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Research Article

HAPTICS: SIMULATION TECHNOLOGY IN DENTAL EDUCATION

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ABSTRACT

In the field of education, to improve the tactile sensation, the sense of touch and force-feedback can offer great improvements to the existing learning methods, thus enhancing the quality of education procedures. The concept of Haptics, which is extensively in use and indispensable in other fields like aviation, telecommunication etc., is now making its way into dentistry. The haptics-based virtual reality periodontal training simulator has been validated. By the use of virtual reality and haptics technology, the periodontal simulator allows trainees to learn performing diagnosis and treatment of periodontal diseases by visualizing a three dimensional virtual human mouth and feeling real tactile sensations while touching the surface of teeth, gingiva, and calculi with virtual dental instruments. Also, haptics offers the possibility of unlimited training hours by which students can gain skills without demands on manpower and resources. This review provides a brief insight about literature on haptics for training of periodontal procedures.

INTRODUCTION

Dental and medical education has utilized technology increasingly over the past few years for learning as well as training. Medical simulation has become a valuable tool for learning and acquiring skills. Acquiring abilities and skills to perform dental procedures is essential for dental students and clinicians. It takes more than only observing patients, diagnosing and managing the disease but also needs a practical experience of the tactile information to gain surgical expertise[1]. Till date, these are gained in the laboratories of the dental faculties in two stages. Firstly, dental students are trained on artificial teeth, placed within a manikin head, using real dental instruments, like burs, etc., Practicing on manikins reduces the risk to some extent but is less effective considering the cost, availability, and lack of rare real-world cases (cannot provide the level of detail and material properties of real life teeth and procedures). In the second stage, the students perform dental procedures on real patients under the close supervision of their professors. So, the students/clinicians go through a trial and error process by working on real patients before achieving better and more consistent experience and safe performance of dental and medical procedures[2]. Students/clinicians must know how to use the tools and the material properties of the organs (e.g. before taking up surgeries on real patients, we need to have a feel of soft tissues and bone texture, which is not possible in a conventional setup). Hence, a system, which simulates real dental procedures graphically and haptically, will be a better option to increase student's knowledge/experience level and to perform mock surgeries before they actually practice them on live patients. Hence, introduction of haptic technology can bring about better outcomes with less error[1].

What is haptics?

Haptics (pronounced HAP-tiks) is defined as the science of applying touch (tactile) sensation and control to interaction with computer applications. The word "haptics" is derived from the Greek "haptikos," meaning able to grasp or perceive[3].

Virtual reality

Virtual reality is a form of human-computer interaction providing a virtual environment that one can explore through direct interaction with our senses.

The real world

User should be able to touch the virtual object and feel a response from it. In order to complete the imitation of the real world one should be able to interact with the environment and get a feedback. This feedback is called Haptic Feedback.

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Haptics Feedback

Haptics is implemented through different type of interactions with a haptic device communicating with the computer. These interactions can be categorized into the different types of touch sensations a user can receive:

1. Tactile Feedback
2. Force Feedback

Haptics Technology

Haptic technology is a tactile feedback technology which takes advantage of the sense of touch by applying forces, vibrations, or motions to the user.

A haptic device gives people a sense of touch with computer-generated environments, so that when virtual objects are touched, they seem real and tangible.

Types of Dental Simulator

There are two types of dental simulator:

1. ***Manikin-based simulators:*** Consist of a physical model of the patient's head and mouth on which dental procedures can be performed using real dental instruments. eg; DentSim™, Image guided implantology (IGI), developed by DenX Ltd)
2. ***Haptics-based simulators:*** Consist of a haptic device and virtual models of a human tooth or mouth which acts as a platform to facilitate dental practicing. Instead of using real dental instruments, the trainee holds the haptic device stylus to manipulate a set of virtual instruments that are shown on a monitor screen. The tactile feedback reproduces clinical sensations in the hand of the operator using dental instruments[4].
3. The field of Periodontics is that field of dentistry which requires dentists to depend primarily on their tactile sensations, for both diagnostic and surgical procedures. This makes haptics ideally suited for periodontal simulators[3].

How it works?

Haptics allows the user to feel, manipulate, and interact with the object displayed on the personal computer monitor.

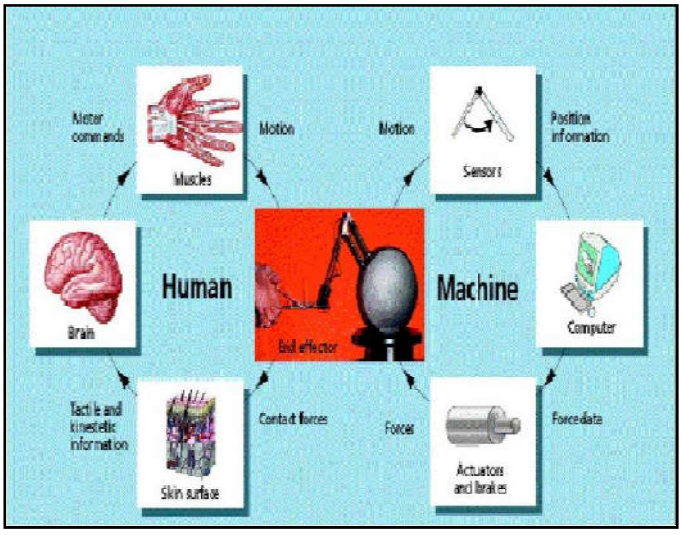


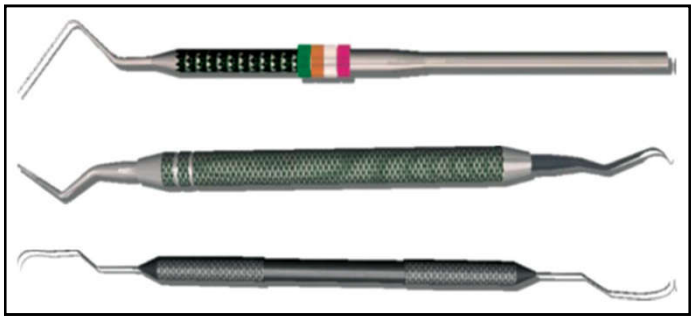
Figure 1

The user can touch, move, and feel an existing distant object indirectly through a robotic arm. Furthermore, haptics provide force feedback to humans interacting with virtual or remote environments since the robotic arm is able to provide preprogrammed guidance. (fig1)

How to Operate A Periodontal Simulator

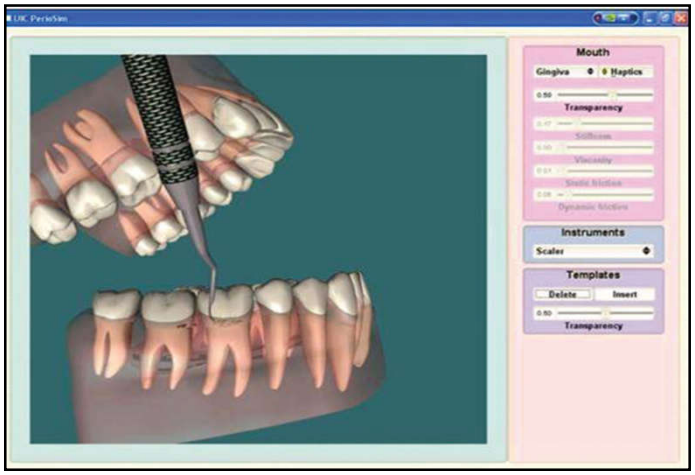
Instrument selection

Using the control panel, one of three periodontal instruments can be selected for on screen use: A periodontal probe, explorer, or scaler. (fig 2)



Graphics control

In the main window of the simulator, the user can see the full screen 3D model of area of interest in a dental arch along with the main control panel. The main control panel contains a variety of controls for navigation which include options to select and manipulate gingiva. The operator can induce varying degrees of transparency of the selected objects using a slider bar. (fig 3)



Haptics control

In the main window of the simulator, the user can control the haptic properties of the simulation process. This includes the basic ability to turn haptics on or off for each selected object. The haptic parameters such as stiffness, viscosity, static friction, dynamic friction can be controlled and altered separately for each object.

By moving the haptic stylus, a trainee can move the virtual instrument on the tooth surface and feel the crevice or pocket area within the margin of the gingiva (gums) along the root surface of the tooth. (fig 4)

Figure 4

The 3D virtual periodontal probe can be used to determine and measure crevice or pocket depths around the gingival margins of the teeth. The textural feel of pocket areas can be differentiated and regions of sub-gingival calculus can be located. Since the root surface is covered by gingiva, the trainee cannot see the area being probed or the underlying calculus and must depend totally on haptic feedback to identify these areas. This situation corresponds to conditions encountered clinically. To assist visualization of what he/she is feeling, control panel adjustments can introduce varying degrees of gingival transparency. Graphical and haptic parameters can be altered by an instructor using control panel adjustments to provide the "feeling" or feedback he/she wishes to impart to the trainee. The system permits any instructor to generate a diagnostic and/or treatment procedure for student use[4].

Haptics and Bone Surgery

In the Stanford Bio Robotics Laboratory, a visuohaptic simulation of bone surgery for training and evaluation has been devised. A hybrid data structure is used to represent the bone: A volumetric array stores the density values and attributes of the data, whereas a surface triangulation is used to render the bone graphically. The volume data and surface triangles are obtained from computer tomography or magnetic resonance data after a preprocessing procedure. The simulation also provides the ability to assess the trainee's performance using predefined metrics together with visual and written feedback. Moreover, the system simulates bone dust, provides drilling sounds, and can incorporate a second haptic device as a suction and irrigation tool. Another computer aided support system for implant surgery, Bone Navi, has been developed in Japan to simulate implant placement and surgical guide fabrication for dental implant surgery.

To accomplish these objectives, this system involves manipulating a 3D computed tomography image of a jawbone with a virtual reality force feedback device. To achieve enhanced haptic realism, this system also provides the haptic experience of bone drilling with virtual vibration and the sound of contra-angle handpiece. These simulation features are useful for inexperienced dentists and for training dental students in bone drilling in dental implant operations[5].

Advantages

- Improved usability: Haptics improve usability by engaging touch, sight, and sound.
- Enhanced realism: Haptics injects a sense of realism into user experiences by exciting the senses and allowing the user to feel the action of the application.
- The inclusion of tactile feedback provides additional context that translates into a sense of realism for the user.
- Restoration of mechanical feel: By providing users with intuitive and unmistakable tactile confirmation, haptics can create a more confident user experience and can also improve safety by overcoming distractions especially during sub-gingival calculus detection, determining bone defects without flap reflection and performing periodontal surgery.
- Self-evaluation: It has the ability to give instant, consistent, and unbiased feedback based on evaluation of the procedure in the form of felt sensations in the hand.
- Correct ergonomic positioning: Incorrect operator or patient positioning can result in blocking the camera from reading the light-emitting diode sensors and prevents the user from continuing by warning signals which encourages the students to support and reinforce good ergonomic habits.
- Standardized evaluation: Consistency and uniformity for preclinical evaluation.
- Faster acquisition of skills: Students develop skills more efficiently in a shorter period of time as compared with the traditional simulator units (phantom heads), which can result in smoother transition for students into the clinic.
- Haptics provide effective learning without any fear of making mistakes on a patient.
- Haptics offers an additional dimension to a virtual reality or 3D environment.
- Reinforcement of learned dental concepts.
- It allows proper selection and manipulation of dental instruments to perform periodontal procedures.

Disadvantages

- The tactile perception for gingiva is not very real.
- The feel of working on dental chair is lacking as it uses desktop system.
- Single hand held haptic arm does not provide the feel of using mouth mirror and working instrument together.
- The initial cost of this advanced technology simulation can be substantial. Difficult equipment to maintain and repair:
- Technology-based systems require faculty/engineering staff to be available for training and supervision of the laboratory.

CONCLUSION

Advanced simulation technology simulators offer an exciting opportunity to dramatically improve student learning. Haptic

technology is a powerful educational methodology which improves the level of perception, sense of touch and feel and reduces the distance between the virtual and the real world. Haptics offer an excellent complementary means of training and could be a replacement for the existing ones.

References

1. Buchanan J.A. 2001. Use of simulation technology in dental education, *Journal of Dental Education*, 65, 1225-1231.
2. Mallikarjun S.A., Tiwari S., Satyanarayana S., and Devi P. 2014. Haptics in periodontics, *Journal of Indian Society of Periodontology*, 18 ((1), 112-113.
3. Khanna R., Sharma S., and Rana M. 2017. Haptics: The science of touch in periodontics, *Journal of Digital medicine*, 1 (2), 58-63.
4. Luciano C., Banerjee P., and DeFanti T. 2009. Haptics-based virtual reality periodontal training simulator, *Journal of Dental Education*, 3, 1-17.
5. Konukseven E.I., Önder M.E., Mumcuoglu E., and Kisnisci R.S. 2010. Development of a visio‐haptic integrated dental training simulation system. *Journal of Dental Education,* 74, 880‐891.

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