Dental Informatics

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Definitions of Dental informatics

Section 1
Dental informatics is the application of computer and information science to improve dental practice, research, education and management.

- A sub-discipline of biomedical informatics

The Discipline of Dental Informatics
Characteristics of a discipline

1. Core of people who conduct research and publish in the discipline;
   - Since 1965 approx 3500 authors -2200 articles related to DI and computer applications in dentistry in 420 journals and conferences

2. An identifiable body of literature;

3. Professional societies and related activities;
   - Sections within AMIA, IMIA, ADEA, ect

4. Educational programs leading to certificate and advanced degrees;
   - General MI degrees with specialization in DI. Joint Degrees.

5. Funded research Programs;
   - Available as 3rd party funds. Limited.

Scope of Dental Informatics

Section 4
Cognitive science:

- is a research area that draws on several fields (such as psychology, artificial intelligence, linguistics, and philosophy) to develop theories of perception, thinking, and learning.

- Cognitive science relates to information science as we try to understand how information is represented in the human mind.

- Computer science relates to information science as we try to simulate our mental processes in computing environments.

- Biomedicine is replete with complex cognitive processes (such as diagnosis, treatment planning, and evaluation).

Computer science:

- is a discipline that involves the understanding and design of computers and computational processes. Here, the emphasis is not on information, but how it is represented, processed, manipulated, and managed in computing systems.

• Information Science:
  • is the collection, classification, storage, retrieval, and dissemination of recorded knowledge treated both as a pure and as an applied science.

Telecommunications:
- Is the science that deals with communication at a distance.
- Transmission of digital images efficiently resulted in new approaches to image compression and transmission.
- Another example is aggregating information from many different sources, such as information about the same patient from different healthcare providers.

A research discipline; Not mere application of computers (≠IT).

<table>
<thead>
<tr>
<th>Dental Informatics</th>
<th>Information Technology</th>
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<tr>
<td>DI= Development +evaluation of information models and computing applications</td>
<td>IT = Hardware and software devices to retrieve and display information</td>
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<tr>
<td>DI = research and application in conceptualization +organization +relevance +utilization of information</td>
<td>DI Technologies = software design + development +creation of I &amp; O devices.</td>
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Innovations = • Computer programs or devices = (IT).

DI technology • Incorporate DI in the technology.

Dental Informatics

Dental Technology

Inter-related
Uses of Dental Informatics

Section 5
• Informatics is key in helping practitioners solve clinical problems and keep current.
• Computers can help practitioners maintain their continuing competency, and many dentists already are using computers to keep abreast of new developments.
Dental Informatics can improve

- Effectiveness
- Efficiency
- Quality of oral care
- Patient experience
- Office management processes.
Dental Informatics Applications
Applications of Dental Informatics

- 3-D image modeler and predictors
- After visit summaries
- Alerts and reminders
- Computerized billing
- Connectivity to patients
- Diagnostic predictive modeling
- Decision support
- Digital radiography
- Electronic Oral health records (EOHR)
- E-prescribing
- Evidence-based Treatment Planning
- Haptic feedback simulation training
- Insurance form generation and claims processing
- Intra-oral cameras and imaging
- Intelligent time series comparative X-ray analysis

- Medical Dental interface
- Nano-robotics
- Online ongoing care relationship
- Outcomes Databases
- Practice Management
- Patient education & decision aids
- Patient registration and scheduling
- Patient Risk Profiling & assessment
- Pre visit preparation
- Recall tracking
- Secure messaging
- Tele-consultation & referral
- Terminology and nomenclature standards
- Voice Recognition
- Web Portal & blogs
## Fields of DI Research

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<tr>
<th>Field</th>
<th>Basic Research</th>
<th>Informatics Challenges</th>
<th>Applications Infrastructure</th>
<th>Office Applications</th>
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<tr>
<td>Clinical</td>
<td>Coding, data structures, high performance computing</td>
<td>Vocabularies, automated retrieval from repositories</td>
<td>Distributed medical records, clinical trials, teledentistry</td>
<td>EDR, Outcomes Predictor, Treatment Planner, Clinical Decision Support Tool</td>
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<td>Imaging</td>
<td>3-D modeling, visualization, data representation</td>
<td>Ontology-based reference models and classification</td>
<td>3-D anatomy atlases, radiological diagnosis</td>
<td>3-D modeler, X-Ray analyzer, dynamic neuromuscular occlusal simulation, Haptic feedback simulation</td>
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<tr>
<td>Bioinformatics</td>
<td>Biochips, algorithms for DNA sequencing, patient specific drugs</td>
<td>Linking genomic and patient data, security, ethics</td>
<td>Genetic-based patient records and protocols</td>
<td>Biometric nano-robotics, bioassay caries/periodontal analyzer</td>
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<td>Public/Population</td>
<td>Databases, searching, data analysis theories and algorithms</td>
<td>Integration and validation of information, knowledge discovery</td>
<td>Data mining, citizen-based services, social networks shared knowledge-base</td>
<td>Blogs, web portals, PHR,</td>
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Applications in Clinical Dentistry
## Electronic Oral Health Record

<table>
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<tr>
<th>EMR</th>
<th>EOHR</th>
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| • Reimbursement  
  • Diagnosis codes (ICD-9) & procedure codes (CPT 4).  
• Documentation :  
  • Finding → Location  
  • Text  
  • Holistic  
• Treatment:  
  • Roadmap for patient to follow | • Dental reimbursement:  
  • Procedure codes only.  
• Documentation :  
  • Location → Finding  
  • Graphics, templates  
  • Sequence  
• Treatment:  
  • Procedure implies pathology present.  
  • Roadmap for dentist |
Endodontics

Digital radiography refers to a method of capturing a radiographic image using a sensor, breaking it into an electronic pieces, and presenting and storing the image using a computer. The sensor receives the analog information and converter (ADC) to converts it to a digital image. The image is displayed within seconds or minutes on the computer screen in front of the clinician and the patient/client.
Viewbox is advanced software for cephalometric analysis. It is used in Orthodontic Departments around the world. Viewbox can be customized to almost any task. Points, measurements and analyses are not 'hard-wired', enabling you to go beyond the confines of cephalometric radiographs and perform measurements on any kind of radiograph, photograph or other two-dimensional or 3-D image. Furthermore, sophisticated algorithms are included for image enhancement, facilitation of point identification and morphometric analyses.
Many Chairside dental CAD/CAM systems and Dental Laboratory CAD/CAM systems use 3D Scanner technologies to capture the 3D surface of a dental preparation (either *in vivo* or *in vitro*), in order to produce a restoration digitally using CAD software and ultimately produce the final restoration using a CAM technology (such as a CNC milling machine, or 3D printer). The chairside systems are designed to facilitate the 3D scanning of a preparation *in vivo* and produce the restoration (such as a Crown, Onlay, Inlay or Veneer).
Image-guided dental implantology

- It provides a full 3D view of the patient’s anatomy, as a basis for evaluation and functional and aesthetic implant planning.
- Accurate examination of bone, muscles and other tissues by switching among them in real-time.
- Its high image definition facilitates the observation of the anatomical structures, allowing proper and secure planning and reducing all uncertainties during surgery.
3D-Time Series Analysis

- Time series analysis stands for comparing image data sets from the same person or specimen taken at different times to show the changes.
- Image segmentation, rigid registration and a voxel based non-rigid registration as well as 3D visualization, allows a time series analysis based on DICOM CT images.
- In dentistry the scope of further application ranges from pre- and postoperative oral surgery images (orthognathic surgery, trauma surgery) to endodontic and orthodontic treatment.
Applications in Research
For years scientists have tried to build an electronic tongue, a robotic tasting device that could have profound applications in improving food quality and safety. But before machines learn to taste their food, they first need to learn how to chew it. Scientists report the design of an artificial mouth that mimics the first vital steps of human digestion -- chewing, saliva release and the initial breakdown of food.
Researchers are testing different washes with a unique artificial mouth - developed by the Dental Research Group - which grows plaque and simulates growth conditions akin to oral disease.
Dental education
Virtual Patients

- The Virtual Dental Patient (VDP) application was designed to aid dentists in getting acquainted with the teeth anatomy, the handling of drilling instruments and the challenges associated with the drilling procedure.
- The VDP simulator allows the user to:
  - view/manipulate a 3-D head and oral cavity model constructed using anatomical data,
  - adapt the model to the characteristics of specific patient using either facial photographs or 3D data,
  - animate it using an MPEG-compatible facial animation player and
  - perform virtual tooth drilling within the oral cavity using a Phantom haptic device to control the drilling tool.
- Drilling is performed on 3D volumetric/surface models of teeth, obtained from cross sections of real teeth.
Manikin-based simulators

- DentSim™, consists of a manikin with head and dentoform (plastic teeth), a dental hand-piece and a light, an infrared camera and two computers. The manikin head and the hand-piece contain infrared emitters that are tracked by the infrared camera. Using this optical tracking system to trace the movements of a hand piece, the simulator scores the accuracy of a student's cavity preparation in a manikin’s synthetic tooth.
Image guidance simulators

- Image Guided Implantology (IGI), for teaching, diagnosis, treatment planning and placement of implants. Providing a particular patient’s CAT scan, the simulator allows the patient and the virtual model image to be coordinated during the actual surgery. If the computer recognizes that the surgeon is making a serious deviation from the treatment plan during the actual surgery, the computer will stop the hand-piece and the surgeon will need to override the computer to continue.
Virtual Reality Dental Training System (VRDTS).

- Aiming for cavity preparation, the software simulates a set of dental instruments.
- Using VRDTS dental students work with a virtual decayed tooth and learn to probe it for diagnosis, use a drill to prepare a tooth for cavity repair, fill the prepared cavity with amalgam and carve the amalgam to match the original tooth contour. Unlike plastic teeth, VRDTS enables the student to feel the difference between enamel, dentin, caries, amalgam and pulp throughout the procedure.
- The student’s operation can be tracked precisely in real time, providing quantifiable feedback to both student and teacher.
- Lastly, since the entire process is virtual, the student has the ability to zoom, rotate and even cut the tooth in cross section to better understand the process. VRDTS offers the student the opportunity to practice procedures as often as needed, with no additional cost for materials.
PerioSim Force Feedback Dental Simulator

- Students guide a stylus on-screen that resembles an explorer. They can feel life-like tactile sensations as they navigate through various procedures.
- Students can access PerioSim via the Internet. A realistic 3-D human mouth is shown in real-time, and the user can adjust the model position, viewpoint and transparency level.
- The system allows instructors to create short scenarios of periodontal procedures, which can be saved and replayed at any time. The 3-D component permits students to replay from any angle, so the user can observe different views of the placement of the instrument and gingival relationships during a procedure, Steinberg said.
- The recorded file is an actual representation of the original scenario, which offers great training potential.
- The program also allows for a second playback mode, where an instructor leads the trainee through the program. By simply holding onto the haptic stylus, the trainee receives the same sensations felt by the instructor.
Teledentistry

- Conditions that only visual inspection or history is needed for interpretation
  - Oral medicine
  - Chronic Facial Pain
- Assisting patients with concerns:
  - Trauma
  - Finding a dentist
- Specific organizations with urban and rural centers:
  - MOH, KFSH, MOD, etc

- using the Internet to consult with an expert. This consultation could be:
  - direct (between the patient and the expert)
  - indirect (between the patient’s doctor and the expert).
- Phone call to expert
- Fax charts and records
- Internet: scanned image, digital image, and audio transfer of requests
• **InteractiveMD** is a telehealth company that connects patients with doctors via real-time videoconferencing, phone, and secure email,

• **MDLiveCare** is an on-demand telehealth company that provides patients with remote access via video, phone, and secure email to board certified doctors and licensed therapists. Recently, the company partnered with **Google Health** to allow their users to sync the data shared during telehealth consultations with their online health records.
Eastman Dental Center Lands a $532K Grant for Teledentistry

December 11, 2007

Eastman Dental Center, at the University of Rochester Medical Center, has landed a five-year, $532,000 grant to explore teledentistry, a novel approach that uses an intraoral camera to image teeth and tooth surfaces. The grant was awarded by the National Institute of Dental and Craniofacial Research, of the National Institutes of Health.

Jahmeek Polland-Randolph, 4, opens wide for a teledentistry exam at Wilson Commencement Park daycare. A trained health specialist captures and views the image on the screen behind Jahmeek before sending it to Eastman Dental Center.

Recent studies by the
Patient Education
Current Issues in Dental Informatics

Section 6
Challenges and future directions

- Quality of information and content credentialing
- Ensuring provision of care
- Licensure of providers
- Reimbursement of providers
- Emerging roles of health professionals
- Robotics utilization
Thank You

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