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Application of Robotics in Dentistry - A Review

[1]Rohit Raghavan, Head of the Department, Department of Prosthodontics and Crown and Bridge, Royal Dental College, Chalissery PIN: 679536, Kerala University of Health Science, Thrissur, India.

[2]Shajahan P A, Professor, Department of Prosthodontics and Crown and Bridge, Royal Dental College, Chalissery PIN: 679536, Kerala University of Health Science, Thrissur, India.

[3]Anju Vijay L V , Post Graduate Student, Department of Prosthodontics and Crown and Bridge, Royal Dental College; Chalissery PIN : 679536, Kerala University of Health Science , Thrissur , India .

Corresponding Author: Anju Vijay L V , Post Graduate Student, Department of Prosthodontics and Crown and Bridge, Royal Dental College, Chalissery PIN : 679536, Kerala University of Health Science , Thrissur , India .

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Abstract

In dentistry, the most amazing human technology, robots, have found their way. Robotics is a technology of the next generation that has opened new avenues for developing and exploring the different fields of dentistry and also helps to perform tasks that are difficult for the dental clinician to accomplish. There are various applications for dental robots, such as teaching dental students, endo-micro-robot, arch wire bending, and dental Implantology. This based thesis focuses on the application of robotics in different dentistry specializations.

Keywords : Dental Patient Robot, Endo Micro robot, Tooth Arrangement Robot, Surgical Robots, Sensor Equipped Implant Setup, Robotic dental drill, Dental implantology robot, Dental Nano robots.

Introduction [1]

Robotics is the technology division that specializes in the design, development, operation and implementation of robots and computer systems for their control, sensory input and information processing. In his science fiction book I Robot, which was published in 1950, the writer Isaac Asimov introduced it.

Application of Robots in Dental Field

Dental patient robot [2]: The skills of dental therapy also rely on the expertise and abilities of clinicians and they need to have extensive experience using techniques and models that accurately represent the actual procedures and conditions of care. Recently, recent pass-out graduates lack clinical ability and patient care experience. Clinical research on consenting volunteer patients has been carried out until recently. Recent developments in ethical problems relating to environmental studies, medicine and

dentistry have, however, made it difficult for such clinical training. The so-called 'Phantoms' currently consist of a basic functional cephalic region and teeth structure that is distinct from actual patients.

Figure 1: To assist in the training of a dentist, the Japanese invented Simroid, which is a humanoid practice robot. It alerts dentistry students if it is uncomfortable. [3]

Endo Micro robot [4-6]: Endodontic treatment effectiveness depends on the skill of the clinician, including his or her sense of touch and judgment. During root canal preparation, endodontic mishaps such as perforation, channel ledging, apical foramen transport and stripping, excessive instrumentation beyond the apex, insufficient or inappropriate canal preparation and instrument separation can occur. In order to reduce the potential for human error and increase the quality of endodontic care, innovative innovation in endodontic technology needs to be implemented through the application of advanced engineering and computer-aided technology.

Tooth arrangement robot [7-10]: It is a single manipulator system which is used for the manufacturing of complete dentures. It was developed using 6 degree of freedom CRS robot and produced in Canada. The various functions of this software are to choose and create medical history files of the patient followed by drawing a jaw arch and dental arch curves and finally according to the jaw arch parameters adjust the dental arch curve. It also displays the 3D virtual dentitions on the screen with a careful observational environment and aids in modification of the individual tooth posture. Its functions are to change the initial location of the tooth arrangement for the robot, create a profile of control data and track the robot for tooth arrangement operations. In the manufacture of upper and lower full dentures, this robot device was used. This multi-finger hand tooth arrangement scheme is built based on the robot MOTOMAN UP6. These hands consist of three fingers to operate in the three degrees of liberty and are thus technically able to accomplish the necessities of tooth arrangement. On the dental arch curve, there are about 14 individual manipulators. Each tooth by tooth arrangement helper is assisted by this manipulator and offers six degrees of freedom to change each tooth for its place along X, Y, Z, lingual, rotation and near-far medium directions to the controls. The development of complete dentures takes only 30 minutes using this robot method and the precession and precision of each robotic system is measured.

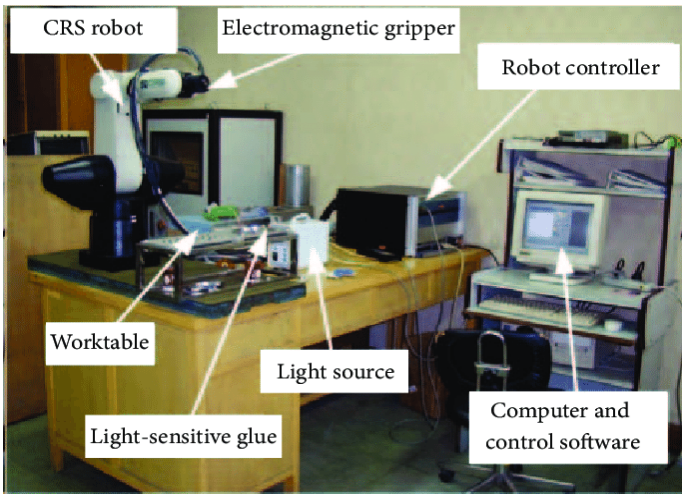

Figure 2: Single manipulator tooth-arrangement robot system for complete denture.[11]

Surgical Robots [12- 13]: A maxillofacial surgical robot system has been created in which the surgeon interactively programs the robot during the operation during which the preprogrammed tasks are performed by the robot. For milling bone surfaces, drilling holes, deep saw osteotomy cuts, selection of osteosynthesis plates, bending and intraoperative positioning in the specified position, and preparation of orthognathic surgery, robotic techniques are used.

Sensor-Equipped Implant Setup [12, 14, 15]: Dental implant is a tooth root replacement surgical procedure that is the most widely used in prosthodontic dentistry. For oral implantology, a new computer-assisted surgery system that includes pre- and intraoperative procedures has now been developed. In order to improve the raw images obtained from the patient before surgery, preoperative surgery should use three-dimensional (3D) views as given. The main objective of this technique is to make a target region and a pathway from computed tomography (CT) data associated with relative organs.It provides 3D orientation of the position and trajectory of the surgical instrument shown on a monitor in real time within the 3D imaging data of the patient. For implant placement, Yomi (FDA Cleared) is a robotically assisted dental surgical device. It is used to prepare a procedure based on the CT scan of patients. It has recently been stated in the morning post in South China that two dental implants have been mounted by a robot dentist on a female patient. The robot was confirmed to have followed a series of pre-programmed commands to mount the implants within a 0.2 to 0.3 mm error range.

Figure 3: The Yomi robotic system for dental surgery [16]

Robotic dental drill [17]: It is a new development that tactile technologies are creating and consists of immobilizing the patient's jaw and suspending thin needles that penetrate the gum and assess the bone's location. This entire unit is connected to a wireless link to a PC and joins the CT scan data to generate a set of drill guides that are self-directing once triggered and can be altered by the clinician as needed.

Dental implantology robot [18 -22] : In order to allow different implant designs and procedures to be tested and assessed prior to animal testing or clinical human trials, this device imitates mandibular movements and occlusal contact forces. Ecole des Mines de Paris in France and Umea Universities in Sweden have developed this robot implant denture technology from preoperative preparation to splint drilling. This method consists of the development of pre-programmed software used to work with data from the CT scanner. A 3D model of the patient's jaw is now made, implant fixtures are installed and an accurate robot is then used to drill a jaw splint in the predetermined positions to create a surgical guide. There are three translations and two rotations of this robot. The University of Coimbra in Portugal is establishing another device using the ABB IRB2400/M98 robot. This device is well designed and includes a manipulator for industrial robots,

a data acquisition board, strain gauges and a sensor for torque. It performs implant drilling and applies pressure to imitate the mastication mechanism on the collected implants. The implant surgery device developed by the University of Duesseldorf includes a robot arm, angle sensors, torque sensors, precision potentiometers, driver shafts and mini bone implants. It is mainly concerned with the impact of the injection angle and depth and the stability and diameter of the pre-drilling of the mini implant.

Dental Nanorobots [23-26]: Nanorobotics is the technique of generating machines or robots on or near the 2 nanometer microscopic scale. Nanorobots are microscopic objects which are artificially capable of free diffusion inside the human body and which, with a nanometric resolution (10-9 m), can communicate with or control human body cells to fulfill their tasks. A nanorobot can be created as a normal robot from thousands of mechanical components made from nanomaterials such as carbon nanotubes, metallic nanoconductors, and diamond materials. For cavity preparation and restoration of teeth, several nanorobots acting on the teeth in unison, invisible to the naked eye, can be used. Specifically, cavity preparation is limited to demineralized enamel and dentin, thereby ensuring optimum security of the structure of the sound tooth. To enter the dental pulp where all sensation will be shut down when inserted in each individual tooth, a colloidal suspension will be instilled on the patient's gingival containing millions of active analgesic micron-sized dental robots. The dentist orders the Nanorobots to restore all sensation after oral procedures are finished, to relinquish control of nerve traffic and to exit from the tooth through similar pathways used for ingress. Within minutes, reconstructive dental nanorobots may selectively and reliably occlude particular tubules, offering patients a fast and permanent cure.

Figure 4: Cavity preparation & restoration by Nano robots [27]

Conclusion

Improved and precise care with good quality of work in less time can be provided by the intervention of robotics in the dentistry sector. It will change people's dental health, and it will be much better. The future of dentistry is unclear with the evolving new technologies and our issue of concern lies in the fact that the technology should be appropriate to people and we can use this technology as clinicians in our everyday teaching and clinical practice.

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