Egyptian Prosthodontic Association (EPA Newsletter)

Facial scanner applications in Dentistry

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The advancement in digital technologies has led to major innovations in dental techniques and workflows. The use of intraoral scanners and CAD/CAM technology for the restoration of teeth and dental implants has become commonplace. More recently, the use of facial scanners to digitally capture and present a detailed three-dimensional representation of a subject's face and head that can be subsequently utilized for patient treatment planning, diagnosis, and communication [1].

Facial scanning technology facilitates the collection and analysis of pretreatment and on-going clinical data to be utilized in esthetic dentistry as part of digital smile design workflow, in immediate denture for virtual teeth set-up on 3D model, in orthognathic surgery by the merging of the patient's CBCT DICOM file and intraoral scan STL file to allow virtual simulation of the surgery for precise and crucial pre-operative planning.

Facial scanning Mechanisms:

There are four scanning methods utilized by facial scanners: photogrammetry, stereophotogrammetry, structured light scanning, and laser scanning. All of them are advantageous because they are noninvasive, accurate, and reproducible [2].

1. Photogrammetry:

In which a single camera captures multiple photographs that are stitched into a 3D image.

2. Stereophotogrammetry:

In which multiple cameras capture multiple photographs from different viewpoints that are transformed into a 3D face model by computer algorithm. This technology cannot detect accurately hair or shiny skin surfaces which is especially useful in maxillofacial prosthetics. Also, it is sensitive to lightening conditions [3] (Fig. 1). Examples: 3dMD Face system (3dMD, Atlanta, GA, USA), Planmeca ProMax 3D Max (PM) (Planmeca USA, Inc., Hoffman Estates, IL, USA).

3. Structured light scanner:

It requires a projector to project white or blue light on the face, then light patterns captured using trigonometric triangulation by calibrated camera to build a 3D face model utilizing computer algorithm (Fig. 2). Examples: Facehunter (Zirconzahn, South Tyrol, Italy), Priti mirror scanner & priti image software (Isravision, Polymetric, Germany).

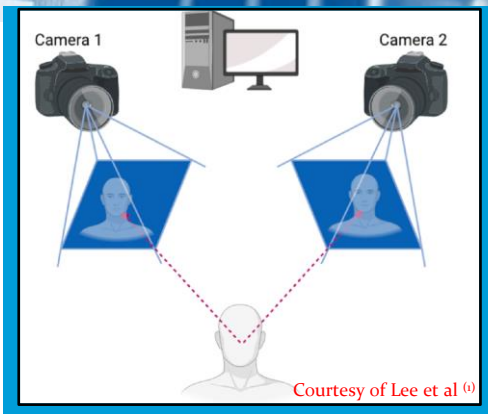

Figure 1: Photogrammetry and stereophotogrammetry scanning technology.

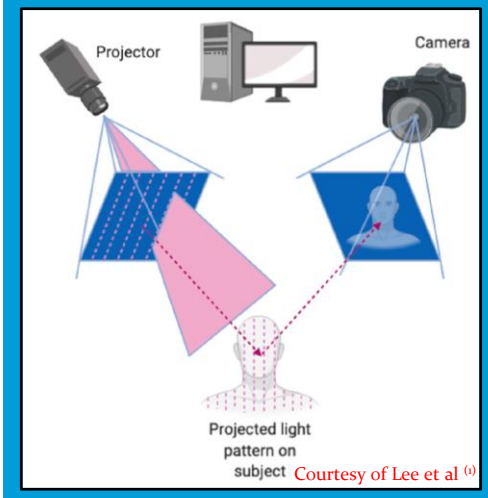

Figure 2: Structured light scanning technology.

4. Laser scanning:

It requires multiple scans at different positions of rotating object that captured by camera to detect geometry & shape of casted laser beam in 3 dimensions to build a 3D face model by computer algorithm. This mechanism is highly accurate, but it is affected by light sources and slower than structured light scanner (4) (Fig. 3). Examples: ObiScanner (ObiScanner, Milano, Italy), iPhone X (Apple, Cupertino, CA, USA) using Bellus3D Face Application (Bellus3D, Inc. Campbell, CA, USA)

Accuracy of Facial Scanners:

A systematic review by Antonacci et al [5] evaluated the accuracy of various face-scanning technologies in the market with respect to the different dimensions of space (x, y, and z axes). They concluded that limiting the movements of the patient and scanner allows accurate facial scans. laser scanners (LS), structured light (SL) scanner have accuracy comparable to stereophotogrammetry while being more cost-effective and less time-consuming. Another systematic review by Bohner et al [6] estimated the mean accuracy of digital technologies used to scan facial, skeletal, and intraoral tissues. They concluded that the current digital technologies are reported to be accurate for specific dental applications. Also, Kühlman et al [7] investigated the overall and regional (trueness and precision) of digital 3-dimensional facial scans obtained from different tablet-based applications. They stated that the trueness and precision of tablet-based applications were clinically acceptable for diagnosis and treatment planning.

Applications of Facial Scanners in Dentistry:

1. Diagnostic Records:

Facial scanners can replace conventional extraoral records, occlusal analysis, and diagnostic wax-ups. Digital radiographs and photographs can provide standard information for accurate diagnosis and treatment plan.

2. 3D Virtual Smile Design:

In digital workflows with facial scanners, the patient's facial features are recorded digitally, and the conversions done virtually, eliminating the introduction of errors arising from multi-step analog conversions from 2D to 3D with the risk of distortion into the workflow. 3D virtual smile design is valuable as a noninvasive, fast, and inexpensive tool to motivate patients to accept treatment. Simulation of future treatment that provides the patient a better opportunity to visualize how the planned dental prosthesis can affect their esthetics.

3. Virtual Dental Patient (VDPs):

With the advent of facial scanners, additional extraoral tissue and facial structure data can be acquired and superimposed to form a 3D virtual model of the patient. A virtual patient is created by merging digital diagnostic records such as a face scan, virtual facebow, intraoral scan and cone-beam computed tomography (CBCT) (Fig. 4).

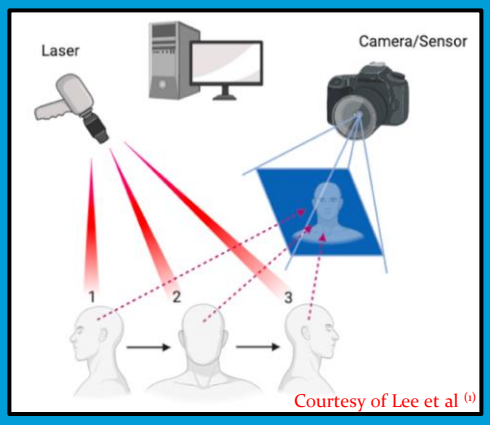

Figure 3. Laser scanning technology.

Virtual patients have many benefits [8]**:**

1. Make it possible to present the entire treatment plan in 3D to a patient. 2. Help with shaping the patient's expectations. 3. Allow for the creation of several alternative treatment plans. 4. non-invasively simulate progress step-by-step. 5. Decrease the number of patient visits, enhancing the doctor's productivity and the patient's quality of life. 6. Offer pre-operative assessment of maxilla-facial surgeries due to their high precision anatomical documentation. 7. Streamline interdisciplinary communication between the dentist and dental technician.

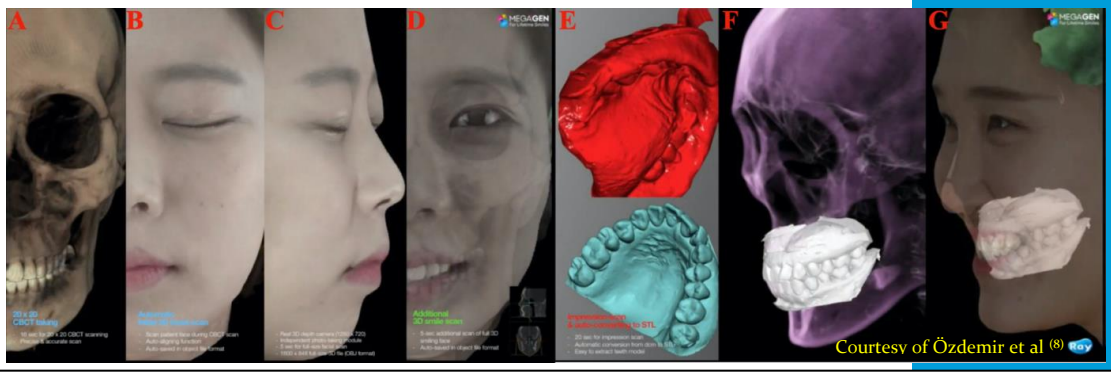

Figure 4. A: CBCT, B-C: Frontal and lateral Facial Scan, D: Superimposing CBCT onto Facial Scan, E: Impression scan, F: Superimposing IOS onto CBCT, G: Superimposition of IOS + CBCT + Facial Scan.

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