

**Human Machine Interface in Robotic Surgery**Akshay Kumar Atery¹

Department of Electrical Engineering

Jodhpur Institute of Engineering & Technology, Jodhpur, India

Raksha Mathur²

Department of Electrical & Electronics Engineering

JIET-School of Engineering & Technology For Girls, Jodhpur, India

Ravina Dadhich³

Department of Electrical & Electronics Engineering

JIET-School of Engineering & Technology For Girls, Jodhpur, India

Abstract- *In this paper, Apparatus and method for controlling of medical instruments in surgery are discussed. The robots & semi robots are not only used in big industrial machines but also in very small equipment in surgery & in nano particle physics very tiny robotic surgical equipments are used to insert in human's body and the operation is done by the coordination of doctor's and Semi robotics. Minimally invasive surgery is at this moment one of the outstanding developments in surgery. An elongated member of a medical instrument can be sensed, and an actuator can be used to apply force to the medical instrument for control and manipulation of the instrument. Via use of the applied forces, the instrument can be moved by human-machine interface to a desired position in a working channel, haptic indications of position can be output to the user, and/or user control over the instrument can be enhanced. Medical robotics refers to robotic systems applied within the domain of health care. From the standpoint of science and engineering, robotics is a highly evolved and well understood discipline involving topics from mechanical engineering, electrical engineering, materials science, and computer science such as kinematics, closed-loop servo control, software development methodology, and digital embedded system design.*

Keywords- *Minimally invasive surgery, Human-machine systems, HMI, manual control, Flexible actuator.*

I. INTRODUCTION

The application of robotic systems to the medical health care industry requires that we bring together a diverse set of disciplines, including the all-important requirement of human compatibility. Medical robotic systems must coexist and interoperate safely and effectively within a human environment. In order to be successful in the marketplace, a medical robotic system must also be user-friendly and interactive. Its value-added features often come from an application specific user interface. Building such an interface requires expertise from the health care discipline as well as from the underlying robotics and engineering disciplines. The difficulty in putting together a team of designers and developers that spans the requisite fields of knowledge needed to create a medical robotic system is one of challenges limiting the emergence of medical robotics today.

II. GOAL OF ROBOTIC SURGERY

The goal of using robots in medicine is to provide improved diagnostic abilities, a less invasive and more comfortable experience for the patient, and the ability to do smaller and more precise interventions. Robots are currently used not just for prostate surgery, but for hysterectomies, the removal of fibroids, joint replacements, open-heart surgery and kidney surgeries. They can be used along with MRIs to provide organ biopsies. Since the physician can see images of the patient and control the robot through a computer, he/she does not need to be in the room, or even at the same location as the patient. This means that a specialist can operate on a patient who is very far away without either of them having to travel. It can also provide a better work environment for the physician by reducing strain and fatigue. Surgeries that last for hours can cause even the best surgeons to experience hand fatigue and tremors, whereas robots are much steadier and smoother.

III. VARIOUS TECHNIQUES IN ROBOTIC SURGERY

Various techniques exist for minimization of physiological tremor amplitude during microsurgery. Wrist rests and other supports are common. Many surgeons govern their sleep and their caffeine intake prior to surgery in an attempt to reduce tremor amplitude. Some take beta-blockers, which have been shown to have an attenuating effect. In recent years, attention has turned to the potential of robotic systems to yield much more substantial increases in positioning accuracy. Vitreoretinal microsurgery has been the focus of several efforts, as it is among the most demanding of specialties in terms of manipulation accuracy. There is some amount of consensus among vitreoretinal surgeons on the need for tool tip positioning accuracy approaching a level that seems to require the assistance of medical robotic devices. There are

several possible robotic approaches to microsurgical accuracy enhancement, each having its advantages and disadvantages. The most common approach is teleportation. The physical separation between command input and manipulator output in such systems allows motion scaling and filtering to be applied in a straightforward fashion. Scaled force feedback to the user is likewise facilitated. The drawbacks of such an approach include the high cost of a telerobotic system and the obtrusiveness or unnatural feel of such a system from the point of view of the surgeon, who is accustomed to treating the patient with his own hands. A robotic arm with the requisite workspace for the application also introduces significant safety and liability issues. To overcome these drawbacks, we have adopted a novel approach: a fully handheld instrument that detects its own motion and deflects its tip for active compensation of the erroneous component of the movement.

In the human arm, the surgeon is already in possession of a high degree-of-freedom (DOF) manipulator with high bandwidth, high accuracy (almost, though not quite, adequate for the task), and an unbeatable user interface. Rather than removing this existing manipulator and then working to develop a robotic system that must duplicate many of its features and which faces great disadvantages in terms of naturalness of feel, the philosophy underlying our approach is to retain the advantages possessed by the human surgeon, and to augment only those aspects that require augmentation, such as tip positioning accuracy. Compared to teleoperation, this approach reduces hardware cost by dispensing with the master.

The active handheld instrument presented here, known as "Micron," is designed for vitreoretinal applications, though the principles are of more general applicability. The instrument must perform three functions: motion sensing; filtering (or estimation of erroneous motion); and tip deflection for compensation. The principal areas of research required by the project have been motion quantification and modeling, filtering algorithms, and electromechanical systems for active handheld error compensation. Initial development and evaluation of the tremor filter was reported by Riviere et al. The present paper reports on the development of a handheld instrument prototype with the necessary sensing and manipulation capabilities to cancel tremor in three dimensions (3-D). It also describes tracking instrumentation that has been developed to serve the needs of the project, and presents preliminary results from evaluation of Micron using this instrumentation.

IV. WORKING OF ROBOTS IN ROBOTIC SURGERY

It is very important to precise control on position of the equipment. There should be real time controlling of machine with very high precision and coordination. The equipment's designs are different for different operation and task. Today some heart surgeries are done with semi robots. Which are used to removal of blockage in heart's veins and nerves by using vacuum suction and drilling the blockage. In this type of surgery the actual operation is performed through a number of small incisions in the skin. In the operations special instruments are inserted via trocars, i.e. tubes which allow the surgeon to bring instruments or sensors into the body. The view at the operating field comes from a laparoscope, a camera presenting a two-dimensional image on a monitor. The minimally invasive surgical technique has many potential benefits for the patients. Tamers are eliminated by shooting the Laser on the particular infected cell.

V. WORKING OF HMI SYSTEM

During actual open or minimally invasive clinical procedures, in physical or virtual reality simulators with or without haptic feedback and during interaction with surgical robotic systems. During open or minimally invasive surgical (MIS) procedures, the surgeon interacts with the patient's tissue either directly with his/her hands or through the mediation of tools. Surgical robotic enables the surgeon to operate in a teleoperation mode with or without force feedback using a master/slave system on figuration. In this mode of operation, visualization is obtained from either an external camera or an endoscopic camera. Incorporating force feedback allows the surgeon to feel through the master console the forces being applied on the tissue by the surgical robot, the slave, as he/she interacts with it from the master console.

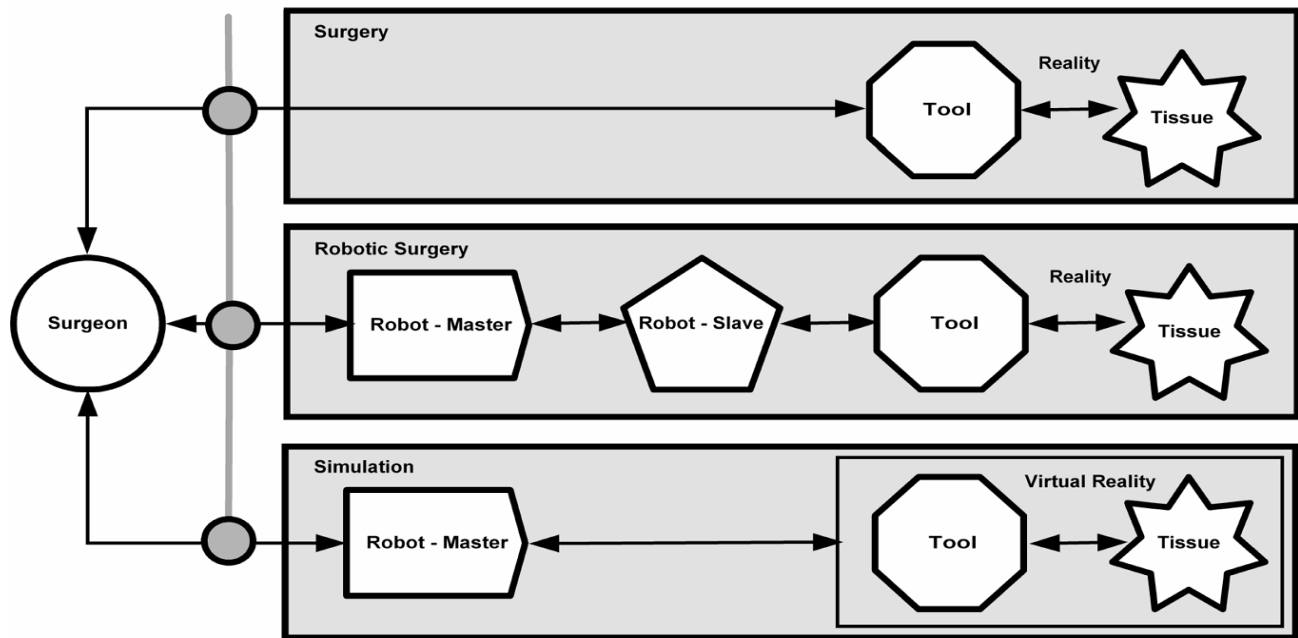


Fig.1. Modalities for Performing Surgery

The surgical tools, the robot–slave, and the anatomical structures are replaced with virtual counterparts for training in a simulated virtual environment. The surgeon interacts with specially designed input devices, haptic devices when force feedback is incorporated, that emulate surgical tools, or with the master console of the robotic system itself, and performs surgical procedures in virtual reality. One element that all of these modalities have in common is the human-machine interface in which visual, kinematic, dynamic, and haptic information is shared. This interface, rich with multidimensional data, is a valuable source of objective information that can be used to objectively assess technical surgical and medical skill within the general framework of surgical and medical ability. Algorithms that are developed for objective assessment of skill are independent of the modality being used, and therefore, the same algorithms can be incorporated into any of these technologies.

VI. WORK STATION FOR SURGERY

This workstation will provide a connection to digital knowledge that they have come to expect. Immediate access to online information will allow surgeons to focus on retrieving knowledge, which will be retained in a database rather than in personal memory, much the way the calculator changed the focus of mathematics from the process of calculation to the meaning of the result. This will translate the art of surgery towards a science capable of reduplication. The workstation also makes case rehearsal possible.

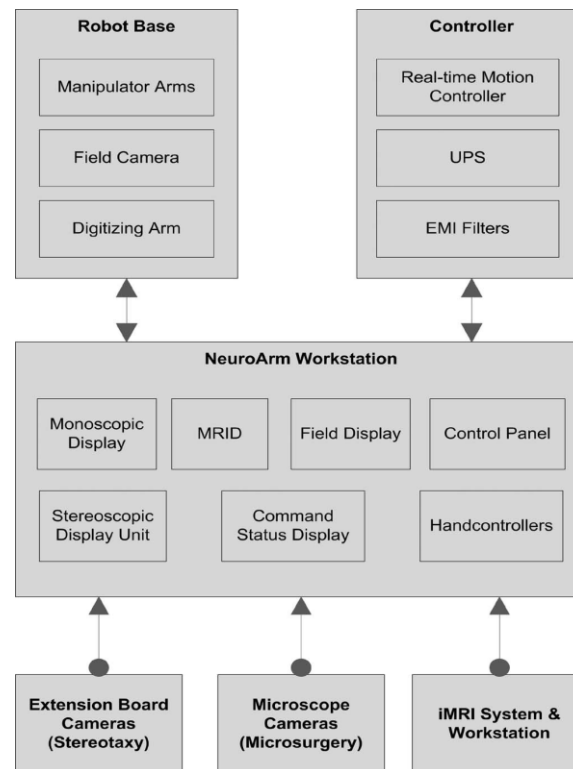


Fig.2. Block Diagram Showing Communication of System Components of the HMI with the Neuro Arm Workstation

Rehearsal increases the experience of each surgeon and provides the ability to practice seldom-used procedures. The human brain has evolved to respond to an incomplete data set based on sensory information, a function that computers cannot yet replicate. Human senses are interconnected; to remove one significantly alters perception, which in surgeons could result in a decrease in surgical performance. Therefore, a robotic system should respond to the workings of the human brain, and the workstation should reproduce human senses as closely as possible, so that surgeons can continue to use their past experience to respond to subtle sensory cues. While current technologies preclude the exact replication of the surgical environment at the workstation, advances in visual, audio, and haptic components indicate that eventually the sensory feedback produced will enhance human capabilities, so that surgeons will be able to see what cannot be seen, hear what cannot be heard, and touch what cannot be felt.

VII. CONCLUSION

There is a lot of research running in robotic surgery. This is used to bring injured soldiers from the battle field automatically start their first aid and normal little surgeries. HMI is already used in cancer treatment, fat removal from vains, prostate & hernia surgeries and still running

VIII. ACKNOWLEDGMENT

This research paper is made possible through the help and support from everyone, including: parents, teachers, family, friends, and in essence, all sentient beings. Especially, please allow me to dedicate my acknowledgment of gratitude toward Dr. S. K. Atrey & team members for his most support and encouragement. He kindly read my paper and offered invaluable detailed advices.

IX. REFERENCES

- [1] Cameron N. Riviere, R. Scott Rader, and Nitish V. Thakor "Adaptive Canceling of Physiological Tremor for Improved Precision in Microsurgery" IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, VOL. 45, NO. 7, JULY 1998.
- [2] Metin Akay, Ivan Marsic, Attila Medl, and Guangming Bu "A System for Medical Consultation and Education Using Multimodal Human/Machine Communication" IEEE TRANSACTIONS ON INFORMATION TECHNOLOGY IN BIOMEDICINE, VOL. 2, NO. 4, DECEMBER 1998.
- [3] Jacob Rosen, Jeffrey D. Brown, Lily Chang, Mika N. Sinanan and Blake Hannaford "Generalized Approach for Modeling Minimally Invasive Surgery as a Stochastic Process Using a Discrete Markov Model" IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, VOL. 53, NO. 3, MARCH 2006.
- [4] Alexander D. Greer, Perry M. Newhook, and Garnette R. Sutherland "Human-Machine Interface for Robotic Surgery and Stereotaxy" IEEE/ASME TRANSACTIONS ON MECHATRONICS, VOL. 13, NO. 3, JUNE 2008.

- [5] Nicolas Gerber, Kate A. Gavaghan, Brett J. Bell, Tom M. Williamson, Christian Weisstanner,Marco-Domenico Caversaccio, and Stefan Weber "High-Accuracy Patient-to-Image Registration for the Facilitation of Image-Guided Robotic Microsurgery on the Head" IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, VOL. 60, NO. 4, APRIL 2013.
- [6] Garnette R. Sutherland "Surgeon at a Workstation: Information Age Surgery" 10.7759/cureus.40,Open Access Technical Report.
- [7] J-Plasma by Bovie Medical CorporationAll About Robotic Surgery "Surgical Robots"
- [8] Antonid Bicchi and Giovanni Tonietti "Dealing with the Safety-Performance Tradeoff in Robot Arms Design and Control" 1070-9932/04 IEEE
- [9] Spiros Kotopoulos, Han Wang, Sandy Cochran and Michiel Postema "Lithium Niobate Transducers for MRI-Guided Ultrasonic Microsurgery" IEEE, Transaction on Ultrasonic, Ferroelectrics and Fr 1570 equency Control, vol. 58, no. 8, August 2011.
- [10] <http://allaboutroboticsurgery.com/surgicalrobots.html>