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Advanced Robotics Trends in Medical Application

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Abstract: It is important for robot designers to known how to make robots that interact effectively with humans. Most of the robots designed till dates are industrial robots. These robots have taken the place of human laborers in hazardous, boring, or otherwise dangerous manufacturing tasks. The recent advancement of nanotechnology leads to nanorobots, which are effectively used as Nano medicine to perform treatments even at the cellular level. Much research work has been carried out based on the nanorobots such as surgery , rehabilitation ,diagnosing, treating, preventing disease, some traumatic injury, of relieving pain and improving human health using some tools and molecular knowledge of human body. The number of robots being used in industrial production has grown significantly. In contrast, the use of other applications, often called service robots, is still limited. An important application for service robots is to serve in medicine. The objective of the paper is to review current research in the field of medical robotics.
Keywords - Robotics, tele-echography, Medical, rehabilitation, Telesurgery.

I. INTRODUCTION

History of the Word 'Robot' Although the science of robotics only came about in the 20th century .The earliest robots as we know them were created in the early 1950 by George C. Devol an inventor from Louisville, Kentucky. He invented and patented a reprogrammable manipulator called "Unimate" from "Universal Automation." For the next decade, he attempted to sell his entire product in the industry but did not succeed. In the late 1960s, one of the businessman engineer Joseph Engleberger acquired Devol's robot patent and was able to modify it into an industrial robot and form a company called Unimation to produce and market the robots [1]. For his efforts and successes, Engleberger is known in the industry as "the Father of Robotics".

A. Today's Robots

However, in the real word most of the robots produced have been industrial robots. Today robots are enjoying resurgence. As computer processors are getting faster and cheaper, robots can afford to get smarter [6]. Meanwhile, researchers are working on ways to help robots move and "think" more efficiently. Although, most robots in use today are designed for specific tasks, the main goal is to someday make universal robots, robots that are flexible enough to do just about anything a human does–and more
An important application of the service robotics is medical application [3]. Recently, the idea of using robots in medical application has become a more interesting topic for both robotics researchers and the general public.

B. New Trends of Robotics in Medical Applications

Recently the interest on medical applications of robotics has grown rapidly. Magnetic Microbots are a group of tiny robots used in various operations such as removing plaque from a patient's arteries or helping with ocular conditions and disease screenings. Healthcare Robotics Nursing Assistant uses a direct physical interface (DPI) that lets a nurse have direct control over the movement of the robot, a "human-scale" mobile manipulator called Cody[1].The current robotics technology has increased in which robots abilities such as precision, sensing, repeatability, and controls, to be more acceptable in the healthcare area especially the safety[9].

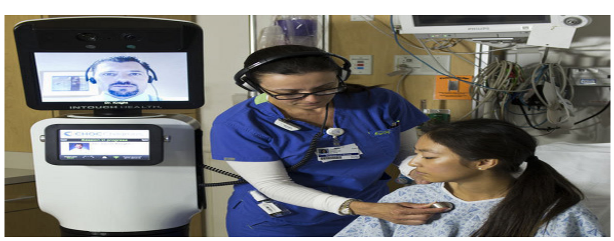

Fig. 1 Nursing Assistant using a DPI

C. Classifications of Medical Robotics

The medical robotics can be classified on the basis utilizations into three fields; 1) rehabilitation robotics, 2) robotics in surgeries, and 3) other applications. However, only the first two topics are discussed here.

The next two sections explicitly describe the applications and also give examples of important efforts in each field.

II. REHABILITATION ROBOTICS

The rehabilitation robots are designed with applications of techniques that determine the adaptability level of the patient. There are different techniques such as: active assisted exercise, active resistive exercise, passive exercise, active constrained exercise and adaptive exercise. In active assisted exercise, the patient moves his or her hand in predetermined pathway without any force pushing against it[8]. Passive exercise needs to be pushed from the patient. Finally, an adaptive exercise is an immoderate workout that the robot has never done and is adapting to the new unknown pathway [13]. An optimization method of spherical robots applied to the domain of medical robotics. This method depends upon specification of indices which describe the constraints and requirements of the particular medical application. The dimensional optimization is demonstrated with two examples of four-degree-of-freedom robots: one dedicated to ultrasound tele-echography and the other tool for minimally invasive surgery. Each of them has been designed to accurately follow medical gestures [14].The robotics in the rehabilitation field has then become widely implemented. Rehabilitation robotics includes assistive devices for the blind, prosthetics and orthotics, rehab-manipulators, and other assistive systems, such as intelligent wheelchair.

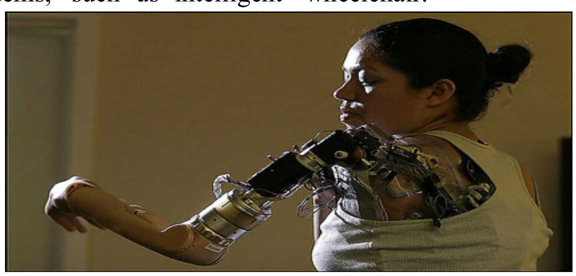

Fig. 2 Rehabilitation Robots used in Arm

"The smart wheelchair" an intelligent wheelchair which has a number of sensors and human-interface systems to aid disabled people. Their novel system has the paradigm of shared control. The user with human intelligence can reason about the environment and command the wheelchair, but the human augmentation software is used to execute the low level tasks underlying navigation: displaying three-dimensional information, planning safe paths, continuous control and execution [11]. This allows the human user to think in "robot-centered" coordinates, i.e. in terms of the sensoly information and the model of the world known to the augmentation software[7]. By doing this, we force the human to indirectly assist with the problems of recognition and identification that are known to be notoriously hard in computer vision. Fig 3 shows the "Smart wheelchair".

The current rehabilitation robot to be discussed here is an exoskeleton. Robot A robotic suit that is worn as an exoskeleton and can be used to help disabled people to walk again, Exoskeletal robot and its control system to support the human elbow motion, and a two degree of freedom (2 DOF) exoskeletal robots for shoulder joint motion assist. The proposed controller controls the angular position and impedance of the exoskeletal robot system based on biological signals that reflect the human subject's intention.

Fig. 3 SMART WHEELCHAIR

III. ROBOTICS IN SURGERIES

Surgical robot is a self-powered, computer-controlled device that can be programmed to aid in the positioning and manipulation of surgical instruments, enabling the surgeon to carry out more complex tasks [12]. Surgery robotics can be categorized into two classes. The surgeon's master console is the robot's user interface that provides the master surgeon with the following functions [10]:

1. A 3-dimensional view of the surgical field relayed from an endoscopic camera inside the patients body, in control of the robot that creates a sense of being "immersed" into the surgical field.
2. Master manipulators, which are handles or joysticks that the surgeon uses to make surgical movements that are then translated into real-time movements of the slave manipulators docked on the patient. Motion scaling (conversion of large natural movements to ultraprecise micro movements) and tremor filtering increase accuracy and precision of the surgeon's movements.
3. A control panel to adjust other functions, such as focusing of the camera, motion scaling, and accessory units etc.
4. Patient-side slave robotic manipulators are robotic arms that manipulate the surgical instruments and the camera through laparoscopic ports connected to the patient's body.

Fig. 4 The da Vinci surgical system

A. Robots in Telesurgery

Telesurgery involves a surgeon operating from a remote location. The remote location can be as far away as the other side of the world, or as near as the next room [6]. Since there is distance separating the surgeon and the victims, it is evident that the surgeon cannot operate using his own hands. A robot, local to the patient, becomes the surgeon's hands, while an complicated interface conveys the robot's senses to the surgeon (making use of visual, force, aural and tactile feedback)

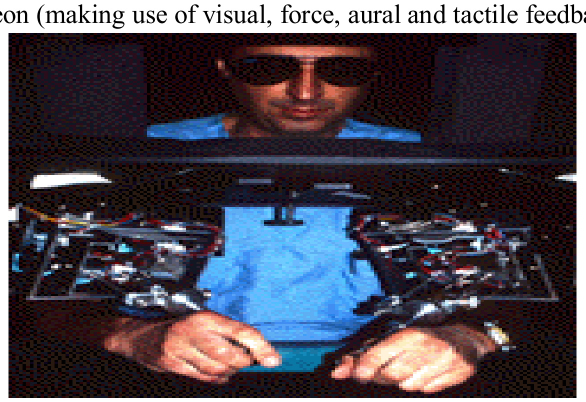

Fig. 5 Robots used in Telesurgery.

IV. CURRENT RESEARCH IN SURGICAL ROBOTS

The use of robotics in clinical procedures is a major breakthrough in the field of medicine. A lot of research is presently being performed on more medical robots that can assist in different clinical procedures that are considered intricate and invasive

A. Neuro Arm and MrBot

The neuroArm is a neuro-surgical robot guided by MRI, with two arms actuated through piezoelectric motors while the MrBot is designed for accessing the prostate gland using MRI data[4].

B. HeartLander

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This medical technology is a minimally invasive robot that is designed for procedures such as epicardial atrial ablation, heart cell transplantation and intrapericardial drug delivery.

C. Amadeus

Amadeus is a laparoscopic surgical robot system with four arms designed to assist in teleoperation in case of long-distance surgeries.

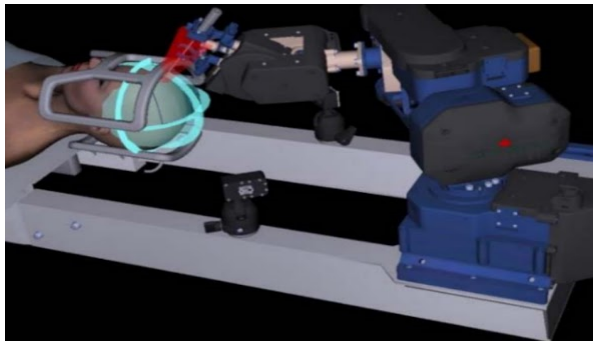

Fig.6 Neuro Arm

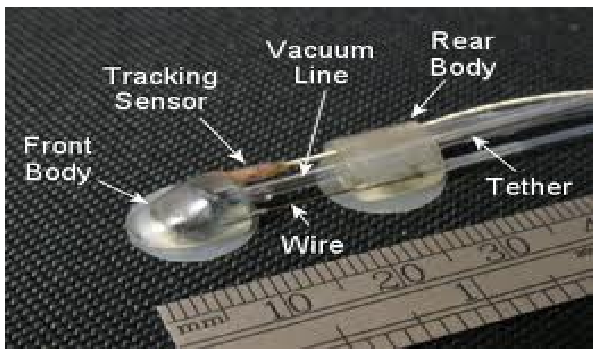

Fig. 7 HeartLander

V. CONCLUSION

From the introduction of this paper, it is obvious that there is a huge demand and advantages of using medical robots. Medical robotics opens up new perspectives in promoting the right to physical health. Robots overcome limitations in the sensory-motor capabilities of human doctors. They may perform surgery and rehabilitation tasks faster and with greater precision than human operators. Properly used robots alleviate both post-surgery pain in patients and the fatigue of health care personnel. The most significant role of medical robots will most likely be to perform tasks that are otherwise impossible, such as enabling new microsurgery procedures by providing high-dexterity access to small anatomical structures, integrating imaging modalities into the Operating Room. Therefore, the medical robotics requires collaborations among engineers and physicians.

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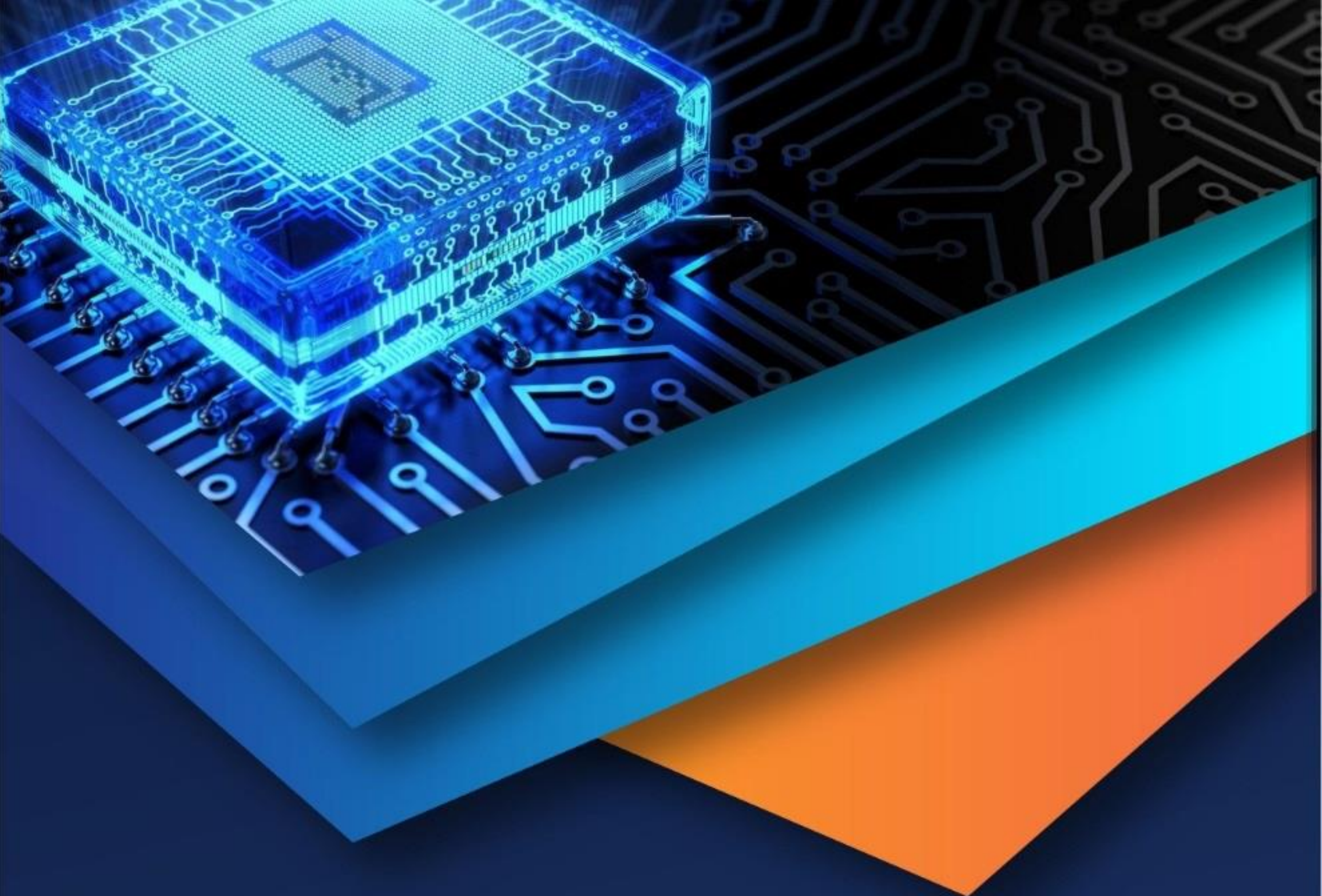

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