



ROBOT IN DENTISTRY

Dental Science

Dr. Mohit Kamra* Professor M. M Dental Institute Mullana, Haryana *Corresponding Author

ABSTRACT

Robot has invaded all the industry executing high precision work without any human error. In medical field robotic surgery is a well-established practice in developed countries and rapidly expanding to developing countries. Robots are being used for local surgery and telesurgery, audiovisual telecommunication for telemedicine and teleconsultation.

KEYWORDS

Dental Robotics, Modern dentistry, Nano Robot

INTRODUCTION

The use of robots in the field of medicine started in 1985. The term "Robotics" is derived from Greek word meaning Slave Labour or Forced Labour. A Robot is "A reprogrammable, multifunctional manipulator designed to move materials, parts, tools, or specialized devices through various programmed motions for the performance of a variety of tasks". In 1942, Engelberg and George C. Devol started the first commercial company to make Robots called Unimation (Universal Automation) based on the ideas of Assimov. Thus, Engelberg is called The Father of Robotics. In the year 1967, Versatron introduced the first Industrial Robot. The field of dental robotics is being applied in dentistry to extend and expand treatment options, robots are being used to reach small spaces and visualize the treatment area more effectively. It is a new area of research with many applications.

Dental Applications –

Oral and maxillofacial surgery - Robotic technique is being used for milling of bone surfaces, drilling of holes, deep saw osteotomy cuts, selection of osteosynthesis plates, bending and intra-operative positioning in defined position, orthognathic surgery planning.

Implant –

Robotic application in Implantology can be broadly classified into Robot-assisted Implantology and fully-autonomous Implant Robots. A Robot-guided Implantology increases accuracy and aesthetics in dental implant procedures through visual and physical guidance and a simple digital workflow. A fully-autonomous implant robot is independent under the supervision of a dentist. Robot has three basic components; sensors, effectors and control systems. The technique involves immobilizing the jaw of the patient and suspending thin needles which can penetrate the gum and determine the location of the bone. This whole unit is connected with a wireless connection to a computer and joins with the Computed Tomography scan data thereby producing a set of drill guides. The primary input to the robot-guided surgery comes from a Computed Tomography scan. System mimics the mandibular movements and occlusal contact forces in order to make it possible for various implant designs and procedures to be tested and evaluated before animal testing or clinical human trials. This method consists of forming pre-programmed software which is used to work with Computed Tomography scanner data. The robotic arm helps the surgeon to achieve the correct location, angulation, and depth when placing dental implants through its sensors, producing true and unique guidance.

Orthodontics-

Apparatus used is a archwire bending robot comprising a robot mounted to a base or table support surface with gripping tools. The tools incorporate force sensors which are used to determine overbends to get the desired final shape of the archwire. It also includes a resistive heating system in which current flows through the wire while the wire is held in a bent condition to heat the wire and thereby retaining the bent shape of the wire.

Conservative dentistry -

The automated operations are carried out by image processing of the patient's teeth. The image processing helps to identify the number of cavities and the position of the each cavity. The dental activities are carried with the help of robotic arm. The drilling is carried out by using

the dental driller in the end effector of the robotic arm. Hardware components consists of camera, computer, robotic arm, power supply and dental equipments like driller and filler. The camera is connected to the computer with image processing software. The image from the camera is processed by the image processing software. The microcontroller is used to move the robotic arm to specific positions of the tooth with cavity. The microcontroller gets the input from the computer by the position values computed from the image processing. The end effector is present in the end point of the robotic arm. The end effector consists of two dental equipments namely the driller and filler. 4 Dental nano robots selectively and precisely occlude selected tubules in minutes, using native biological materials, offering patients a quick and permanent cure. The cavity preparation is very precisely restricted to the demineralised enamel and dentin, thus providing maximum conservation of sound tooth structure. Device identifies particles of food, plaque or tartar and lift them from the teeth to be rinsed away. 5 The advantage is its effectiveness in terms of immediate accuracy, conservative grinding of teeth preventing the necrosis of the pulp, avoidance of anaesthesia, speed and precision, accuracy and perfect fit, painless sessions and high aesthetics and recovery speed including immediate results. The patient can return to his routine activities after only one visit. Limitations include the fact that the judgment of the situation is limited to the data fed into the software and/or tracked by patient tracking system, supervision by an experienced dentist is still required and the cost of the system is prohibitive.

Robot programming is a two step procedure: In the first step the position of one feature is determined by the researcher and afterwards the robots perform the operation with a set of different parameters, second step can easily be performed independently by the researcher with the help of appropriate software, for the first step the presence of a robotics expert is mandatory. 6 Machine incorporates sensors for intelligent monitoring of the treatment process. Because of the compact features of the sensors, they can be fabricated using a surface micro machine method to produce silicon-on-insulator wafers, which are embedded in the micro robot. Micro actuators are used to control the axes and the on/off spindle of the tool. Each actuator is independently controlled by a digital controller. The computer-aided treatment process planning system will generate the standard codes as output from a computer aided design file. These codes will control the movements of the robot through a digital controller.

There are two group of Robots, the first group, the telemanipulators, which are not pre-programmed. The other group of system, the pre-programmed surgical Robots, execute on a preoperatively defined trajectories.

There are six types of medical robots. They are Surgical robots, Rehabilitation robots, Biorobots, Telepresence robots, Pharmacy automation and Disinfection robot. Surgical operations in medical field use surgical robots, remote surgery is possible with this type of medical robot where a human surgeon is physically absent. The rehabilitation robot help the elderly people and the people with dysfunction of body parts and is useful for training and therapy. Biorobot uses biological characteristics in living organisms as the

knowledge base for developing new medical robot designs. These robots are also used to measure the state of disease and to track the body conditions. The Telepresence robot help the medical

professionals to move, look around and communicate with the patients in the remote locations. The pharmacy automation is very helpful to dispense oral solids in a retail pharmacy setting. The mechanical process of handling and distributing medications helps in tracking and updating customer information in database. The disinfection robot has the capability to disinfect the surrounding area in few minutes using ultra violet light technology. Manual robot are also there in dental field, where the dentist controls the robot equipments manually by using the control interface of the equipments in the computer. 4

Biological Applications

The primary purpose for use of robotics in biology is precision in experiments related to research and development of life science, involving the delivery and dispensation of biological samples / solutions in large numbers each with very small volumes.

Applications include systems for large-scale DNA sequencing, single nucleotide polymorphism analysis, haplotype mapping, compound screening for drug development, and bio-solution mixing and dispensing for membrane protein crystallization. The second purpose of robotics for biological applications is for effective handling and exploration of molecular and cell biology. This type of application includes immobilization of individual cells, cell manipulation, and cell injection for pronuclei DNA insertion. Special tools fabricated using different technologies have to be developed such as lasers for microsensing and manipulating, electroactive polymer for cell manipulation, and microneedles for cell penetration. Robotics-inspired algorithms for molecular and cellular biology, include the work for predicting protein folding, and for structural biology (Zheng and Chen, 2004). 8

Nanorobotics is the technology of creating machines or robots at or close to the microscopic scale of 2 nanometers. Nanorobots represent microscopical objects artificially capable of free diffusion inside the human body and which can interact with human body cells or can manipulate them, in order to fulfill tasks. 7 "Nano" is derived from the Greek word which stands for "dwarf". Nanotechnology is the science of manipulating matter, measured in the billionths of metres or nanometer, roughly the size of two or three atoms. Nanodentistry which involves the maintenance of oral health by the use of nano materials, biotechnology and dental nanorobotics. The first observations and size measurements of nanoparticles were made during the first decade of the 20th century by Zsigmondy, 1914.

Nanorobots are theoretical microscopic devices measured on the scale of nanometres. Medical nano robot can be controlled by onboard computers capable of performing thousand or more computations. A broad cast type acoustic signal helps in communication with these devices, it basically consists of sensors, actuators controlled by light or electric signals, control, power, communication and interfacial signals across facial scales. A navigational network may be installed in the body which provides, positional accuracy to passing nanorobots to know their location. Possible ways of communicating between nano robots are either by means of light signals through optical nano sensor or by chemical signals through chemical nano sensors. Nano robots with embedded chemical biosensors can be used to perform detection of tumour cells in early stages of development inside the patient's body. Integrated nano sensors can be utilized to find intensity of E-cadherin signals. 5

Engineers and neuroscientists have problems of measuring haptics, that require consideration prior to the sensor design and manufacturing stages. Design team must be compounded by mechanical engineers to navigate the latest machine design technologies such as in depth finite element analysis, three dimensional printing and rapid prototyping. The team should also include electrical engineers capable of designing instrumentation solutions to meet strict signal conditioning requirements. This multidisciplinary approach results in instruments that meet the specifications.

CONCLUSION

Robotic surgery has started a new era of tele surgery. Total automation is not desired or possible and surgical robots will always work in cooperation with the surgeon and cannot substitute them. The preoperative planning, takes much time and is not desired in routine clinical work, therefore new concepts for computer assisted surgeries rely on intraoperative planning. One of the main challenge is still the interdisciplinary work of engineers and surgeons, which have to find

to a common language. Researchers will continue the search to create optimal natural-looking dentition replacement, with predictability, shorter healing times and advances in developing bio-active implant materials and surfaces. Robot related faults and safety issues require numerous series of well documented cases, randomized controlled trials comparing robotic assisted and autonomous robotic procedures with traditional techniques.

REFERENCES

1. Avi Bansal, Vishal Bansal, Gourav Popli, Neha Keshri, Gagan Khare, Siddhartha Goel, (2016), Robots in Head and Neck Surgery, Journal of Applied Dental and Medical Sciences, 2 (1), 168-175.
2. Dr. Manju Natarajan, (2018), A Review of Robotics in Dental Implantology, E- MIDAS Chennai, 5 (1), 1-16.
3. Deepakshi Dimri, Siddharth Nautiyal, (2020), Dental Robotics- Get Going. International Journal of Science and Healthcare Research, 5 (2), 424-426.
4. S. Naveen, (2017), A Novel approach for carrying out dental activities such as drilling and filling using automated robots, International Journal Of Electrical, Electronics And Data Communication, 5 (9), 56-60.
5. Biji Balan, Sreejesh Narayanan, (2014), Nano Robotics – its time for change, IJOICR, 2 (5), 41-46.
6. Germano Veiga, Francisco Caramelo, Pedro Malaca, Pedro Brito, J N Pires, (2012), On the use of Robotics in implant dentistry research, The Fourth IEEE RAS/EMBS International Conference on Biomedical Robotics and Biomechatronics Roma, Italy, June, 24-27.
7. Manjusha Rawtiya, Kavita Verma, Priyank Sethi, Kapil Loomba, (2014), Application of Robotics in Dentistry, Indian J Dent Adv, 6 (4), 1700-1706.
8. Yuan Zheng, George Bekey, Arthur Sanderson, (2005), Robotics for Biological and Medical Applications, International assessment of research and development in Robotics, chapter 6, 49-56.