

# Dental Robotics - Get Going

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## ABSTRACT

Technology has become an integral part of our day to day life. In the recent times, Dentistry too has witnessed emergence of new technologies which have the potential to transform dental practice in many ways. Dental robotics is the next generation technology which opened new pathways for it to expand and explore the various areas of dentistry and it also helps in fulfilling tasks which is difficult for the dental clinician to achieve. Dental robots have various application related to teaching dental students, endo micro robot, arch wire bending and dental implantology. This focused review aims at application of robotics in various specializations in dentistry.

**Keywords-** Robotics, Endo-microrobots, Dental Nanorobots, Surgical Robots

## INTRODUCTION

The simple act of smiling sends a message to our brain that we're happy. And when we're happy, our body emits feel-good endorphins. When we have good dental care, we tend to smile more often, thereby making our life pleasurable. Now, dentists are utilizing robots to help keep us smiling. Robots, the most wonderful invention of human being, have made their way into dentistry.

Robotics is the branch of technology that deals with the design, construction, operation, and application of robots as well as computer systems for their control, sensory feedback, and processing the information. The term robotics was introduced by writer Isaac Asimov in his science fiction book, "I Robot", published in

1950.<sup>1</sup> According to the Robot Institute of America a robot is defined as "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".<sup>2</sup>

## Footsteps of Robots in Dentistry DENTAL PATIENT ROBOT-

Dental therapy dexterity mainly depends on the ability and expertise of clinicians and it is certain for them to have ample experience using methods and models that precisely reflect actual treatment procedures and conditions. Currently, the concept of dental patient robot is named as phantom heads which consist of simple functional cephalic region with an arrangement of teeth much different from actual patients. The concept of phantom heads was initiated in Japan.<sup>3</sup>

### Showa Hanako

Tokyo's Showa University engaged robotics company Tmsuk to manufacture the realistic robot which is designed to simulate a number of typical patient gestures and responses, allowing dental students to experience what it's like to work with a real patient. The robot is also capable of simulating a gag reflex, which is frequent during dental procedures, it can blink, roll its eyes, sneeze, shake its head, cough, move its tongue and even get tired when having to keep its mouth open for too long.<sup>4</sup>

### Geminoid DK

This robot is a realistic android designed for research into human-robot interaction. It is modeled after Danish professor Henrik

Scharfe, who remotely operates the android as his robotic surrogate. The Geminoids can be controlled, being equipped with advanced motion-capture technology.

### **Simroid**

It is a super realistic dental teaching robot for clinical training at dental schools created by Kokoro Company Ltd. It is actually an upgrade to Simuloid, a less sophisticated dental training robot created back in 2007. This robot is loaded with sensors that give feedback to dental students. It can express pain when poked hard; it grimaces to show pain; and it also moves its hands and eyes to say that it is hurt.

### **ENDO MICRO ROBOT-**

Success of endodontic treatment depends on the clinician's knowledge, expertise including his/her tactile sense and judgment. To help with this, endo-microrobots were fabricated. It consists of a visually guided robotic system will be mounted on the teeth within patient's mouth, while a robotic controller and a root canal image processor share control over its motion. With online monitoring and positioning control, the multipurpose robotic system will perform automatic treatment procedures, including probing, drilling, filing, cleaning and filling. This robot consists of a micro position and orientation adjustment device, an automatic feed rate and travel distance controller, micro sensors and apex sensors.<sup>5</sup>

### **DENTAL NANOROBOTS-**

Nanorobots are miniature devices measured on the scale of nanometers (1n equals one millionth of 1 millimeter) constructed with nanoscale or molecular components. A dental nanorobot have a nanocomputer on board which store and performs pre-programmed actions and processes signals and external stimuli.<sup>6</sup>

The possible treatment options of using nanorobots may include the application of nanotechnology to local anesthesia, dentition renaturalization, the permanent cure of hypersensitivity, complete

orthodontic realignment in a single visit, covalently bonded diamondized enamel, and continuous oral health maintenance using mechanical dentifrobots.

### **SURGICAL ROBOTS-**

The intervention of robotics into surgery has allowed surgeons to create a new kind of environment in the operating room. Robotic technique is being used for milling of bone surfaces, drilling of holes, deep saw osteotomy cuts, selection of osteosynthesis plates, bending and intraoperative positioning in defined position, and orthognathic surgery planning.<sup>7</sup>

### **SENSOR-EQUIPPED IMPLANT SETUP-**

Dental implants are long-lasting tooth replacements that use Titanium screws embedded directly into the alveolar bone. Recently a new system of computer assisted surgery for implants has been developed consisting of preoperative and intra operative stage. The preoperative stage, uses the 3D views obtained from the raw images of the patient before surgery followed by the intra operative stage, which it shows 3D orientation of surgical instrument position and trajectories which are displayed on the monitor within a patient's 3D imaging data.<sup>3</sup> "Yomi" (FDA Cleared) is robotically assisted dental surgical system for implant placement. It is used to plan a procedure based on patients' CT scan.

### **ROBOTIC DENTAL DRILL-**

It is a recent advancement, developed by Tactile Technologies, consists of 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 PC and joins with the CT scan data thereby producing a set of drill guides. Once activated, these are self-directing and can be altered by the clinician as per the requirement.

### **TOOTH ARRANGEMENT ROBOT-**

It is a single system used for the manufacturing of upper and lower complete dentures. The various functions of this software is to choose and create medical history files of the patient followed by drawing a jaw arch and dental arch curves and finally, adjustment the dental arch curve as per the jaw parameters. This system aids in adjusting the tooth arrangement initial position for the robot, creates control data profile and controls the robot for tooth arrangement operations. The manufacturing of complete dentures takes only 30 minutes using this robot system and the precision and accuracy of each robotic system is measured.<sup>8</sup>

### **DENTAL IMPLANTOLOGY ROBOT-**

This 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 CT scanner data. Neocis, a Precision HealthCare Robotics company, has introduced an FDA-cleared computerized navigational system (robot) intended to assist in both the planning and surgery of dental implants. The YOMI® robotic arm provides an enhanced level of precision and control while using haptic guidance and multisensory feedback to perform dental implant surgery. 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.

### **ORTHODONTIC ARCH WIRE BENDING ROBOTS-**

This new bending apparatus is known as "SureSmile archwire bending robot." The apparatus comprises a robot mounted to a base or table support surface with 2 gripping tools. The tools incorporate force sensors

which are used to determine overbends to get the desired final shape of the archwire. They may also include 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.

### **CONCLUSION**

The intervention of robotics in the field of dentistry can offer improved accuracy, predictability, safety, quality of care and speed of treatment. With the emergence of new technologies, future of dentistry is unpredictable. Main concern lies in the vision and feasibility of adapting these technologies in day today teaching and clinical practice.

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