strict regulations to protect consumer data. In addition, in order to accommodate the shifting nature of the labor market, efforts are needed made to retrain and elevate the skills of the workers.

The Internet of Robotic Things has the potential to bring about a significant transformation in our daily lives. Its applications are diverse and can help us achieve greater efficiency, convenience, and safety. However, it is essential to address the concerns surrounding this technology and take necessary precautions to ensure its responsible and ethical use. With the right approach, IoRT can pave the way for a more connected, intelligent, and automated future.

3. Material and Methods-

The discipline of medicine has continuously been at the vanguard of technological breakthroughs, and professionals in the field are continually looking for innovative ways to enhance the outcomes for patients and make surgical procedures safer and more efficient. A considerable rise in the utilization of has been observed over the course of the past few years, robotic technology in various surgical specialties, including cardiac surgery. This is known as the Internet of Robotic Things (IoRT), a network of connected robotic devices that can communicate and work together to perform complex tasks with precision and accuracy.

When it comes to cardiac surgery, IoRT refers to the utilization of sophisticated robotic systems and technologies that provide assistance to surgeons in the execution of complex procedures. In addition to being outfitted with cutting-edge sensors, cameras, and robotic arms, these systems are also equipped with a console that allows the surgeon to exercise control over them. This enables them to be better visualization and dexterity, as well as more precise movements during surgery. When it comes to cardiac surgery, the higher level of precision that is offered by IoRT constitutes one among the most significant advantages and benefits. The robotic arms used in these procedures are much smaller and more flexible than the human hand, allowing for delicate movements that are not possible with traditional surgical instruments. This is especially important in cardiac surgery, where even the smallest error can have serious consequences. With IoRT, surgeons are able to perform procedures with greater accuracy, resulting in better outcomes for patients.

Another advantage of IoRT in cardiac surgery is the improved visualization it provides. The use of high-definition cameras and 3D imaging provides doctors with a more detailed view of the surgery site, which makes it simpler for them to recognize and eliminate any potential issues that may arise. This is particularly useful in minimally invasive procedures, where the surgeon has limited visibility. With IoRT, surgeons can get a better view of the heart and its surrounding structures, leading to more precise and efficient surgeries.

Furthermore, IoRT can also reduce the physical strain on surgeons during lengthy and complex procedures. With traditional open-heart surgeries, surgeons have to stand for hours, often in uncomfortable positions, which can lead to fatigue and potential errors. With IoRT, surgeons can sit at a console and control the robotic arms with their hands, reducing the strain on their bodies and allowing for more comfortable and precise movements.

The use of IoRT in cardiac surgery also has the potential to reduce the length of hospital stays and recovery time for patients. Since these procedures are less invasive and involve smaller incisions, patients experience less pain and have a faster recovery. This means they can return to their daily activities sooner, reducing the overall cost of their care and improving their quality of life.

Furthermore, IoRT also has the potential to improve access to cardiac surgery for patients in remote or underserved areas. With the use of telemedicine, surgeons can perform procedures from a remote location, allowing them to reach patients who may not have access to specialized cardiac care. This can be life-saving for patients who require immediate surgery but are unable to travel to a hospital equipped with a cardiac surgery unit.

However, as with any new technology, there are also some challenges and limitations to the use of IoRT in cardiac surgery. One major concern is the cost of these systems, which can be expensive and may not be affordable for all hospitals. Additionally, there is a need for extensive training for surgeons to learn how to use these systems effectively, which can also be a barrier to widespread adoption.

Further in this article, we will explore some of the methods used in the IoRT for cardiac surgery shown in Figure 3.

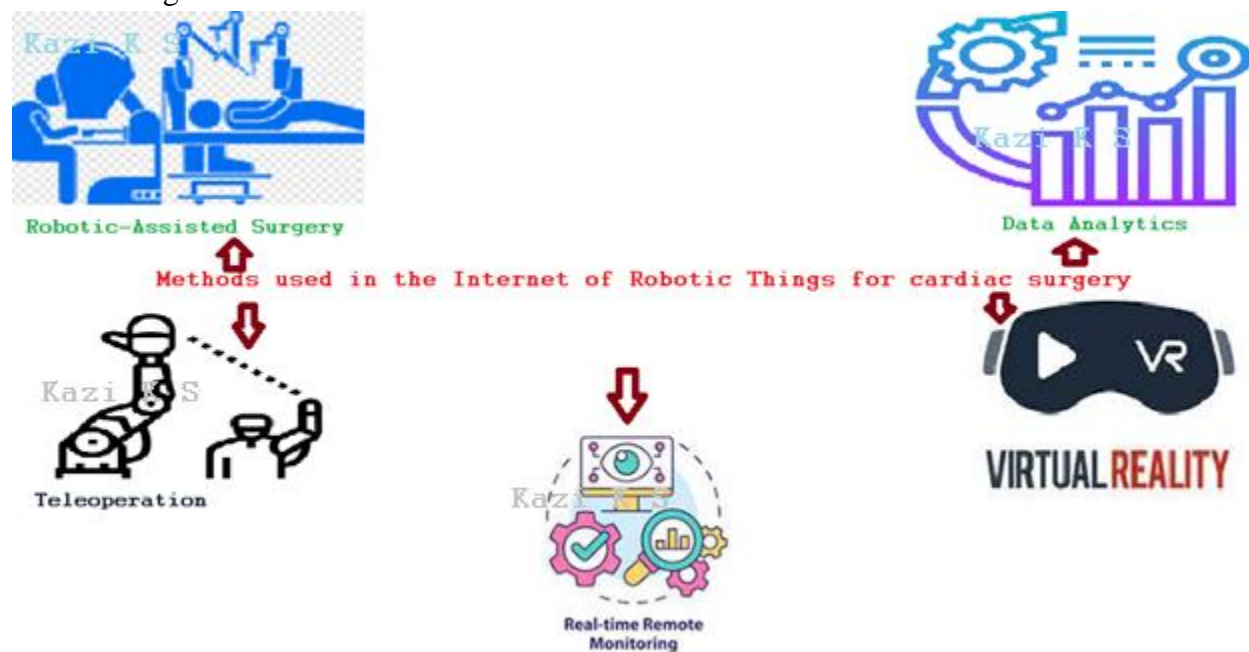


Figure 3- Methods of IoRT for Cardiac Surgery

1. Robotic-Assisted Surgery:

One of the most common methods of utilizing the Internet of Robotic Things in cardiac surgery is through robotic-assisted surgery. This entails the utilization of robotic devices to provide assistance to surgeons during the performance of treatments such as the replacement of heart valves or the bypass of coronary arteries. A console is used to manage these systems, which are made up of robotic arms that have specialized instruments connected to them. The surgeon is in charge of

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controlling these systems. More successful outcomes for patients are achieved as a result of the utilization of these robotic devices, which enable more accurate motions and lower the likelihood of errors caused by human intervention.

2. Teleoperation:

Teleoperation is another method used in the Internet of Robotic Things for cardiac surgery. This involves the use of a remote-controlled robotic system to perform surgery on a patient located in a different location. This method is particularly useful in emergency situations, where a patient may not have access to specialized cardiac surgeons. With teleoperation, a surgeon can remotely control a robotic system and perform the necessary procedures, providing timely and life-saving care to the patient.

3. Real-Time Monitoring:

IoRT also provides the ability to monitor patients in real time while they are and after cardiac surgery. This is made possible through the use of sensors and connected devices that collect vital signs, such as heart rate, BP-blood pressure, and transmit them to a central monitoring system. This allows surgeons in order to keep a careful eye on an individual's health while carrying out adjustments as required, for the purpose of lowering the likelihood of problems and accelerating the healing process.

4. Data Analytics:

The use of data analytics is another method in IoRT that has significant implications for cardiac surgery. With the help of advanced algorithms and machine learning, data from previous cardiac surgeries can be analyzed to identify patterns and trends. This information can then be used to improve surgical techniques and outcomes, leading to better patient care. Data analytics also allows for the early detection of potential complications, enabling surgeons to take proactive measures to prevent them.

5. Virtual Reality:

Virtual reality (VR) has been gaining popularity in various industries, and healthcare is no exception. In the context of cardiac surgery, VR can be used to create realistic simulations of a patient's anatomy, allowing surgeons to plan and practice procedures before performing them on a live patient. This technology also enables surgeons to visualize the surgical site in 3D, providing a more accurate and detailed view. This can lead to more precise and efficient surgeries, reducing the risk of complications and improving patient outcomes.

The Internet of Robotic Things has opened up a world of possibilities for cardiac surgery. The use of robotic-assisted surgery, teleoperation, real-time monitoring, data analytics, and virtual reality has transformed the field, making procedures more efficient, precise, and safe. As the state of technology keeps advancing, we can anticipate the appearance of even more cutting-edge

approaches being used in the Internet of Robotic Things for cardiac surgery, further improving patient care.

4. Discussion-

Diseases of the cardiovascular system are the largest cause of death across the globe, and cardiac surgery plays a significant role in treating these conditions. However, traditional cardiac surgery techniques have limitations, such as long recovery time, high risk of infection, and human error. With the integration of robotics and the internet, these limitations are being overcome, leading to improved patient outcomes.

The IoRT in cardiac surgery involves the use of connected medical devices, sensors, and robotic systems to perform minimally invasive procedures shown in Figure 4 and Figure 5 shows the block diagram of IoRT Cardiac surgery system. These devices are controlled remotely by surgeons, allowing them to perform surgeries with greater precision and accuracy. The use of robots also reduces the risk of infection as they can work in a sterile environment, minimizing the need for human contact.

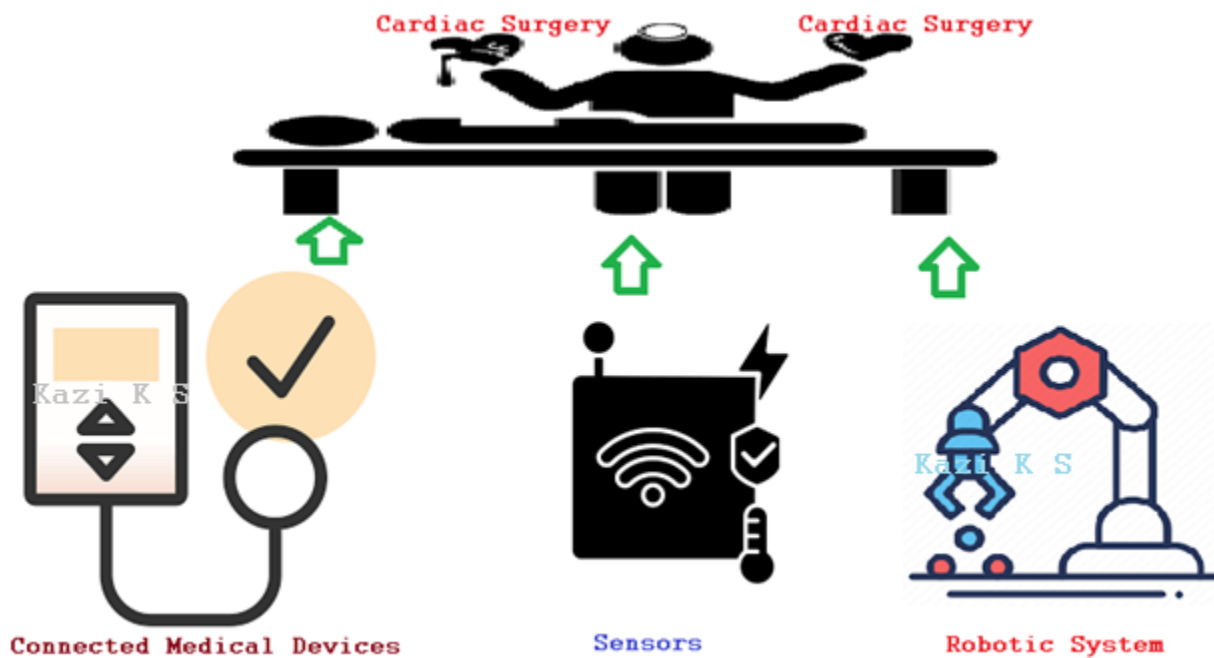


Figure 4- Procedure of Surgery using IoRT

One of the major benefits of IoRT in cardiac surgery is the use of telemedicine. Through the internet, surgeons capable of performing real-time monitoring of patients' vital signs, including blood pressure-BP, heart rate, , and SO₂-oxygen levels, from a distant location. It is possible to detect any difficulties at an earlier stage thanks to this timely intervention, reducing the risk of post-operative complications.

Moreover, the integration of AI and machine learning in IoRT has enabled the development of advanced surgical planning and simulation tools. These tools use patient data, such as CT scans and MRI images, to create a 3D model of the heart, allowing surgeons to plan and practice the

surgery before the actual procedure. This not only saves time but also improves the accuracy and success rate of surgeries.

Another significant advantage of IoRT in cardiac surgery is the ability to perform complex procedures with smaller incisions. Traditional open-heart surgery requires a large incision, leading to longer recovery times and increased risk of infection. With IoRT, surgeons can use small robotic arms to access the heart through tiny incisions, reducing the recovery time and risk of infection. This also leads to less scarring and a better cosmetic outcome for patients.

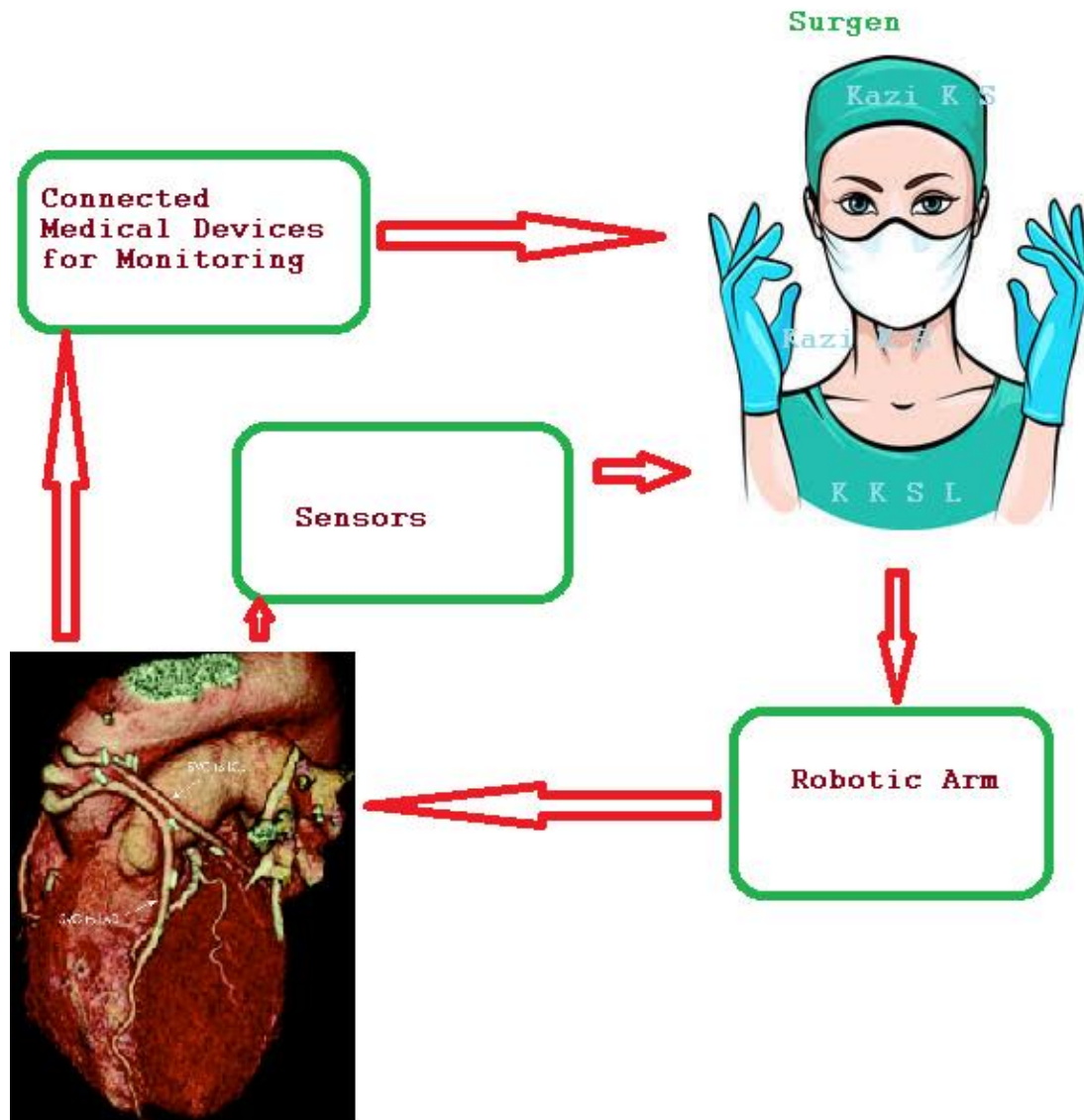


Figure 5- IoRT Surgery method

The use of IoRT in cardiac surgery is not without its challenges. One of the main concerns is the high cost of implementing and maintaining these advanced technologies. The cost of robotic

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systems and the need for specialized training for surgeons and medical staff can be a barrier to the widespread use of IoRT in cardiac surgery.

There are also concerns about the reliability and security of these interconnected devices. Any malfunction or hacking of these devices can have serious consequences for patients' health. Therefore, strict regulations and protocols must be in place to ensure the safety and security of patients' data and the devices themselves.

5. Conclusion-

A revolution in the area of medicine and an improvement in patient outcomes are both possible results that could be achieved with the utilization of Internet of Robotic Things in cardiac surgery. It is possible for IoRT to assist surgeons in performing complex procedures with increased accuracy and efficiency thanks to its cutting-edge technology, precision, and enhanced visualization capabilities. It is reasonable to anticipate that the field of cardiac surgery will undergo even further development as this technology continues to further development making it safer and more accessible for patients around the world. The Internet of Robotic Things has the potential to transform the field of cardiac surgery. With its ability to improve precision, reduce recovery time, and enhance patient outcomes, IoRT is a promising technology for the future of healthcare. However, it is essential to address the challenges and concerns associated with its use to ensure its safe and effective implementation. With further advancements and research, IoRT can revolutionize the way cardiac surgeries are performed, leading to better outcomes for patients worldwide.

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