

# APPLICATIONS OF MEDICAL ROBOTICS IN COMPUTER INTEGRATED SURGERY

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**ABSTRACT** – The analysis provides a review of medical mechanism history and surveys the capabilities of current medical mechanism systems, in the main that specialize in commercially obtainable systems whereas converge a couple of distinguished analysis comes. By examining robotic systems across time and disciplines, trends square measure visible that imply future capabilities of medical robots, for instance, augmented usage of intraoperative pictures, improved mechanism arm style, and viscous feedback to guide the sawbones. Like all mechanism systems, medical robots essentially mix data to physical action to considerably enhance human's ability to perform necessary task during this case surgical interventions, analysis, or just serving to incapacitated folks in daily living tasks. analysis space includes modeling and analysis of anatomy and task setting, interface technology between the "data world" and also the physical world. though the most focus are going to be on AI systems for surgery, it'll additionally discuss the link of those analysis areas to treatment and help robots. Finally it'll embrace some thoughts on the factors driving the acceptance of medical AI and of however analysis will be most effectively organized.

**Keywords:** Computer-integrated surgery, Analysis of Robotics, Assistive Robotics, Prosthetics, Orthotics, Surgical Robotics, Machinery, Applications.

## I. INTRODUCTION

Medical robotic systems are cyber physical systems that are wont to arrange and perform medical interventions with high accuracy and repeatability to permit access to places and scales that don't seem to be accessible with manual instruments and traditional techniques, or to perform surgery with the utilization of huge amounts of quantitative data. These systems will improve patient health and scale back prices by guaranteeing care and accuracy, thereby decreasing time within the surgery, rushing patient recovery time and minimizing aspect effects.

An advanced medical robotic system is sort of advanced, with reference to each its mechanical device style and therefore the code that gives its user-interface, coordinates its activities, and controls the

system's actuators. This complexness will increase the chance of risky accidents because of hardware and code malfunctions, human-machine interface issues.

## II. COMPUTER INTEGRATED SURGERY

Computer Integrated Surgery (CIS) can have three phases which are given below

### A. First Phase

A surgical set up is developed from a patient-specific model generated from surgical pictures associated prior data concerning human structure contained in an info coming up with is extremely application-dependent since the surgical actions area unit greatly totally different. In some cases, it should be straightforward interactive simulations or the choice of some key target positions, like play acting a tumor diagnostic assay in surgery. In alternative cases, like in craniofacial surgery, coming up with will need refined optimizations incorporating tissue characteristics, biomechanics, or alternative data contained in the atlas and custom-made the patient-specific model.

### B. Second Phase

The images, patient-specific model, and set up info area unit brought into the operating theatre and registered to the patient, supported info from a range of sensors, like a special following system and/or intraoperative imaging device. In some cases, the model and set up could be additional updated, based mostly on the pictures. the pc then uses a range of interface devices to help the doctor in capital punishment the surgical set up. counting on what's most acceptable for the appliance these interfaces could embody active devices like robots, "smart" hand tools and knowledge displays. As the surgery income, further pictures or different measurements could be taken to access progress and give feedback for dominant tools and treatment delivery. Supported this feedback, the patient model is also updated throughout the procedure. This updated model is also accustomed refine or update the surgical arrange to make sure that the required goals area unit met. Ideally, intra-operative imaging and different feedback will make sure that the technical goals of the surgical

intervention are achieved before the patient leaves the operating theatre. Further, the pc will establish and record a whole record of relevant info regarding the procedure while not vital further value or overhead.

### C. Third Phase

The pre-operative and intra-operative info are combined with further pictures and tests, each to verify the technical results of the procedure and to assess the longer-term clinical results for the patient. Further, the results of the many procedures is also registered back to Associate in Nursing anatomical atlas to facilitate applied mathematics studies relating surgical technique to clinical outcomes.

## III. ANALYSIS OF ROBOTICS

The most in depth use of robotic technology for medical applications has been in analysis of AI that historically includes helpful robots, medicine, orthotics, and therapeutic robots. Helpful robots give bigger independence to folks with disabilities by serving to them perform activities of daily living as an example, mechanism manipulators will assist people World Health Organization have impaired arm or hand perform with basic tasks like uptake and drinking, or with line of work tasks like gap a filecabinet. Helpful AI additionally includes quality aides like wheelchairs and walkers with intelligent navigation and management systems, for people with impaired lower-limb perform. Robotic medicine and orthotics are developed to exchange lost arms, hands, and legs and to supply help to weak or impaired limbs. Healing robots square measure valuable tools for delivering neuron-rehabilitation to the limbs of people with disabilities following stroke.

## IV ASSISTIVE ROBOTICS

### A. Mobility support devices

Robotic technology is accustomed equip quality a day like wheelchairs and walkers with intelligent navigation and management system. Such quality day and ordinarily utilized by the senior and other people with impaired lower limb operate or impaired vision.

### B. Occupational support devices

Recent studies have shown that robotic technology will greatly profit motion impaired people throughout the performance of business tasks. In one study, folks with manipulation disabilities used a robotic digital computer to perform manipulation tasks that they'd are unable to perform otherwise. In another

study, impaired people used a force-reflecting spirit internal organ interface to regulate a mechanism manipulator and to perform activity tasks employed in deftness tests. The result showed that the help provide by the force feedback device improved task employed organ interface to regulate a mechanism manipulator and performance and reduced task completion time. These show that robotic technology has the potential to produce folks with disabilities with abundant bigger access to activity opportunities.

## V. PROSTHETICS

A Prosthetic could be a robot that substitutes for missing a part of the body. These devices square measure usually accustomed give quality or handling talents once a limb is lost. This commercially obtainable arm is controlled exploitation feedback from diagnostic technique (EMG) sensors that live the response of a muscle to nervous stimulation (electrical activity inside muscle fibers). Motion management, Inc. additionally makes a two-fingered prosthetic hand that's controlled exploitation my electrical signals from the remains limb. Robotic medical specialty may also be accustomed replace lower limbs..

One difficult space of medicine analysis is deciding the supposed action of the human so the restorative is properly controlled. University Medical Centre have developed a system that uses established electrodes to live the brain signals in associate degree bird of Minerva monkey and permits the monkey to regulate a mechanism arm to achieve for a chunk of food. The analysis could eventually result in brain-machine interfaces which chunk of food. will management prosthetic limbs.

## VI. ORTHOTICS

An orthotic may be a mechanism won't to assist weak or ineffective joint, muscle, or limb. Several orthotics utilize robotic technology, and that they typically take the shape of an exoskeleton a powered human like suit that's worn by the patients. Exoskeletons have links and joints that correspond to those of the human and actuators that assist the patient with moving his or her limb or lifting external masses

## VII. SURGICAL ROBOTICS

In the last decade, surgery and AI have reached maturity that has allowed them to be safely assimilated to make a replacement quite operating theater. This new atmosphere includes robots for native surgery and telesurgery, audio-visual telecommunication for telemedicine and teleconsultation, robotic systems with integrated imaging for computer-enhanced surgery, and video game (VR) simulators increased with internal organ feedback, for surgical coaching. per Stave, "the operating theater of the longer term are an

advanced mixture of stereophonic system imaging systems, microdots, robotic manipulators, video game workstations, and laptop integrated surgery.

The recent evolution of surgical AI is that the results of profound analysis within the field of AI and robotics over the past four decades. The combined system permits the human to produce high-level strategic thinking and deciding where as permitting the automation to deliver the particular toll / issue interaction, mistreatment its high exactness and accuracy. and deciding whereas permitting the automaton to deliver the particular tool/tissue interaction, mistreatment its high exactness and robots have emerged within the field of surgery and different fields of medicine nearly naturally.

Surgical robots will be categorized into three categories: i)—semi-autonomous systems; class ii)—guided systems; and sophistication iii)—teleportation systems. Special robotic arms are designed in one or a lot of of those classes to satisfy the necessities of varied surgical specialties, as well as medicine, orthopedic, urological, external body part, ophthalmological, cardiac, and general surgery. every discipline in surgery encompasses a special set of necessities, settled by the body part and therefore the surgery, that necessitate special style and configuration of the robotic system.

## VIII. MACHINERY

### A. Modeling And Analysis

As medical robotics evolves, computational modeling and analysis will become more and more important. There is a robust and diverse research topics and techniques. A related challenge is modeling the tasks themselves and the environment in which the tasks are performed- whether the operating room, intensive care facility, clinic, or home. Some Common things include:

- Medical image segmentation and image fusion to construct and update patient-specific atomic models;
- Biomechanical modeling for analyzing and predicting tissue surgical planning, control, and rehabilitation;
- Optimization methods for treatment planning and interactive control of system;
- Real-time data fusion for such purposes as updating models from intraoperative images;

### B. Crossing point Technology

Crossing point Technology including robots & sensors, connecting the “virtual reality” of computer

models and surgical plans to the “actual reality” of the operating room, patients, and surgeons :

#### 1. Focused Mechanism Design

Medical robots frequently employed conventional industrial manipulators, usually with modifications for safety. Although this approach had many advantages and is still frequently taken for laboratory use or rapid prototyping, surgery and rehabilitation applications impose special requirements for workspace, compactness and work environment.

#### 2. Teleportation and Concrete Control

Many surgical robots are teleported. Two potential drawbacks of this approach are that more equipment is needed and the surgeon is often somewhat removed. These systems provide very high stiffness and precision and eliminate physiological tremor while still permitting the surgeon to exploit his natural kinaesthetic sense and eye-hand coordination.

#### 3. Human-Machine Supportive System

The medium is that the suggests that through that the operating surgeon sees, interacts, and communicates with the patient. it's going to embody normal surgical instruments, associate degree scrutiny camera system, laparoscopic instruments, a robotic surgery system, and varied different technologies. The operating surgeon console includes a group of handles, a vision system, and in some cases voice command parts. The robotic system interacting with the patient includes a minimum of 3 robotic arms: 2 to control the surgical instruments and a third to manage scrutiny camera. The operating surgeon controls the position of the golem arms by manipulating the 2 handles at the console. The scrutiny camera arm is controlled by voice commands from the operating surgeon, and therefore the read is transmitted back to the surgeon console.

#### C. Structure Science

System science to develop improved techniques for ensuring the safety and reliability of systems, for characterizing expected performance in the presence of uncertainty, for analysis of how subsystems and components will interact, and for system performance validation.

## IX. APPLICATIONS

### A. Preparation

Robotic mannequins are developed for simulated medical steering. It's many computer controlled mechanical device options, as well as eyes that open and shut, arms that move, arms and legs that swell, and lungs embedded within the chest that breathe suddenly.

### B. Tele-ethnography

A French association has developed a telerobotic anthropology system consisting of a slave automaton, with a true search as its end-effectors, and a master interface with a sensible search. This method transmits motion and force data directionally, permitting associate knowledgeable interacting with the master interface to perform associate examination at a foreign location, victimization the slave automation.

### C. Robots for Particular Learning

These robots mix treatment, education, and recreation and may be controlled victimization body movements, voice commands, or associate in Nursing interactive management station

### D. Robots for the hard of hearing and Blind

Dexter, a robotic hand communication aid for those that square measure each deaf and blind, uses finger orthography to speak data written on a keyboard, keep during a laptop, or received from a special phone phone.

## ISSUES IN MEDICAL ROBOTICS

### A. Patient activity in the Operating Room

Image-guided surgery requires good markers used as references, as it is based on the principle that the real-world setup does not change unpredictably over time; therefore the registration to the pre-operative image space remains valid. IGS is sensitive to spatial changes, when the patient is unintentionally moved relative to the marker that tracks their motion. The event of external patient motion occurs when the body's position moves relative to the base frame of the device executing the surgical plan. (Physiological tissue motion is not addressed here, as its tracking requires different techniques and methods.) The fundamental problem with patient motion is that without proper identification and recompense, the whole surgical plan may become out of date, and the treatment potentially harmful. From the clinical point of view, a few millimeters of error could be tolerated at the most.

Depending on the speed of the tool, this translates to a maximum of a second of latency.

### B. Insufficient modeling of system error propagation

Surgical procedures and integrated medical devices relying on patient-imaging should provide a clear indication of the system's error at the Point of Interest (POI) and the expectable distribution of it (point spread function). Widely accepted metrics should be applied to make systems comparable. Deterministic spatial accuracy analysis of image registration and surgical robot systems was performed by many research groups

### C. Difficulty of telesurgery over huge distances

Space application of telerobotic surgery has been a major focus of the research community since the early days of the field. While advanced internet-based communication theoretically enables terrestrial telesurgery, serious technological problems arise in the case of long-distance operations or space exploration missions. These days, it seems inevitable to have a flight surgeon on board of a spacecraft for long duration missions, as robots do not have enough autonomy to adapt to unpredictable events. A realistic teleportation system suffers from communication delays between the masters (controller) and slave side (effectors system). Unless the process is significantly slower than the latency, the control lag time can cause the deterioration of control quality, and instability can occur due to unwanted power generation in the communications. Time-varying delay poses further difficulties to classical PID controllers, while model predictive control is extremely hard to apply due to the human operator's complex behavior. Scalable empirical methods, such as Kessler's Extended Symmetrical Optimum (ESO) method could provide better solution to these problems

## X. CONCLUSION

Robotic technology has effectively made expensive tools for analysis, surgery, and medical coaching, in addition as new and improved medicine and helpful. A art movement replica of a number of the subsystems that may be intrinsic into the operating theatre of the long run, together with a standard table, surgical robotic arms, atolls changer, associate instrumentality dispenser, associated an imaging device for individuals with disabilities. Future applications of robotic technology can still offer advances in these and alternative areas of drugs. the foremost vital role of medical robots can possibly be to perform tasks that area unit otherwise not possible, like change new surgical process procedures by providing high-dexterity access to tiny anatomical structures, integration imaging modalities into the or, providing purposeful replacements for lost limbs, and sanctioning new human-machine

interfaces and techniques for delivering neuron-rehabilitation medical care.

The approaches for AI for biological and medical applications, particularly for the previous, square measure organic process, not revolutionary. Still there square measure several opportunities for collaboration between engineers and biologists, and between engineers and doctors. it's believed that any new breakthrough in biology and in drugs may have innovatory tools, presumably in AI, to require place.

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