ROBOTICS IN DENTISTRY: A REVIEW

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*Abstract— **The purpose of this paper is to give overview of existing application and concept of robotic system in dentistry. By applying the robotics to the medical field of surgery has increased accuracy and made surgical procedure more successful. Being the digitalized world today, technology plays a crucial role in each sector. Thereby digital technology has led to vast progress in dentistry. Dental robot provides various applications related to teaching dental students, Endo micro robot, Tooth arrangement robot, Dental Nano robot and dental implantology. By extracting the data from selected paper, the reviewed data was synthesized.***

***Keywords—**Robotic Implantation, Endodontic Micro Robot, Dental Nano robot, Dental patient robot, Tooth arrangement robot, dental robotic drill.*

I. INTRODUCTION

Karel carpel coined the term "Robot". Robotic technology increased the amount of intelligence of machines [4]. It derives from the check term "robota," which refers to forced labour[4].Numerous industries, including machinery, electronics, aerospace, and medical, have used robotics. Robotic automation and assistive technology have many prospects in dentistry to improve the standard of dental care [15]. Among these, the use of robotics in medicine has drawn more and more attention. Macro-robot, micro-robot, and bio-medical robots are the three main categoriesof medical robots [16]. The technologies are utilized in dental implant dentistry with computer assistance, including the creation of surgical guides [12]. The current technological infrastructure could be enhanced in many positive ways by utilizing smart robot technology in dental clinics, such as as dentist assistants [13]. According to a study conducted at Oxford University, dental hygienists and assistants responsibilities are more likely to be automated than those of dentists [15].

II. APPLICATIONS OF ROBOTICS IN DENTISTRY
ROBOTICS IMPLANTOLOGY

A dental implant is a small metal pin fixed into the jaw to mimic the tooth root. Dental implant surgery is the procedure that replaces the tooth roots with metals and replacing the damaged or messing teeth with artificial teeth that teeth looks and functions like real ones[1]. The methods for dental implants generally involve three steps. The implant is first inserted into the jawbone. The fake tooth will be attached to the implant after the addition of the abutment. The artificial tooth, or crown, is then affixed to the abutment. For precise implant placement, robotic implant systems typically require real-time surgical monitoring [15] There may be various quantities of accessible bone for the implant depending on the patient. Support must be provided surrounding the implant by a minimum of 2 mm . These spacing requirements imply that sub-millimeter accuracy is required[8].This method will be more accurate and can avoid mistakes done by human like missing teeth which may result in terrible surgery in challenging implant situation. In order to place and position implants with the required level of accuracy, surgical navigation systems and template guiding are used [14]. While preparing an

implant osteotomy, this method delivers extremely high accuracy and predictabilityand will reduce the amount of the bone which in turn, minimizes bone damage [14]. In oral rehabilitations, computer-guided implant surgery can be quite successful, giving the surgeon a chance [7].

Figure 1

ENDODONTIC MICRO ROBOT

Endodontic therapy, also referred to as root canal treatment, involves cleaning out the inner canals of teeth of any damaged or infected tissue and sealing the canals to stop the teeth from becoming an infection source [3]. The treatment success rate is 60-65% by general dentist and 90% by the specialist [3]. To achieve endodontic therapy, it requires expected clinician to tackle this Endo micro robot were fabricated [1]. Byapplying advanced engineering and computer aided technology endodontic micro robot were invented whichreduces human errors and improves quality. These robots perform probing, drilling, cleaning, filling of root canal with on line monitoring and intelligent control [1]. This robot consists of a micro position and orientation adjustment device an automatic fuel rate and travel distance controller, micro sensor and apexsensor [4].
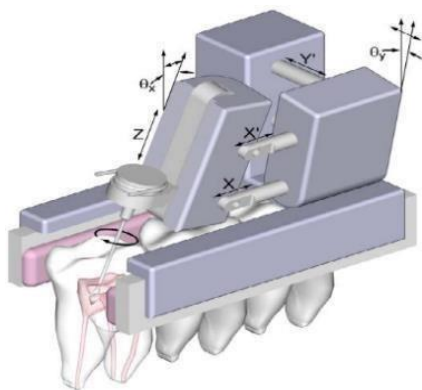

Figure 2

TOOTH ARRANGEMENT ROBOT

The manufacturing of an entire denture is done with the help of this teeth arrangement robot. Also, it alters each tooth's position on the screen by seeing 3D virtual teeth in that format [2]. The software allows for free movement of the complete dentition, local dentition, and individual teeth in the coronal, sagittal and Horizontal planes [16]. The main operations of this software include selecting and creating the patient's medical history data, then drawing the jaw arch and dental arch curves, and finally adjusting the dental arch curve in accordance with the jaw specifications [1]. To start, the patient's jaw arch measurements were gathered, and control data were generated using a program that arranges teeth. The fake teeth , tooth-arrangement assistant and intermediate blocks were then built by the robot.The entire denture was modified by adding wax to the tooth-arrangement assistant to create a fixed tooth arch[16].It encounters a number of challenges of various kinds. One such barrier is the high cost of applying new technology in the medical and dental fields. Robotic systems are complicated and need skill to operate and work properly
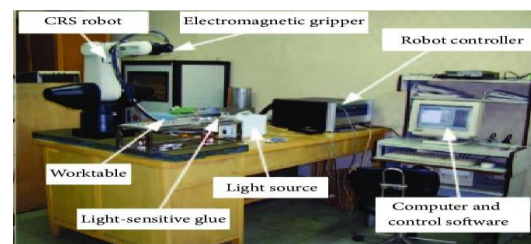

Figure 2

DENTAL PATIENT ROBOT

This is realistic robot with which student practice such that they get to know how patient react to surgery. It will be useful for the students to observe patient's expression like sudden motion of patients to pain, sweeping motion of patient's hand due to pain. Phantom is the term given to the dentistry patient robot concept [1]. Patient robot also has installation of voice recognition and voice synthesis system. This system is controlled by PC which are made with hardware and software, this robot also ulva and tooth sensor which simulate thevomit and pain as human does[2].These robot also consists of movable tongue and eye balls[2].Dental patient robots like Showa Hanaka ,Genuinoid DK were invented in Japan [1].

The realistic robot known as ShowaHanaka ,that act similar to the patient Germinoid dk is another robot that is remotely controlled robot to perform human facial expression

simroid the robot that is based on sensors in the mouth that suggest negative and awaken the students to it, the robot can feel pain and communicate discomfort.[9]
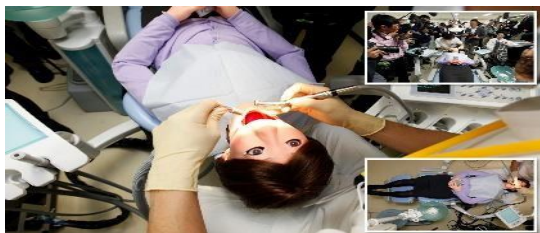

Figure 4

DENTAL NANO ROBOT

Figure 5

As compared the regular robots, Nano robots are manufactured out of thousands of mechanical parts. It is made by using the nanoparticles such as carbon nanotubes, metallic Nano conductors and diamondoid material[5] . These are minute robotic device which helps in injecting local anesthesia and in permanent cure of hypersensitivity[6]. Swarms of dental Nano robots are programmed to swim through human tissue by specific motility mechanisms which settle down in a precise position and monitor their surrounding individual nerve cell which will be very useful during surgery[5].

They are also used to neutralized harmlful biofilms which are present on the teeth targeting diseased sites using nano robot. These smart nano robots are fused with mouthwash which id entities and kills harmful Bacteria and improves oral health entities and improves oral health

DENTAL ROBOTIC DRILL

Nowadays, to overcome the complexity of dental implant surgery designed the dental robotic drill is developed by technologies[1].this technology has already tested on animals and is approved by US food and drug administration[2]. This robot immobilize patient's jaw and gum is penetrated by suspending thin needles and location of the bones is determined[1].

Figure 6

This data is wirelessly transmitted to a PC that combines with the CT scan data to configure a set of drill guides once the drill is activated,it is self-guiding but thus process can altered by practioner at any time[2]

TABLE 1: Methodologies for Robotics in Dentistry

Author	Methods	Purpose	Year
Dimri D et al.[1]	Endo Micro robot	This method is used to treat and detect inner canal of infected teeth	2020
Hideaki Takanobu et al.[2]	Dental Therapy-patient robot	This method is used to achieve easy replacement of oral tissue	2004

J Dong et al[3]	Endo dontic robot	This treatment involves drilling through the crown of the tooth to the canal in which the root resides.	2007
Manjusha Rawtiyaet al.[4]	Surgical robot	This method is used to achieve complex surgery	2014
Neetha J Shetty et al.15]	Dental nanorobot	This method is used to detect and kill infectious bacteria	2013
Verma SK et al.[6]	Orthodontic treatment	This method is usedto achieve accurate teeth position.	2013
Mauro Giordano et al.[7]	Virtual modeling	This method involves Robotic stimulation of 3D modeling which has capable of emulating the actual robot to the real time robot	2012
Xiaoyan Sun et al.[8]	Automated dental implantation	Reliable and successful result for dental implantationusing image guided robotics	2010
Hindol Das [9]	Oral Surgery	This method is used to achieve precise correction of jaws	2021
Janet Dc iT.. et al [10]	Microscopy and Endoscopy	This process involves optical bioscopy also uses optical coherence tomography	2007
David B. Camarillo et al.[11]	Da Vinci Surgical system	This method uses surgical armsto minimize stress on thoracic wall during manipulation	2004
Hossein Hassani et al.[121	Intra oral camera	The technology with small camera with mirror is used toexplores the patient mouth	2021
Jasmin Grischke etal [13]	X-ray imaging radiography	Accurate position of x-ray source with no adverse effect is made by 6 DoF robotic arm	2020

Yiqun Wu et al[14]	Robot assisted dental implantology	This method uses Surgical navigation systems and template guidance to meet the demands of high accuracy in implant placement and positioning.	2019
Paras Ahmad et al[15]	Robotics in dentistry	Manual robots can provide safer and more accurate drilling than traditional dentistry	2021

III.   CONCLUSION

Robotics are used in dentistry to enhance human activity and overcoming the shortcomings of manual labor and enabling more accurate and refined movements than are possible with a human hand. Robots in many countries have already brought about the reality of educational systems.The use of robotics in dentistry can increase precision, predictability, safety, the standard of care, and treatment efficiency. Robotics in the field of dentistry has the potential to alter people's quality of dental health in just few years. Robots in many countries have already brought about the reality of educational systems. Because of the development of new technologies, the future of dentistry remains unknown. The vision and viability of implementing these technologies in clinical practice and for educational purposes are the main areas of concern.

REFERENCES

1. Dimri D, Nautiyal S"Dental robotics - get going". International Journal of *Science &* Healthcare Research. 2020; 5(2):424-426

2. Hideaki Takanobu Akihisa Okino, Atsuo Takanishi, Mutsumi Madokoro, Yoshikazu Miyazaki, Koutarou Maki, "Dental patient robot"Proceedings of the 2006 IEEE/RSJ International Conference on Intelligent Robots and Systems October 9 -15,2006, Beijing, China **DOI: 10.1109/IROS.2006.281888**

3. THE DEVELOPMENT OF ENDODONTIC MICRO ROBOT* J Dong, PH.D. and H Everett Department of Mechanical Engineering Technology University of Cincinnati, OH 45206-2839 USA

4. Manjusha Rawtiya, Kavita Verma,Priyank Sethi, Kapil Loomba"Application of robotics in dentistry Quick response code" 2014(doi: 10.5866/2014.641700)

5. Neetha J Shetty 1, P Swati, K David DOI: 10.1016/j.sdentj.2012.12.002 "Nanorobotic in dentistry"-2013

6. . Verma SK, Chauhan R, "Nanorobotics in dentistry A review, Indian Journal of

Dentistry"(2013), (http://dx.doi.org/10.1016/j.ijd.20I 2.12.010)

7. Mauro Giordano , Pietro Ausiello , Massimo Martorelli , Roberto Sorrentino , "Reliability of computer designed surgical guides in six implant rehabilitation with two year follow up"(2012)https://doi.org/10.1016/j.denta1.2012.06.005

8. Xiaoyan Sun , Frederic D. McKenzie ,Sebastian Bawab , Jiang Li ,Yongki Yowl •.len-K Huang "Automated dental implantation using image guided robotics:registration results"(2010)(DOI 10.1007/s 11548-010-0543-3)

9. Robotics in Dentistry: The Next Generation Technology. Retrieved from https://dentalreach.today/robotics-in-dentistry-the-next-generation-technology/.DR. HINDOL DAS .

10. Janet Dong, PhD, Shane Hong, Ph, Gannar Hesselgren, PhD., DDS,"study on the development of endodontic micro robot"(2007) International Journal of Modern Engineering Volume 8, Number 1 Fall 2007

11. " Robotic technology in surgery: past, present, and future" David B. Camarillo, M.S.a Thomas M. Krummel,M.D.b,*, J.Kenneth Salisbury Jr.,Ph.D.b,"2004 doi:10.1016/j.amjs urg.2004 .08.025

12. Hossein HassaniPedram Amiri Andi , Alireza Ghodsi , Kimia NorouziNadejda Komendantova and Stephan Unger "shaping the future of smart dentistry: From Artificial Intelligence (Al) and IntelligenceAugmentation(IA)"
(2021https://doi.org/10.3390/iot2030026)

13. Jasmin Grischke , Lars Johannsmeier , Lukas Eicha,Leif Grigaa, Sarni Haddadinb "Dentronics: Towards robotics and Artificial Intelligence in dentistry"(2020) (hops://doLorg/10.1016/j.denta1.2020.03 .021)

14. Robotics in Dental Implantology Yiqun Wu, DDS, MDa , Feng Wang, DDS, MDb , Shengchi Fan, DDSa , James Kwok-Fai Chow, MDS, FRCDC, FRCSc, *https://doi.org/10.1016/j.coms.2019.03.013

15. Review Dental Robotics: A Disruptive Technology Paras Ahmad 1 , Mohammad Khursheed Alam 2,* , Ali Aldajani 3 , Abdulmajeed Alahmari 3 , Amal Alanazi 3 , Martin Stoddart 4 and Mohammed G. Sghaireen 3 2021 **https://doi.org/10.3390/s21103308**

16. Robotics in Dentistry: A Narrative Review by Lipei Liu, Megumi Watanabe, Tetsuo Ichikawa *Dent. J.* 2023, *11*(3), 62; https://doi.org/10.3390/dj11030062