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Research Article

Review of the robotics technology in the dentistry

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ABSTRACT

Robotics is a revolutionary technology that will alter the standard methods of diagnosis and treatment in dentistry. Robots can conduct repetitive processes without deteriorating quality or quantity of patient care, even over long periods of time. Medical robots of the modern age have evolved over the last decade, and the newest have gained the ability to assist patients without the supervision of a human operator. However, the therapeutic dependability and accuracy of autonomous robots are currently unavailable because to a lack of study data. The article that follows presents an analysis of current robot systems in dentistry based on evaluations of commercial robot systems that exist in dental implantology, oral and maxillofacial surgery, prosthetic and restorative dentistry, endodontics, orthodontics, oral radiography, and dental education. This concludes that although there are present limits in dental robotics, these issues may diminish in the future as well as have a substantial effect on oral healthcare and the dentistry profession.

Keywords: Robotics, machine learning, positioning, GPS, PSO, sensor network

INTRODUCTION

Robots are machine automation tools that conduct automated, machine-assisted manual activities that are preprogrammed by a computer. The technological advances in robotics and artificial intelligence have increased the number of activities that are performed by robots. Particularly boring and repetitive occupations have all but disappeared. As robots are able to do a variety of different tasks, they are being integrated into both our personal and professional life [1,2]. Robots constantly provide high-performance, economic relevance, and they increasingly operate alongside humans in public places as smart assistants and colleagues. A significant increase in demand exists for the development of more efficient and effective healthcare techniques while standardising existing procedures. Robotic automation and assistive technology provide numerous possibilities for dental practise enhancement. Robots may serve as a supply of human resources for activities like talking to patients or fulfilling tasks that call for a great deal of cognitive capacity [1]. While robotic dentistry devices may aid in the accuracy of treatment, several technological issues need to be resolved [5]. There may be one of the most significant reasons for robotic dentistry in the implementation of robots in dental clinics. Dental hygienists and dental assistants had a higher likelihood of using computers for their daily duties compared to dentists. At the end of the 1960s, Jenkins saw 1967 as a robotic dental secretary. And now in dentistry, many robot applications have become a reality. Potentially leading to errors in the oral examination, illness diagnosis, and treatment planning, dental professionals may suffer physical and mental fatigue after hours of rigorous operations in ergonomically difficult postures. Cleaning everyday routines, such as equipment and surfaces at the dental office, may also result in less attentive hygiene. Computers and robots combined with digital medicine/dentistry may assist to improve the accuracy and amount of treatment delivered [6–8]. Robots are now being utilized for three things becoming dental assistants, performing tooth preparation and autografting operations, as well as autonomous dental implant installation. Robotic devices may be used to assist with educational tasks as well. Using full-body robots, haptic interface technology, and sophisticated simulation, it is possible to educate trainees the basics of oral health care before interacting with patients.

ROBOTICS' HISTORICAL DEVELOPMENT

NASA's pioneering research with robots began the field of robot-assisted surgery. Remotely operated robotic systems were developed by NASA in the 1980s for military and space-bound surgery, as well as military and space-bound surgery. Robotic systems for conducting laparoscopic surgery were first approved by the FDA in 2000. A transatlantic live robotic cholecystectomy was used to validate the doctor-robot idea in 2001. It was the first time a team of surgeons worked on a patient through telepresence (i.e. being in another location via technology) As a result, robots have been used in surgeries that require fine motor skills, such as gynaecology, urology, and general surgery. Instrumental and hand tremors are eliminated, and freedom of

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movement is provided, along with accurate positioning and vision. These results have spurred advancements in minimally invasive surgery by offering instrumentation with great precision and flexibility of movement. Robots give surgeons improved access to their instruments and simpler working environments. Recent developments in the medical robotic business have seen the industry move emphasis to autonomous robotic technology, whereby robots execute a treatment without the assistance of a human. Finally, robotic microrobots have been envisioned to inject lethal chemicals into cancer cells from a distance.

AUTOMATED DENTAL ASSISTIVE DEVICES

Because implant placement is so important, the results of dental implant therapy are completely reliant on the location of the implant. Achieving more accuracy and precision in implanting techniques is accomplished by using surgical template guiding and navigation systems. Additionally, missing teeth and restricted mouth opening may impede effective work postures, resulting in operator fatigue and the likelihood of human mistake. Robotic implant surgery may make implant placement more flexible, stable, and accurate [9]. The development of computer-assisted dental implantology began with the fusion of prosthodontics and dental implantology. For precise implant placement, the devices typically need real-time surgical monitoring of the robot. The first robot-guided implant implantation was reported in 2002 by Boesecke et al. [10]. An illustrative example of a robot's performance. An autonomous robotic system with 6 degrees of freedom (DOF) placed a root-shaped dental implant in 2012, using a volume-decomposition-based method. To gain the trust of their patients, dentists had to show patients how well they could position implants in advance of surgery. Next, a 3-DOF robotic system equipped with a stereo camera was developed, and the dental handpiece could be monitored and modulated to ensure implant placement according to the preoperative plan. In order to guarantee the right cutting location and appropriate force, the planned surgical operation was performed automatically by the computer. The first computerised navigation robotic system (CNS) authorised by the FDA for use in augmenting the clinical accuracy of dental implant surgery was named YOMITM (Neocis, Miami, FL, USA) in 2017. YOMI offered physical guiding of the drill's depth, orientation, and position, eliminating the need for the doctor to manually fabricate surgical guides or the surgeon to control their own hand position throughout the operation. Precise and predictable navigation is achieved while using vibrational feedback for implant surgery in which an osteotomy is created. YOMI does, however, need supervision, which is one of the reasons why it is not widely used. Zhao developed the world's first implant-placement device that is fully autonomous in 2017. Surgery may be done without the assistance of a dentist, and it is possible to autonomously modify surgical duties. Conceptually, however, validation data on the implant positioning's practicality and dependability as well as the robot's automated choices are few. Dental implants produced by the Fourth Military Medical University Hospital (Xi'an, China) and Beijing University in 2017 were developed by the two organizations independently. Robotic systems were created to address a scarcity of highly skilled dentists in China and help avoid surgical mistakes. The robot, software, implantation foundation, and image-guided foundation were all included into the system. To calibrate the operation foundation with the image-guided system, the robot, the operation foundation, and the geographical coordinates of patients utilised four different types of tooth defect models as mapping tools. The accuracy of the treatment was verified by comparing postoperative cone-beam CT scans with the originally intended preoperative CT scans for dentition defects. As a result, the calculated mean error was 0.705 mm with a standard deviation of 0.145 mm, and the calculated mean apex error was 0.998 mm with a standard deviation of 0.232 mm, all while the actual apex deviation was 2.077 mm with a standard deviation of 0.455 mm. A different independent robotic surgical system was examined in vitro with the goal of inserting 5-cm long zygomatic implants into edentulous maxillae, and as a result, the implant location had much improved accuracy [29]. In a research on zygomatic dental implant placement, a 6-axis robotic arm was shown to improve the accuracy of the procedure. According to the authors, including a force feedback device that uses a haptic tool may enhance the robot [11]. In difficult implant situations, using robotic implantology has reduced the amount of alveolar bone while having no effect on other aspects of the implants' health. In other research, industrial robots have been employed in simulated trials of robot-assisted implant insertion. According to the results of the industrial robots having 6-DOF, the implant insertion variation was 1.42 ± 0.70 mm, and the implant placement was repeatable, within ± 0.02 mm.

MAXILLOFACIAL AND ORAL SURGERY

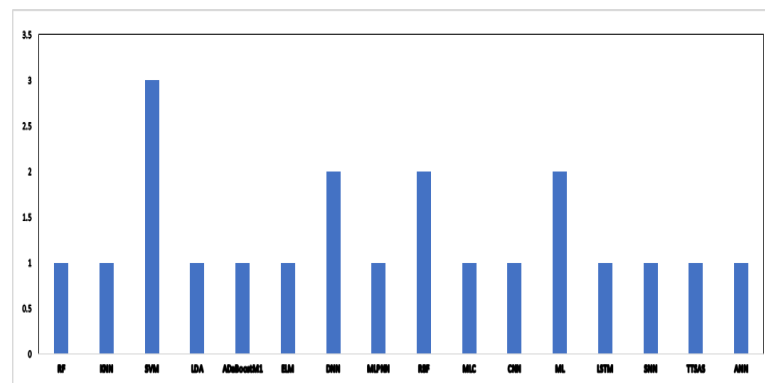
Radio- and/or chemotherapy may be necessary to treat malignant lesions of the oropharynx, since some are not as easily accessible as others. Mandibulotomy with mandibular displacement and lip split is typically performed during salvage surgery. Orthognathic surgery is still rather novel, but robotic oral and maxillofacial surgery offers it as a potential opportunity, particularly for oropharyngeal cancer therapy. The da Vinci system, which had been cleared by the U.S. Food and Drug Administration (FDA) in 2009, was authorised for the treatment of malignant illnesses, as well as all non-malignant lesions of the oropharynx, even when situated near the base of the larynx and the tongue. As the procedure becomes more commonplace, computer-assisted dental implant surgery is used more and more often by healthcare professionals. The CBCT assessment is performed, but bi-dimensional radiographs are also standardised. In addition to robotic surgery in the lower digestive system, robotic surgery has also been performed in the upper aerodigestive tract, which is accessible through the mouth cavity [12]. Stereoscopic vision, multi-articulated tools, and robotic arms allow for the minimally invasive operation of the oropharynx. The good local management of low-risk oral squamous cell carcinoma [13] may also be achieved with robot-assisted surgery. The popularity of machine learning application based robotics in the dental world is analyzed according to the previous studies and the Figure 1 is demonstrating the same.

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Table 1: Machine learning based robotics popularity in dental applications

Reference	Technology
[1,2,4]	SVM, LDA
[5,3]	CNN, FFNN
[7]	LPNN
[6]	MLC
[8,9]	LSTM
[10]	SNN
[11-13]	TTSAS

**Figure 1: Machine learning methods popularity**

CONCLUSION

Survey approach is made for testing the popularity of deep learning and their impact on the robotic field in the dentistry. Several studies were identified and the results shown that deep learning is essentially impacting the mentioned application in positive way. The results shown that SVM is popularly used in this field. The most of the research paper reviewed in this study have applied SVM algorithm for position detection of the robot.

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