A Qualitative Review on Intervention of Robotics in Medical Science

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ABSTRACT

Robots have entered into many aspects of human life, including medical science. The impact of robotics on medicine is undeniable. Robots can be defined as "automatically controlled multitask manipulators, which are freely programmable in three or more axes." The success of robots is based on their precision, lack of fatigue, and speed of action. Medical robotics is a promising field that really took off in the 1990s. Since then, a wide variety of medical applications have emerged: laboratory robots, surgical training, remote surgery, telemedicine and teleconsultation, rehabilitation and hospital robots. There are, however, many challenges in the widespread implementation of robotics in the medical field, mainly due to issues such as safety, precision, cost and reluctance to accept this technology. Medical robotics includes a number of devices used for surgery, medical training, rehabilitation therapy, prosthetics, and assistance to people with disabilities.
Robotic surgery has been successfully implemented in several hospitals around the globe and has received world wide acceptance. This paper provides an overview of the impact of robots in multiple medical domains, which is one of the most active areas for research and development of robots.

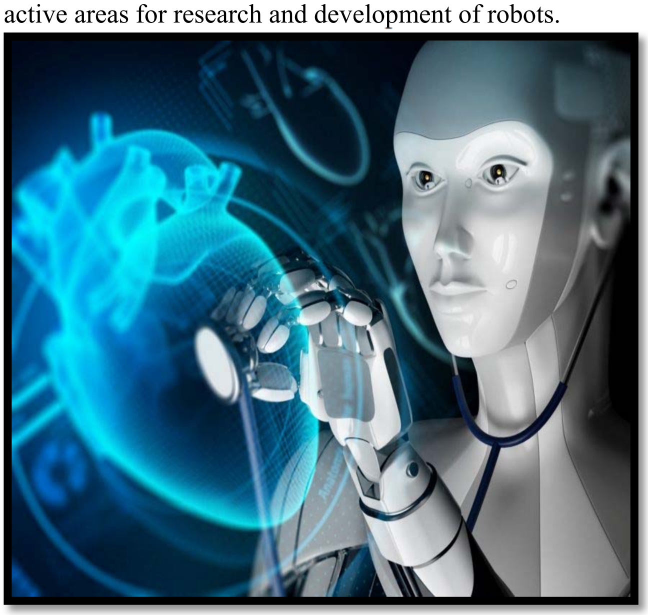

Figure 1

Keywords
Robotics in medicine , Robotic Surgery, Medical Robotics, Surgical Robots, Robots, AI in medicine, Cyber Knife , Steerable Catheters.

INTRODUCTION OF AI

Intelligence refers to the ability to learn and solve problems. Humans are intelligent creatures. We've been learning about the issues we face and developing solutions for them for centuries. AI solutions act like humans, think like humans, and make choices like humans.
These machines are capable of expanding their knowledge and make better decisions with their increasing awareness. If we use AI with robots, we can avail of the advantages of those machines as well, such as higher efficiency. Artificial intelligence (AI) has been defined by Alan Turing, the founding father of AI, as 'the science and engineering of making intelligent machines, especially intelligent computer programs'[1].
AI in health uses algorithms and software to approximate the cognition undertaken by human clinicians in the analysis of complex medical data. AI research has been divided into subfields, based on goals such as machine learning or deep learning, and tools such as neural networks, a subset of machine learning. AI has the potential to significantly transform the role of the doctor and revolutionize the practice of medicine, and it is important for all doctors, in particular those in positions of leadership within the health system, to anticipate the potential changes, forecast their impact and plan strategically for the medium to long term. The impact of automation and robotics has been felt by blue-collar jobs for a while.
There is a false sense of security in assuming that automation will only impact blue-collar type work that requires more manual, repetitive actions and less intellectual input. PwC released a report based on a survey of 2500 US consumers and business leaders, which predicts that AI will continue to make in-roads into white collar industries.[2] A large stock broking firm ran a trial in Europe of its new .
AI program this year that showed it was much more efficient than traditional methods of buying and selling shares.[3] A Japanese insurance firm replaced 34 employees with an AI system, which it believes will increase productivity by 30% and see a return on its investment in less than 2 years.[4] The Washington Post used an AI reporter to publish 850 articles in the past year.[5] Not even the jobs of computer programmers, the creators of the code for AI, are safe. Microsoft and Cambridge built an AI capable of writing code that would solve simple math problems.[6] Lawyers are not exempt either.
Late last year, an AI was able to predict the judicial decisions of the European Court of Human Rights with 79%

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accuracy.[7] Compared with other industries like hospitality or airlines, health has been a relative slow adopter of electronic systems, such as electronic health record (EHR) systems, which have only recently become mainstream.[8] Similarly, although AI is now embedded in many forms of technologies such as smart phones and software, its use in the frontline of clinical practice remains limited. Nevertheless, research in this area continues to grow exponentially.

INTRODUCTION OF ROBOTICS

Robotics is a field that has many exciting potential applications. It is also a field in which expectations of the public often do not match current realities. Truly incredible capabilities are being sought and demonstrated in research laboratories around the world.[9]. The word "robot" originated from a 1922 play called "Rossum's Universal Robots (R.U.R.)" by Karel Capek (Capek 2001). The play was about a future in which all workers are automatons, who then revolt when they acquire souls. This idea was further proved by the introduction of Maria, the first female robot on the silver screen, in Fritz Lang's silent science fiction movie 'Metropolis', which was released in 1927. A Few years later, in 1959, John McCarthy and Marvin Minsky established the Artificial Intelligence lab at the Massachusetts Institute of Technology (MIT). The first modern robotic hand was created by Heinrich Erst in 1961. The first industrial robot was invented in 1962 and named as 'Unimate'. General Motors used the robot to perform repetitive or dangerous tasks on its assembly line [10].

Robots were first introduced in medical industry in early 1980's. Based on the role of the robot, they can be classified as active, passive, synergistic, semiactive and intra corporal systems (Smith-Guerin et al.,2008). The active robots play significant role in medical industry than other classification due to their flexibility and adaptability. Robots in medical industry are used for various applications such as diagnosis, support actions during the surgeries and to perform complicated surgeries (Susilo et al., 2009; Zhao et al., 2015; Gomes, 2011; Hockstein et al., 2007). Robots have been introduced in orthopedics to help the patients to recover from physical disorders (Napper and Seaman, 1989; Xiong et al., 2009). Due to the reason that the medical tasks performed by robot are high accurate and thus leads to low human error[11].

AI IN TREATMENT

AI is transforming the practice of medicine. It's helping doctors diagnose patients more accurately, make predictions about patients' future health, and recommend better treatments. This Specialization will give you practical experience in applying machine learning to concrete problems in medicine.

Medical artificial intelligence (medical AI) mainly uses computer techniques to perform clinical diagnoses and suggest treatments. AI has the capability of detecting meaningful relationships in a dataset and has been widely used in many clinical situations to diagnose, treat, and predict the results. In the research and studies of medical AI, we primarily focus on the viability and feasibility to incorporate various computer AI techniques in medical information modeling and clinical procedure deployments. %e state-of-the-art AI methodologies have shown great capabilities and capacities in recognition of meaningful data patterns and thus been widely experimented as tools for clinical trials, especially, to aid the decision making in each phase for diagnoses and subsequent treatments, as well as prognoses and projections.[12]

Researchers found that soldiers are more likely to open up about post-traumatic stress when interviewed by a computer-generated automated virtual interviewer, and such virtual interviewers were found to be superior to human ones in obtaining more psychological symptoms from veterans.[13] What about robot surgeons? Robotic surgical devices already exist, but they still require human control—is AI able to perform autonomous surgery without human input?

In a robotic surgery breakthrough in 2016, a smart surgical robot stitched up a pig's small intestines completely on its own and was able to do a better job on the operation than human surgeons who were given the same task.[14]What is even more impressive is that late last year, a robot dentist in China was able to carry out the world's first successful autonomous implant surgery by fitting two new teeth into a woman's mouth without any human intervention.[15]

A recent working paper by the National Bureau of Economic Research found that the arrival of one new industrial robot in a local labor market coincides with an employment drop of 5.6 workers.[16] Last year alone, there have been news reports of apple-picking robots,[17] burger-flipping robots[18] and a barista robot that makes you coffee.[19]Nature even ran an editorial on sex robots.[20]

MEDICAL ROBOTICS

Robots are poised to revolutionize the practice of medicine. Artificial intelligence, miniaturization, and computer power are contributing to the rise in design and use of robots in medicine.

The field of medicine has also been invaded by robots. They are not there to replace doctors and nurses but to assist them in routine work with precision tasks. Medical robotics is a promising field that really took off in the 1990s. Since then, a wide variety of medical applications have emerged: laboratory robots, telesurgery, surgical training, remote surgery, telemedicine and tele consultation, rehabilitation, help for the deaf and the blind, and hospital robots. Medical robots assist in operations on heart-attack victims and make possible the millimeter-fine adjustment of prostheses. There are, however, many challenges in the widespread implementation of robotics in the medical field, mainly due to issues such as safety, precision, cost and reluctance to accept this technology. Medical robotics includes a number of devices used for surgery, medical training, rehabilitation therapy, prosthetics, and assistance to people with disabilities[21].

ROBOTIC APPLICATIONS IN MEDICINE TODAY:

1. **Telepresence** Physicians use robots to help them examine and treat patients in rural or remote locations, giving them a "telepresence" in the room. "Specialists can be on call, via the robot, to answer questions and guide therapy from remote locations," writes Dr. **Bernadette Keefe, a Chapel Hill, NC-based** healthcare and medicine consultant. **"**The key features of these robotic devices include navigation capability within the ER, and sophisticated cameras for the physical examination."
2. **Surgical Assistants** These remote-controlled robots assist surgeons with performing operations, typically minimally invasive procedures. "The ability to manipulate a highly sophisticated robotic arm by operating controls, seated at a workstation out of the operating room, is the hallmark of surgical robots," says Keefe. Additional applications for these surgical-assistant robots are continually being developed, as more advanced 3DHD technology gives surgeons the spatial references needed for highly complex surgery.
3. **Medical Transportation Robots** Supplies, medications, and meals are delivered to patients and staff by these robots, thereby optimizing communication between doctors, hospital staff members, and patients. "Most of these machines have highly dedicated capabilities for self-navigation throughout the facility," states Manoj Sahi, a research analyst with Tractica, a market intelligence firm that specializes in technology.
4. **Sanitation and Disinfection Robots** With the increase in antibiotic-resistant bacteria and outbreaks of deadly infections like Ebola, more healthcare facilities are using robots to clean and disinfect surfaces.
5. **Rehabilitation Robots** These play a crucial role in the recovery of people with disabilities, including improved mobility, strength, coordination, and quality of life. These robots can be programmed to adapt to the condition of each patient as they recover from strokes, traumatic brain or spinal cord injuries, or neurobehavioral or neuromuscular diseases such as multiple sclerosis.
6. **Robotic Prescription Dispensing Systems** The biggest advantages of robots are speed and accuracy, two features that are very important to pharmacies. [22]

NEUROLOGICAL

Brain surgery involves accessing a buried target surrounded by delicate tissue, a task that benefits from the ability for robots to make precise and accurate motions based on medical images [23, 24, 25]. Thus, the first published account investigating the use of a robot in human surgery was in 1985 for brain biopsy using a computed omography (CT) image and a stereotactic frame [26].Using the system, the surgeon specifies a target and trajectory on a pre-operative medical image, and the robot guides the instrument into position with sub millimeter accuracy [27]. Reported uses of the system include guiding needles for biopsy and guiding drills to make burr holes [28].

Renaissance (Mazor Robotics, the first generation system was named SpineAssist) has FDA clearance (2011) and CE mark for spinal surgery, and a CE mark for brain operations (2011) [29]. The device consists of a robot the size of a soda can that mounts directly onto the spine and provides tool guidance based on planning software for various procedures including deformity corrections, biopsies, minimally invasive surgeries, and electrode placement procedures. Renaissance includes an add-on for existing fluoroscopy C-arms that provides 3D images for intraoperative verification of implant placement. Studies show increased implant accuracy and provide evidence that the Renaissance/SpineAssist may allow significantly more implants to be placed percutaneously [30].

Neuro-robotics Systems (NRS), a combined study of neuroscience, robotics, and artificial intelligence, is interested in working on models and hardware that promote the fusion of neuroscience and robotics.

- NRS is current state-of-the-art research as branch of neuroscience within robotics
- NRS is a design approach mainly aimed at the fusion of neuroscience and robotics to develop advanced human centered robotic SW/HW.

The aim of the neuro-robotics TC (Technical Committee) is to provide an entity within the IEEE for neuro-robotics researchers, engineers and practitioners interested to promote neuro-robotics as a research domain[31].

The mission of NRS TC is to develop Brain-inspired control of rehabilitation robot system, medical healthcare robot system, prosthetic device system, assistive robot system, wearable robot system for personal cooperative assitance

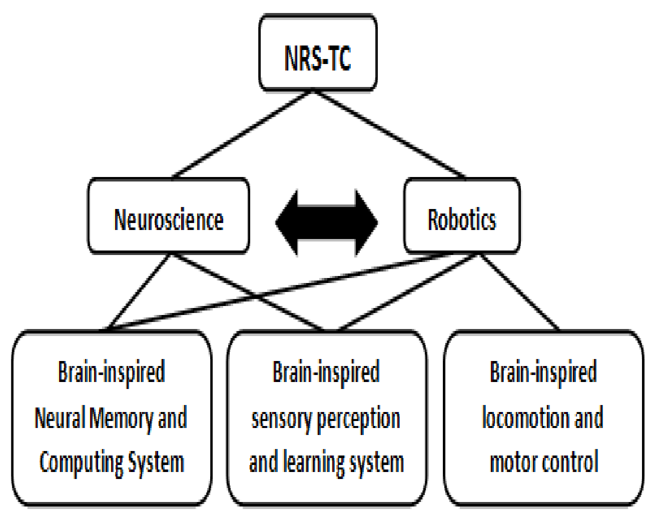

Figure 2 Neuro-robotics Systems 1

ROBOTIC NURSES

Nurses are miracle workers and the true life-blood of any medical setting. But they are also hopelessly overworked and chronically short on time, not to mention in short supply in many places. That's where robotic nurses come in.
Some new robotic nurses have taken aim at other menial tasks that nurses get stuck with, like moving carts and gurneys from room to room, or even drawing blood! At the end of the day, if it's saving nurses time and allowing everyone to take better care of patients.[56]

Figure 3

ROBOTIC-ASSISTED BIOPSY

This is a very cool and potentially life-saving advancement lead by a project called MURAB (MRI and Ultrasound Robotic Assisted Biopsy.)
It is a minimally invasive technique for early cancer diagnoses where a robotically steered transducer is guided to a biopsy site by a novel MRI/Ultrasound combination technique.
It then scans the target to get overall data on it and then a surgeon can pick from the 3D-image created exactly where they want to get a biopsy from[32].

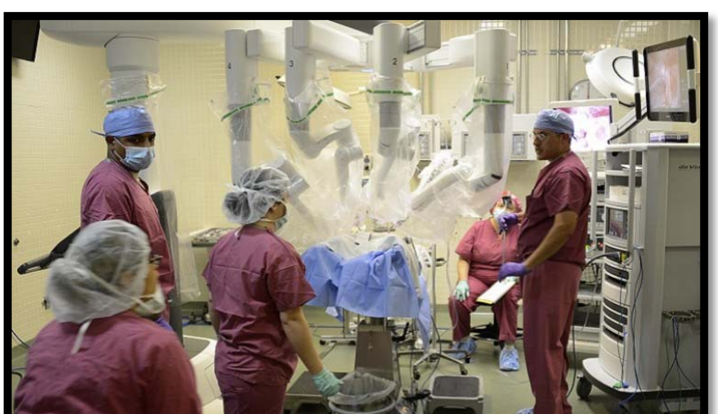

Figure 4

LAPAROSCOPIC SURGERY

Laparoscopic surgery, a group of minimally invasive surgery procedures, is improving the quality of life of patients. In the operating room, the laparoscope is maneuvered by a camera assistant according to verbal instructions from the surgeon. Laparoscopes with 3D high-definition have been commercialized. 3D vision can provide a sense of depth, which is expected while performing MIS. "Camera shake" may occur due to fatigue of the person holding the laparoscope/camera, which may cause the surgeon to lose orientation, especially when using 3D vision. Therefore, a laparoscope holder is an important and effective advancement for performing laparoscopic surgery.[33]
Laparoscope holders have been studied for many years, and some are commercially available. The AESOP (Automatic Endoscopic System for Optimal Positioning) robot was put into practical use in 1994 [34]. This is a SCARA-type robotic arm with four degrees of freedom (4 DOFs). Voice commands were added in the second version. Voice commands have the advantage that the operator's hands remain free throughout the operation. Naviot went into clinical use in 2002 [35]. Endoscope holder robots such as FreeHand [36], Viky [37], and SOLOASSIST [38] are now commercially available. We have launched the robotic holder EMARO from a start-up venture originating in universities [39] (Figure).
Figure

Figure 5 AESOP Robot

Figure 6 Endoscope holder robot (EMARO)

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Previously developed robotic holders use electrical motors. However, the EMARO uses pneumatic actuators instead. Pneumatic actuators have many safety advantages such as low heat generation, compressibility, the ability to control the maximum force by regulating the supply pressure, ease of releasing the acting force by discharging the compressed air in the actuator, and the ability to develop a robotic arm that is both compact and lightweight.

EMARO has 4 DOFs in total, consisting of 3 rotational DOFs around the insertion point of the trocar cannula and 1 translational DOF along the insertion direction.

The movable range of pitch is from − 3° to 47°, where 0° is defined as the point where the laparoscope becomes horizontal. The movable range of yaw angle is ±90° and zoom-in and zoom-out is ±100 mm. EMARO controls the endoscope by sensing the vertical and horizontal movements of the surgeon's head, through a gyroscope that is worn on the forehead (Fig). The movement in the up/down and left/right directions are controlled by movement of the head while pushing the left foot pedal (1 of 3). The zoom in and out operations are performed by pushing the right and middle foot pedals, respectively. Five motion speeds can be selected. The effectiveness of the holder has been demonstrated in some hospitals in Japan.

Fig.

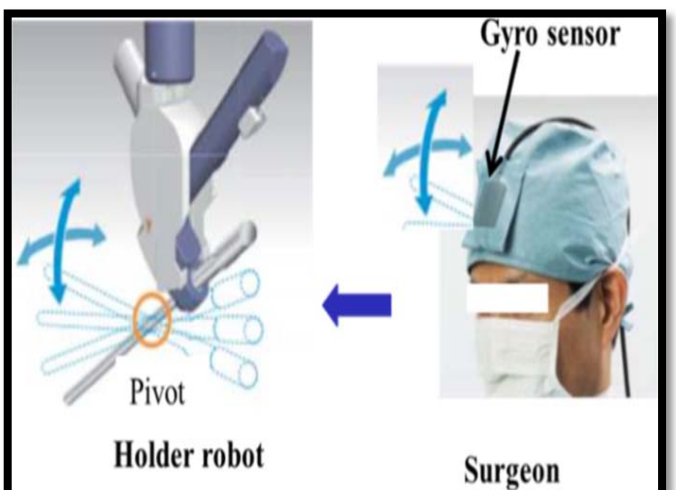

Figure 7

THE CYBER KNIFE

CyberKnife is a radio surgery system composed of a linear accelerator mounted on a robotic arm coupled with an X-ray imaging device that is capable of delivering high-precision radiotherapy. The robotic arm allows a wide array of noncoplanar beam angles that can produce a highly conformal dose distribution.

The submillimeter accuracy of CyberKnife ushered in widespread use of frameless radio surgery, facilitating both multi-fractionation schedules and the treatment of extracranial lesions. [40]

It uses real-time image guidance and a robot to deliver dose from thousands of beam angles, setting a new standard for delivery precision anywhere in the body and enabling stereotactic radiosurgery (SRS) and stereotactic body radiation therapy (SBRT) treatments for the full range of indications. The robot moves and bends around the patient, approaching the tumor from thousands of unique angles, significantly expanding the possible positions to concentrate radiation to the tumor while minimizing dose to surrounding healthy tissue.[41]

CyberKnife has successfully been used in the treatment of tumors in the brain, spine, thorax, liver, prostate, kidney, and pancreas as well as other body sites with excellent results.

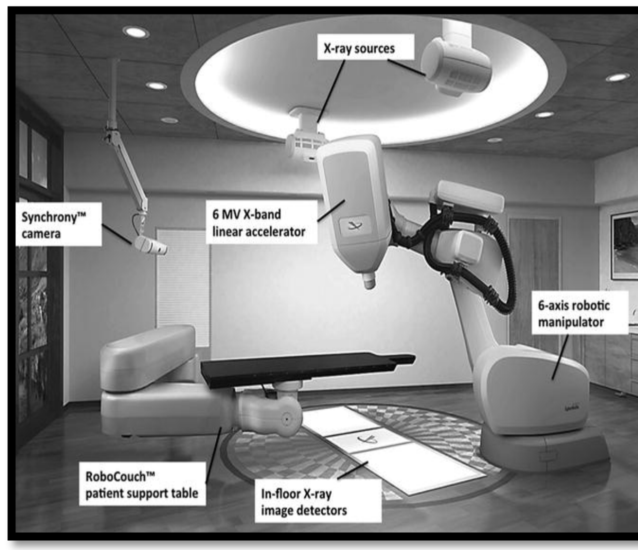

Figure 8

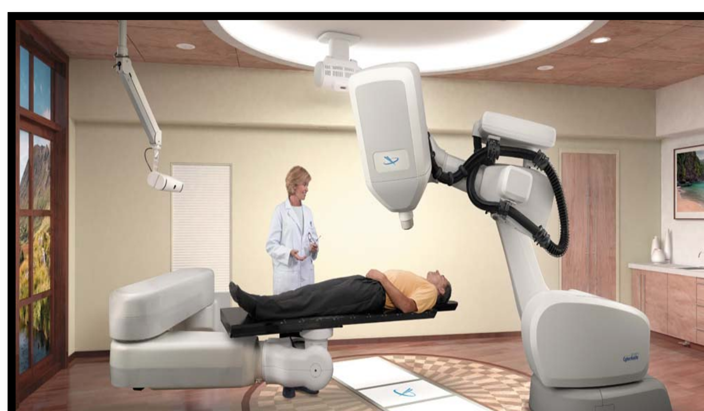

Figure 9 Cyber Knife treatment

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ORTHOPEDICS

The expected benefit of robot assistance in orthopedics is accurate and precise bone resection [42, 43]. Through good bone resection, robotic systems (Figure) can improve alignment of implant with bone and increase the contact area between implant and bone, both of which may improve functional outcomes and implant longevity [44]. Orthopedic robots have so far targeted the hip and knee for replacements or resurfacing . Initial systems required the bones to be fixed in place, and all systems use bone screws or pins to localize the surgical site. The initial robot assistance for orthopedics came via Robodoc (Curexo Technology Corp, originally by Integrated Surgical Systems), first used in 1992 for total hip replacement [44, 45]. Robodoc has received a CE mark (1996), and FDA clearance for total hip replacement (1998) and total knee replacement (2009) [46]. The robot is used in conjunction with OrthoDoc, a surgical planner, with which the surgeon plans bone milling is based on preoperative CT. During the procedure, the patient's leg is clamped to the robot's pedestal, and a second clamp locates the femoral head to automatically halt the robot if the leg moves. The Robodoc then performs the milling automatically based on the surgical plan. Many initial attempts in surgical robotics involved such autonomous motions, which generated concerns about patient and doctor safety. To address those concerns, Robodoc has force sensing on all axes, as well as a six-axis force sensor at the wrist [47].

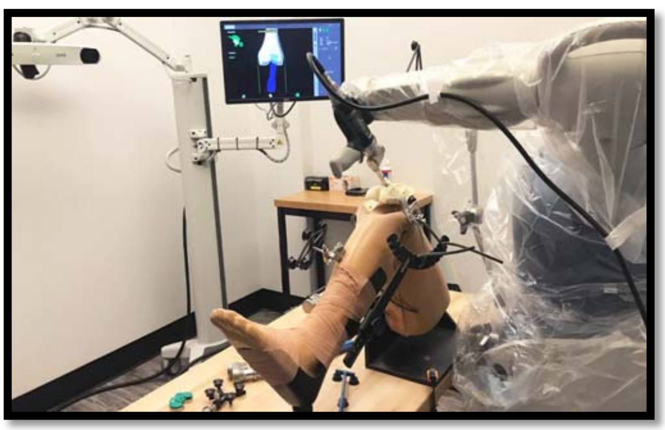

Figure 10

ASSISTIVE AND REHABILITATION SYSTEMS

Assistive robotic systems are designed to allow people with disabilities more autonomy, and they cover a wide range of everyday tasks. In 1992, Handy 1 (Rehab Robotics, Ltd.) became the first commercial assistive robot [48]; it interacts with different trays for tasks such as eating, shaving, and painting, and it is controlled by a single switch input to select the desired action. One task-specific system is the Neater Eater (Neater Solutions Ltd.), a modular device that scoops food from a plate to a person's mouth, and can be controlled manually or via head or foot switches.

More general systems rely on arms with many degrees of freedom, such as Exact Dynamics' iARM, a robotic arm with a two-fingered grasper, that attaches to electric wheelchairs and can be controlled via keypad, joystick, or single button. Rehabilitation systems can be similar to assistive systems, but are designed to facilitate recovery by delivering therapy and measuring the patient's progress, often following a stroke [49]. The Mobility System (Myomo, Inc.) is a wearable robotic device that moves the patient's arm in response to his/her muscle signals, thus creating feedback to facilitate muscle reeducation[50].

Figure 11 Robotic Rehabilitation

STEERABLE CATHETERS

Vascular catheterization is used to diagnose and treat various cardiac and vasculature diseases, including direct pressure measurements, biopsy, ablation for atrial fibrillation, and angioplasty for obstructed blood vessels [51–53]. The catheter is inserted into a blood vessel and the portion external to the patient is manipulated to move the catheter tip to the surgical site, while fluoroscopy provides image guidance. Due to the supporting tissue, catheters only require three degrees of freedom, typically: tip flexion, tip rotation, and insertion depth. Possible benefits of robot-steered catheters are shorter procedures, reduced forces exerted on the vasculature by the catheter tip, increased accuracy in catheter positioning, and teleoperation (reducing exposure of the physician to radiation) [54].

The Niobe (Stereotaxis, CE mark 2008, FDA clearance 2009) is a remote magnetic navigation system, in which a magnetic field is used to guide the catheter tip [55]. The magnetic field is generated by two permanent magnets contained in housings on either side of a fluoroscopy table . The surgeon manipulates a joystick to specify the desired orientation of the catheter tip, causing the orientations of the magnets to vary under computer-control, and thereby controlling the magnetic field. A second joystick controls advancement/retraction of the catheter. Chun et al. report significant improvements in

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surgical outcomes due to advances in the design of magnetically guided catheters [56].

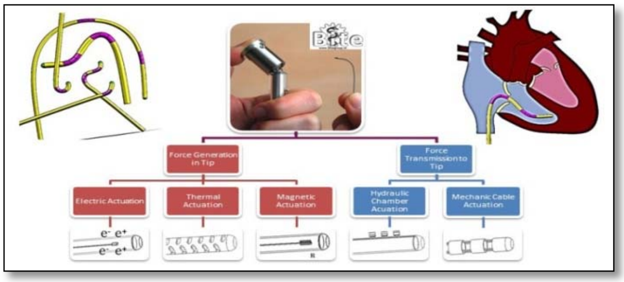

Figure 12

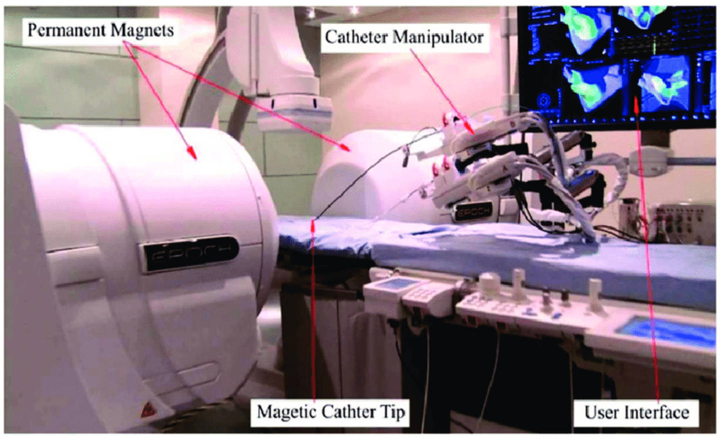

Figure 13 Niobe magnetic navigation system 1

ENDOSCOPIC

An endoscopy is a procedure where organs inside your body are looked at using an instrument called an endoscope. An endoscope is a long, thin, flexible tube that has a light and camera at one end.

Conventionally, the endoscope is controlled by the surgeon or nurse. With the surgeon at the control, s/he is forced to switch at least one hand between the endoscope and a tool.

Robotic systems provide the advantage for freeing up staff and reducing the surgeon's workload. Two endoscope systems are examined here: Freehand 1.2 (Freehand Ltd., UK) and ViKY (EndoControl, France). Both systems offer a robotised endoscope, which can be controlled through an HMI (Human machine interface). Freehand 1.2 comes with a robot arm holding the endoscope mounted on a moveable cart.

The surgeon activates the control of the endoscope by a foot pedal. A marker placed on the surgeon's head then allows the system to register head movements and to translate those into the corresponding camera motions [57]. The ViKY, on the other hand is directly placed on the port for MIS (Minimally Invasive Surgery). This offers a minimal footprint of the system within the OR [58]. To accompany different needs in the various surgical interventions, the systems comes in two different sizes [58, 59].

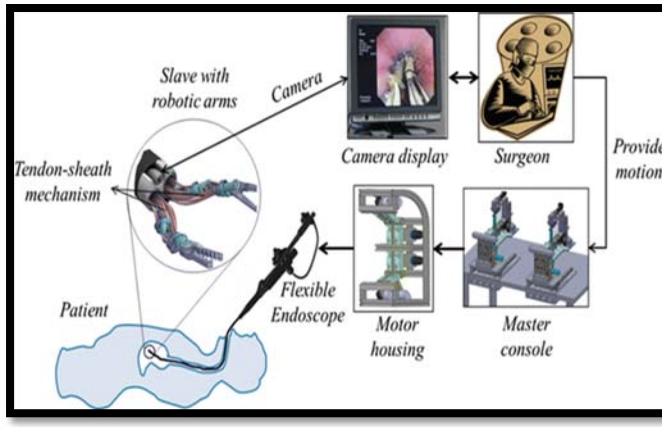

Figure 14 **Robotic Endoscopy System 1**

Figure 15 ViKY Endoscope positioning system

ROBOTS TO FIGHT WITH CORONAVIRUS

From the first detailed outbreak of (COVID-19) in China to the spread of it over the globe, Medtech organizations are turning out robots and drones to help battle it and offer types of services and care to those isolated or practicing social distancing. This pandemic has optimized the "testing" of robots and drones in broad daylight as authorities search out the most catalyst and safe approach to think about the outbreak and limit contamination and spread of the virus.

UVD Robots, a Danish organization formed from Odense University Hospital and Blue Ocean Robotics, has been at the front line of giving disinfection robots to China to help battle the spread of the virus. The organization consented to an arrangement with Sunray Healthcare Supply in February and has since shipped a considerable lot of its self-driving robots that disinfect hospitals and different areas with ultraviolet light.

The organization said this confines the spread of corona viruses without exposing medical clinic staff to the risk of contamination.

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Robots are likewise ending up being important while delivering fundamental things to individuals who shop and buy online and are isolated at home.
Inside the hospitals, robots can be deployed for disinfection, medicine and food delivery, vital signs monitoring, thus helping to significantly reduce the infection risk of all personnel.

Figure 16

Figure 17 Blue Ocean Robotics UVD Robots - OR Today 1

Medical Robotic Systems Market: By Application Estimates & Trends Analysis

The global market for medical robotics was valued at USD 4,029.45 million in 2018 and is expected to grow at a CAGR of 19.1% over the 2025. [60]

We have estimated the overall medical robotic systems market by segmenting it on three levels, product, application, and geography.

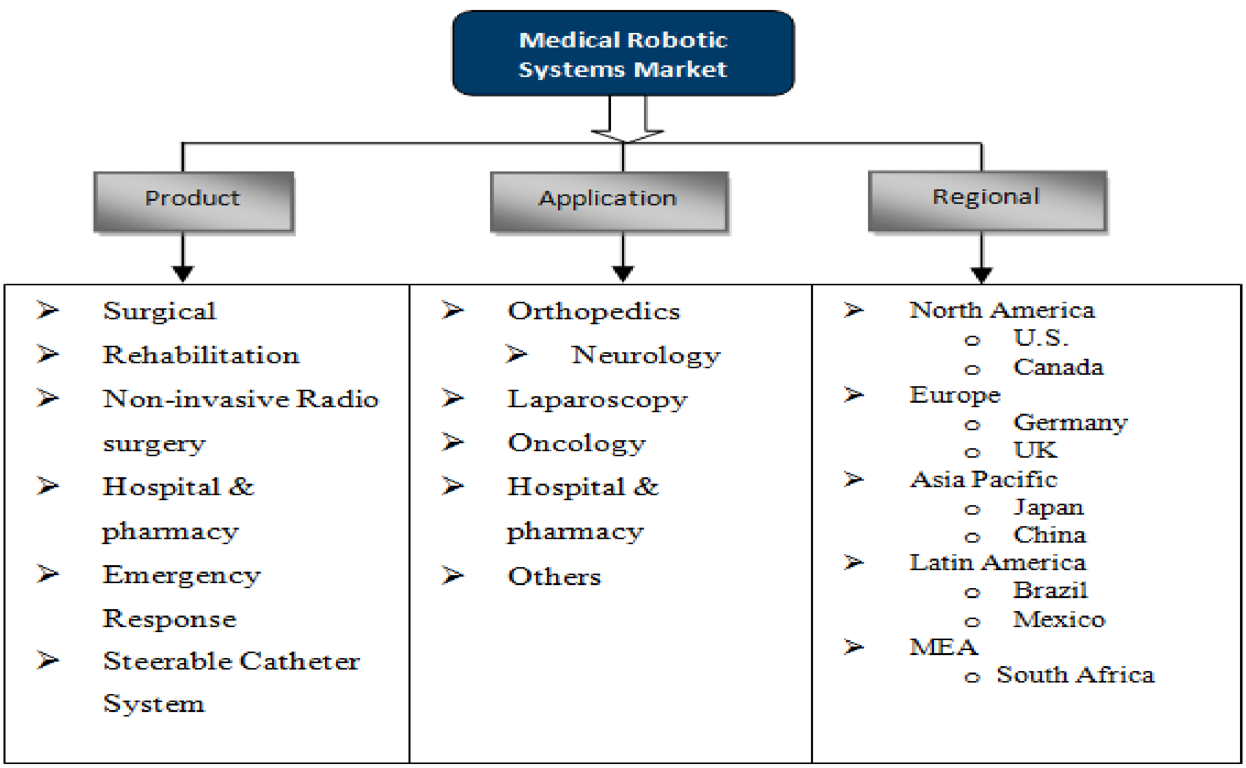

Figure 18 Medical Robotic Systems Market

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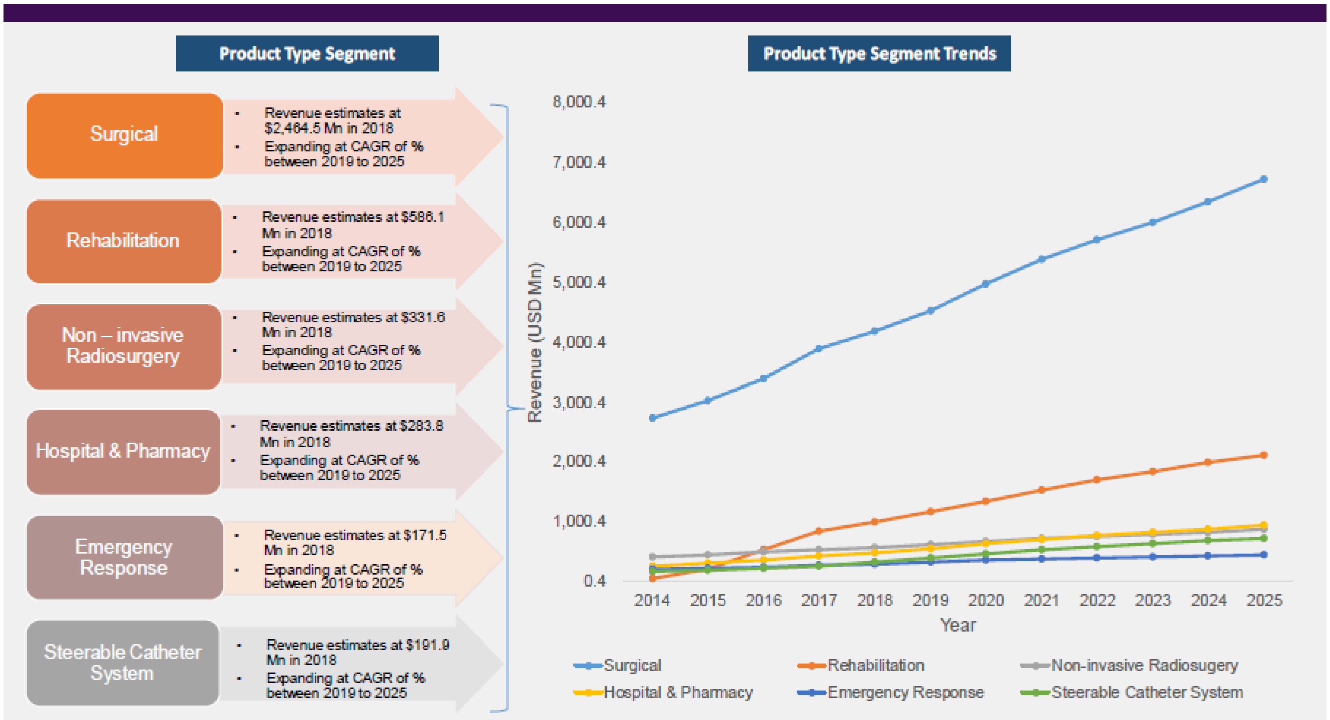
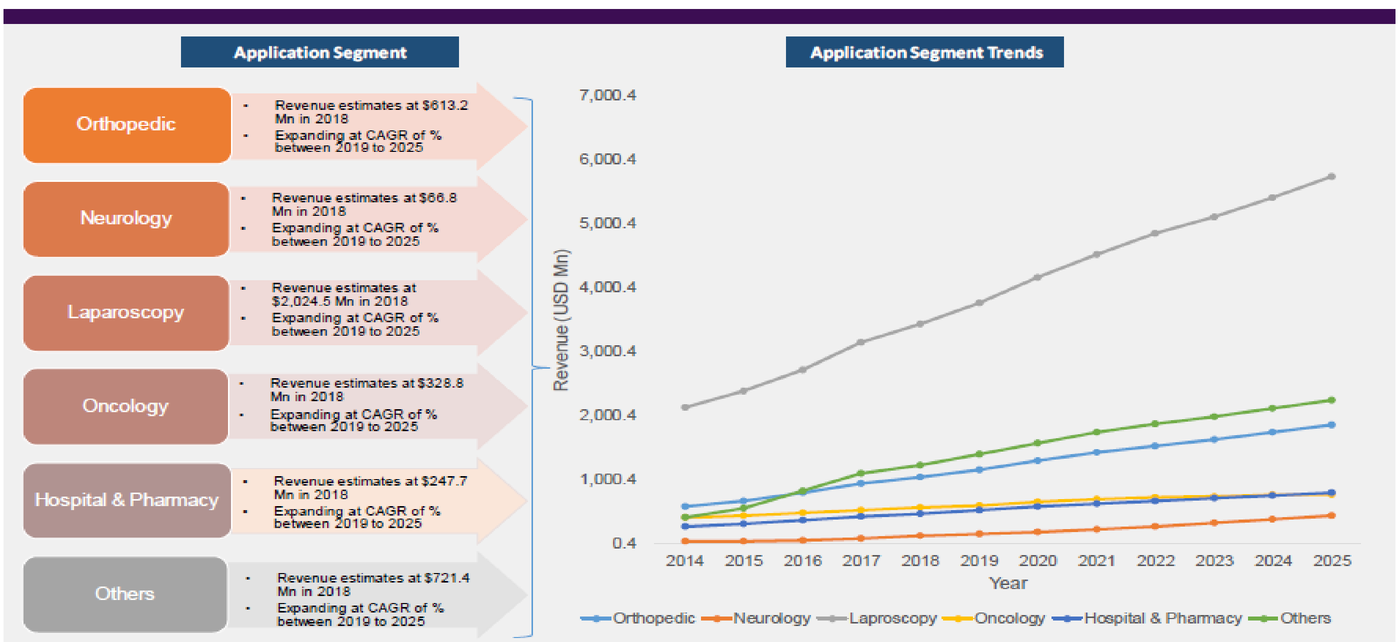
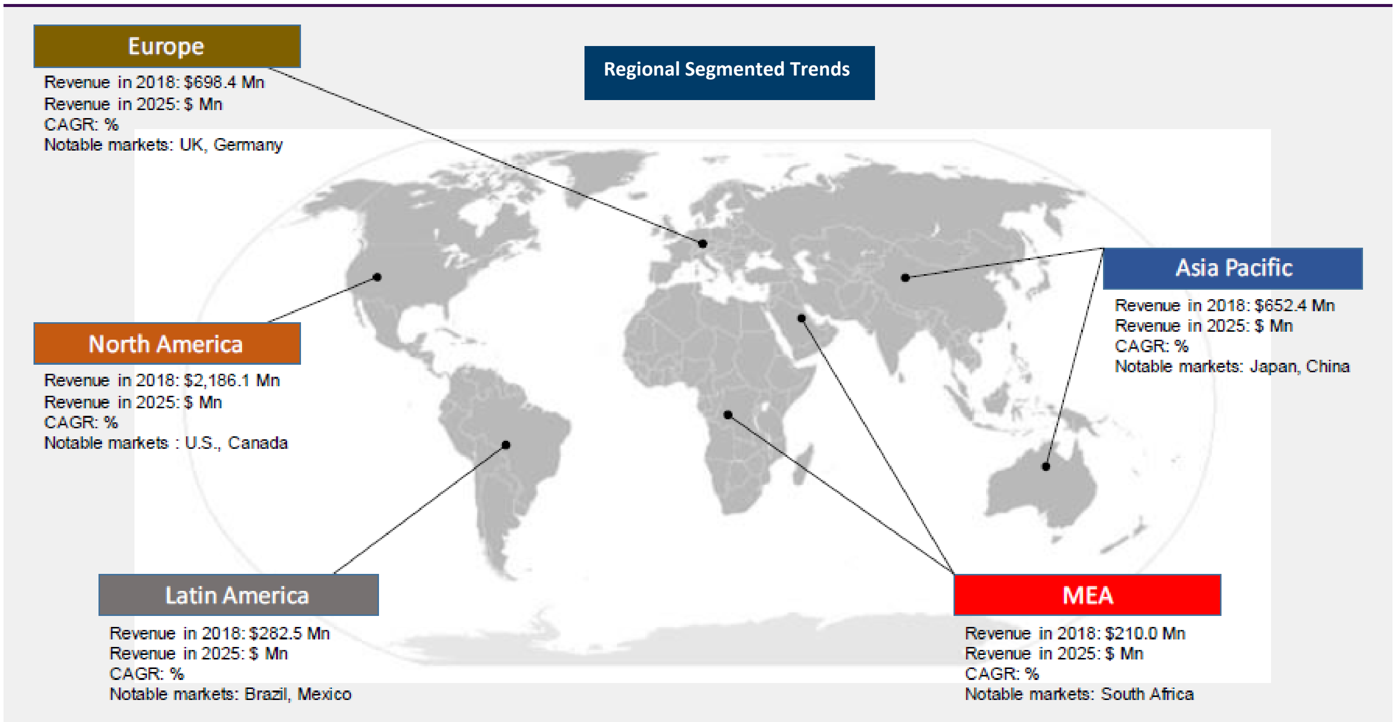


Source: Industry Journals, Annual Reports, Investor Presentations, Primary Interviews, Grand View Research



Source: Industry Journals, Annual Reports, Investor Presentations, Primary Interviews, Grand View Research



Source: WHO, U.S. CDC, FDA, NIH Journals, Investor Presentations, Primary Interviews, Grand View Research Analysis

DISCUSSION

Advancements in medical technology are creating a world where robots may play a bigger part in healing the sick than doctors.

After studying on robotics in health care we can classify robots as-

1.Active Robots : These types of robots are completely actuated where interaction between the robot and the surgeon is very minimal.

2.Passive Robots: The information about the position of the tool relative to the pre-planned data is displayed to the surgeon.

3.Tele operated robots: Tele operated robots are usually helpful in situations where there is a necessity to manipulate objects from a distance, e.g., underwater applications, surgical robots, atomic/nuclear centers etc.

Some of the most popular robots in medical industry are:

- daVinci
- Endoscopy-Bot
- Orthoses (AKA Exoskeletons)
- Disinfectant bots
- Telepresence Robot Surrogates
- Robotic nurses
- AI diagnostics
- Robotic-Assisted Biopsy
- Antibacterial nanorobots

FUTURE MODEL

Advanced robots continue to be designed for an ever-expanding range of applications in the healthcare space. For example research team is developing a compact, high-precision surgical robot that will operate within the bore of an MRI scanner, as well as the electronic control systems and software that go with it, to improve prostate biopsy accuracy.

Robots of all types will continue to evolve to complete tasks autonomously, efficiently, and accurately.

Intel is working in collaboration with technology providers and researchers to explore the next generation of robotics solutions. For example, Intel Labs China is partnering with the Suzhou Collaborative Innovation Medical Robot Research Institute to establish a medical robotics incubator for startups. Providing technology and research support, Intel is aiding the discovery of new applications for AI and IoT technologies within the field of medical robotics.

Hopefully there will be more and more robotic instruments to help surgeons in the future, as well as tools used in diagnosis and so on. Many prototypes of robotics arms are being developed to help surgeons in many task, and even to allow tele-operation.

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AI components in imaging machines would reduce this workload and drive greater efficiency in the radiology field as they have access to greater number of data .

CONCLUSION

Over the last three decades of development in the area of computer-assisted medicine and robotic surgery, many new technologies emerged. This paper introduces developments and future directions of robots in multiple medical domain.

Robots in medicine are ideal for relieving medical personnel from tedious routine tasks, allowing them to make time to attend to more imperative responsibilities around the healthcare facility. With time, robots will make medical procedures safer and more affordable.

Robots can help older adults and chronically ill patients to remain independent, reducing the need for careers and the demand for care homes. They may also serve as attendant to patients who have a few or no visitors by entertaining them.

Robots can be extremely helpful in continuous monitoring of patient and data collection for emergency cases like heart failure and diabetes and then pass on such data to a human nurse or doctor for action to be taken. Robots neither get nor transfer the diseases.

This paper tries to accumulate some knowledge and information in concern to the advancement in the robotic technology. It covers major industries and scientific area to give a brief idea in the latest happenings of the research. This paper is a glance over robotics for new researchers, they can extend their research with various scientific area.

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