Case Report

Superimposing Intraoral and Facial Digital Scan: A Novel Technique for Accurate Spatial Alignment of Dental Arches

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Abstract

A reliable novel technique for superimposing intraoral and face digital scan without using any aligner or scan abutment is presented. This technique involves scanning the perioral area by incorporating parts of the upper dental arch into the perioral tissue scan. Unlike other proposed methods, including the upper dental arch scan in the perioral tissues scan, ensure accurate spatial positioning of intraoral dental arches scans within the facial scan.

Introduction

Assessing facial and dental structures is crucial for achieving successful esthetic prosthodontic treatments. A Two-Dimensional (2D) esthetic analysis utilizing facial and dental photographs has been introduced to ensure predictable esthetic outcomes [1-4]. This analysis involves importing full-face photographs taken in a relaxed state, during a wide smile, and smartphone video editing software that supports the smile design for an esthetic treatment plan [5].

Advancements in Three-Dimensional (3D) facial scanning have made it possible to virtually plan a prosthetic design that aligns with the corresponding facial appearance in a 3-D perspective [6]. Through 3D facial scanning, a virtual face can be generated and seamlessly integrated with 3D dental images obtained from digital scans of the teeth [7].

Many different techniques were proposed to superimpose the intraoral scan into a facial scan to create a 3-dimensional virtual patient, using aligner systems or scan abutment [8-10] or simply collecting additional facial scans and perioral scans to collect some skin and dental references merging in superimposition [11,12].

This article presents a novel technique for superimposing facial and intraoral scans, eliminating the need for aligners, scan bodies, or extraoral landmarks. It works well even in patients who do not expose upper incisors smiling. Furthermore, this technique enables precise spatial alignment of intraoral scans within facial scans.

Technique

To simplify the digitalization and superimposing of the facial and intraoral scans to obtain a 3D virtual representation of a patient, the subsequent protocol was performed:

1. Make intraoral scans of lower and upper arches by using an intraoral scanner (TRIOS 3, 4 or 5;3 Shape A/S), scan maxilla mandibular relationship following the scanner workflow (Figure 1) and send it to a laboratory computer-aided design and computer-aided manufacturing software program (Dental System; 3shape A/S).


Figure 1: Scan of an initial situation with the patient maxilla mandibular relationship.

2. Go to IOS settings and remove the AI option. Scan the lower part of the forehead, eyebrows, nose, and teeth (perioral scan). Unlike other proposed techniques,12 is necessary to scan not only central and lateral upper incisors, but also to detect the occlusal surface and part of the palatal surface of premolars and molars if present (Figure 2). A cheeks and lips retractor (Optragate; Ivoclar Vivadent AG) could facilitate an upper arch scan. Send the scan to CAD-CAM software program (Dental System; 3 shape A/S).
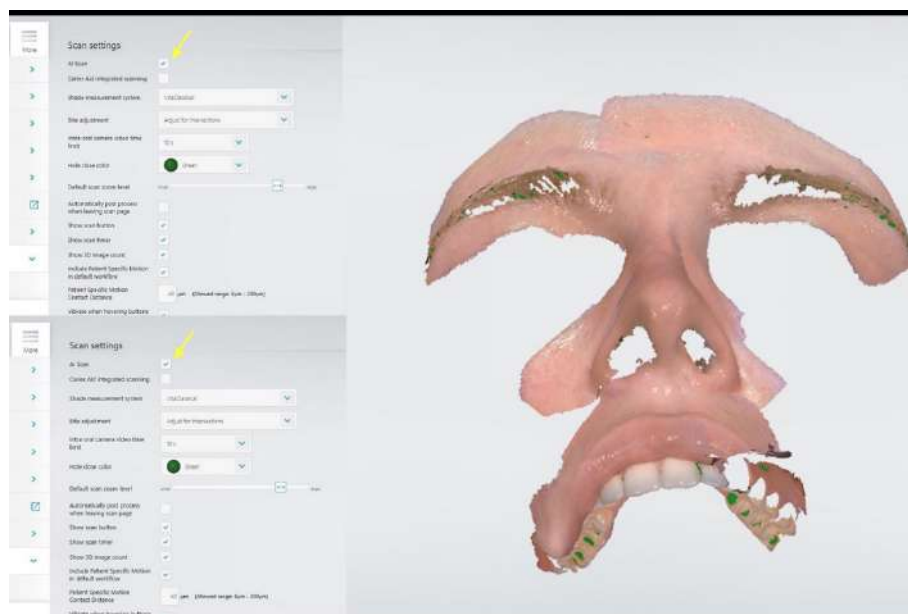

Figure 2: Intraoral Scanner's setting page with AI function disabled and perioral scan with posterior teeth scanned.

3. Make the patient smile and scan the face with a face scanner (RAYface 100-200; Ray Co., Ltd), (Figure 3): do not need to move the patient or the scanner. The patient must maintain a smiling face for 0.5 seconds, and facial scan acquisition is made easily by clicking an icon on face scanner software (RAYface application; Ray Co., Ltd.). In patients who use facial treatments such as foundation or setting powder, perioral scanning may prove to be quite challenging. It is recommended to clean the patients' face if they use these treatments before proceeding with the detection of perioral scaning using an intraoral scanner.
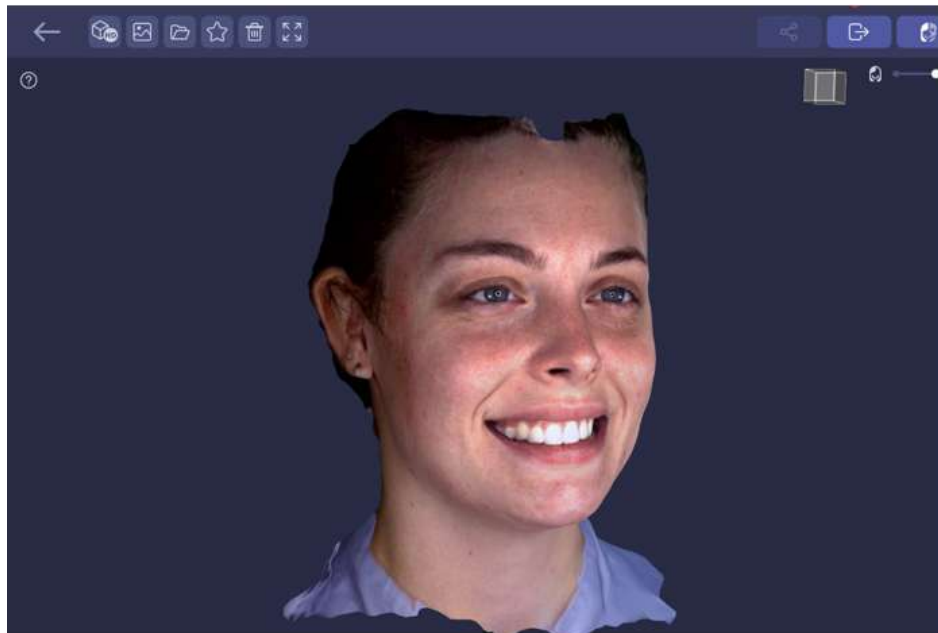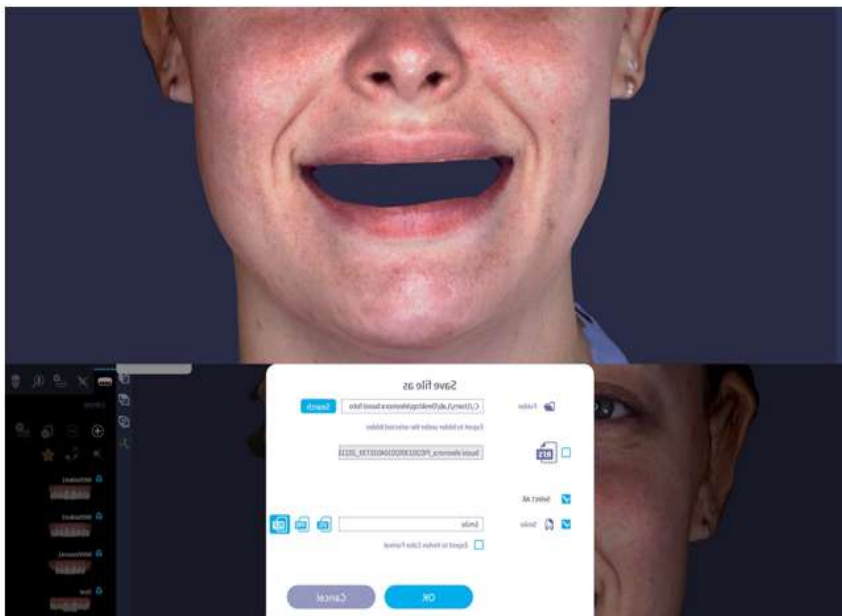
Figure 3: Smile facial scan performed with face scanner.

4. Trimming the dental arches from the facial scan using the cut tool available in the scanner software (Figure 4). Process and save the facial scan file with a .ply extension (Figure 5). Send it to a CAD-CAM software program (Dental System; 3 shape A/S).
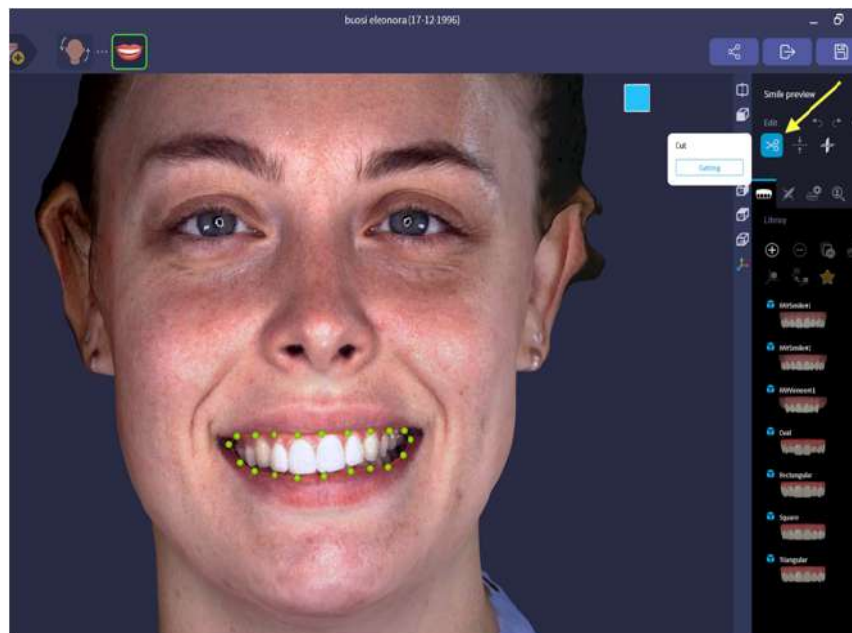

**Figure 4:** Cut tool used to trim dental arches from a facial scan.

Figure 5: Facial scan file with dental arches trimmed, processed, and saved.

5. Superimpose dental arches scan with a perioral scan using CAD-CAM software program (Dental System; 3shape A/S) alignment point tool. Choose one point between the edge of the central incisors, one on a left premolar or molars cuspid, and one on the right premolars or molars cuspid (Figure 6). Scanning the posterior teeth in perioral scan allows to perform this technique in patients that don't expose upper incisors and to obtain an accurate spatial alignment of dental arches.
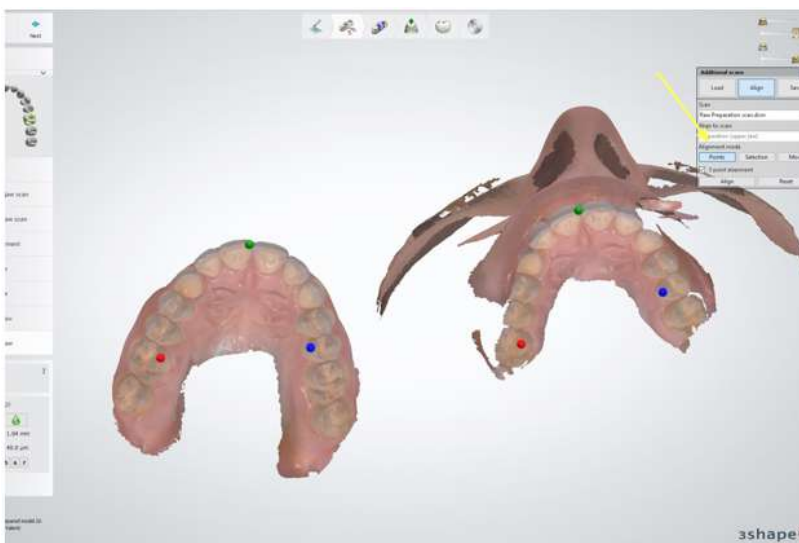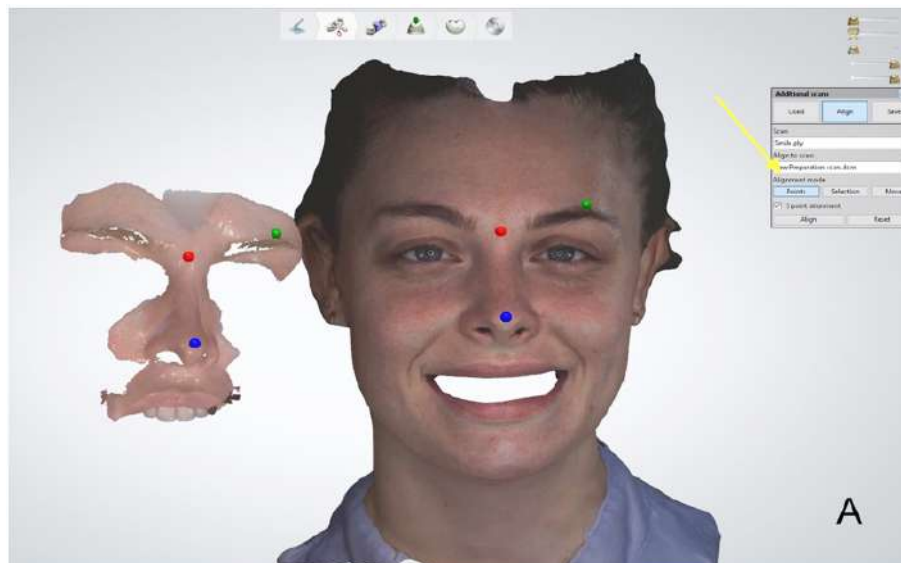

Figure 6: Superimposition of intraoral scan over the perioral scan using the alignment point tool in a CAD software program.
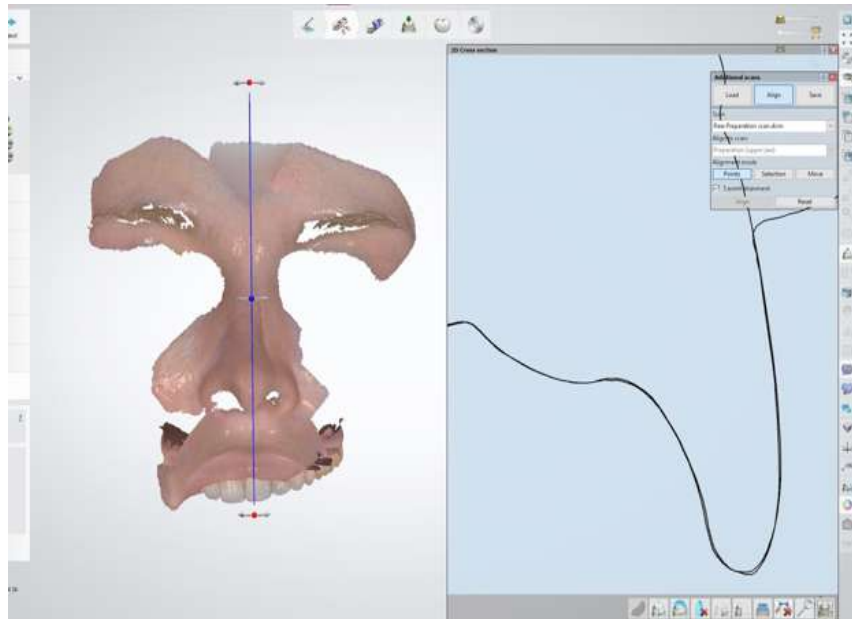
Figure 7: Cross-sectional tool to check the alignment accuracy.

6. Check the alignment accuracy of superimposition with CAD-CAM software program (Dental System; 3shape A/S) cross-section tool (Figure 7).

7. Superimpose perioral tissue scan with a facial scan with CAD-CAM software program (Dental System; 3shape A/S) alignment point tool (Figure 8A, 8B). Try to choose the points on the face where the skin is very thin, for example, glabella, nasal bone, malar process, and supraorbital ridge. The dental arches scan is automatically spatially positioned into the facial scan, as it had already superimposed with the perioral tissues scan.

Figure 8A: Superimposition of perioral scan over face scan using the alignment point tool.
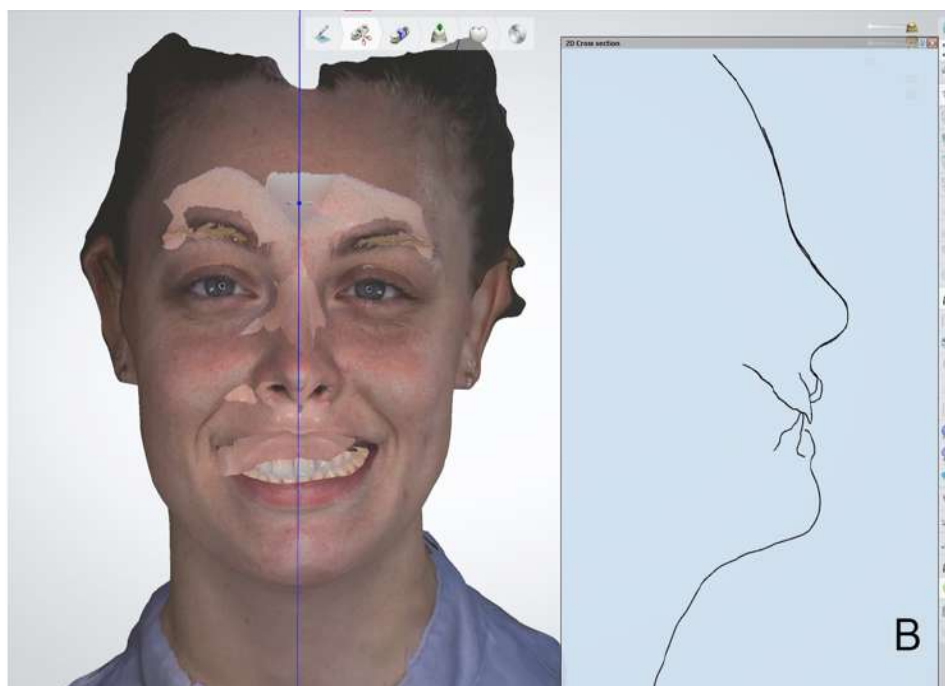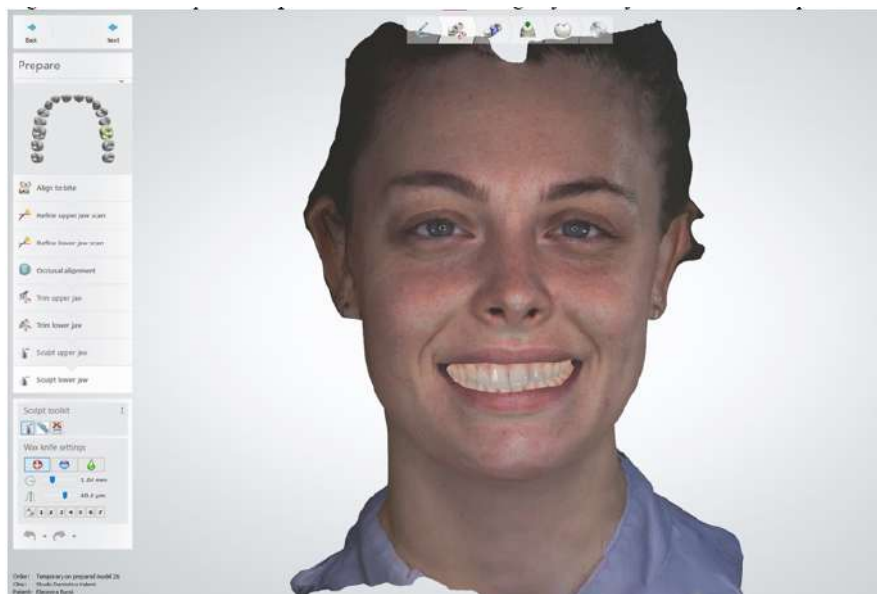
Figure 8B: Superimposition of perioral scan over face scan and alignment accuracy check with cross sectional tool.

8. Check the alignment accuracy of superimposition with CAD-CAM software program (Dental System; 3 shape A/S) cross-section tool (Figure 9). Lips could not be aligned if a cheeks retractor is used.

Figure 9: 3D virtual patient representation for facilitating any facially driven treatment plan.

All intraoral scans performed subsequently on the patient using an IOS (TRIOS 3, 4 or 5;3Shape A/S) for any future treatment and superimposed with the initial one through a CAD-CAM software program (Dental System; 3 shape A/S), will automatically set themselves correctly in the facial scan along the x-y-z axis [13]. Alternatively, it is possible to manually superimpose any patient intraoral scan with the initial one aligned with the facial scan, using an alignment point tool.

Discussion

In prosthetic treatments involving the esthetic area, the challenge for the dental technician and dentist is to precisely define the interpupillary and midsagittal planes to correctly establish ideal teeth shape concerning the patient's smile line and lips position (Figure 10). Facial scanning, in comparison to the 2D photography, offers greater accuracy [14], and by incorporating 3D restorations design onto the 3D facial file, it is possible to assess the shapes of the teeth on the x-y-z axis and evaluate their aesthetic outcome before testing it on the patient with interim restorations or resin mock-up. Both facial scanning and its superimposition with intraoral scanning must be accurate to perform these assessments [15].
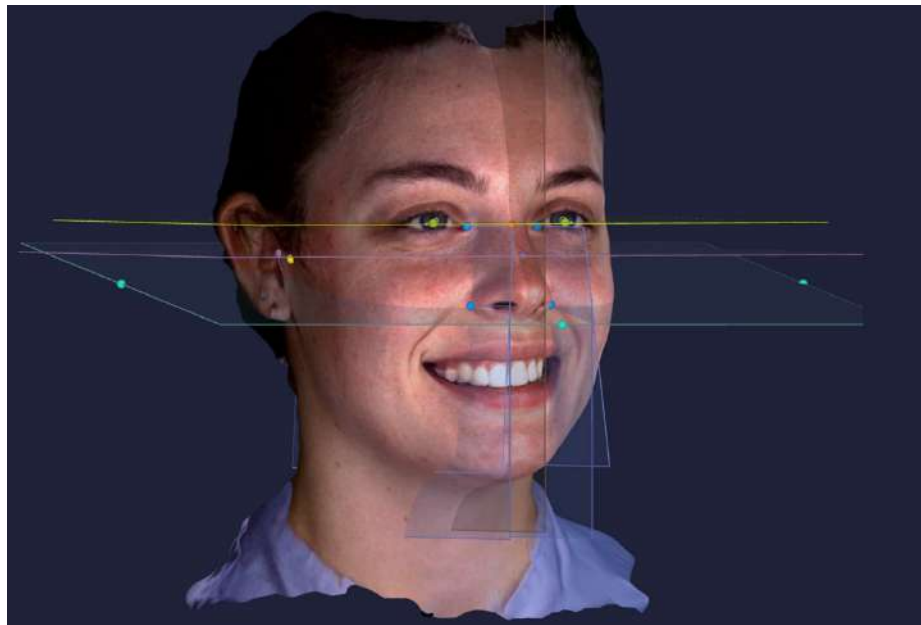
Figure 10: Positioning inter pupillary, midsagittal, and Camper planes on the facial scan helps the dentist and technician in determining the ideal teeth shape in relation to the patient's smile line and lips position.

Conversely to a smartphone-specific application that uses a 3D sensor camera [10,12,16] or industrial scanners adapted for medical use [17,18] the advantage of using a static face scanner (Rayface 100,200; Ray Co., Ltd) is that the patient remains still and in 0,5 seconds the scanner scans patient's face, reducing the risk of inaccurate scans due to movements by the patient, scanner or operator [19,20].

An accurate facial scan [21] is not enough because, due to the distortion all face scanners introduce in the patient's teeth, it is impossible to superimpose a facial scan to the patient's dental arches scan. The key to this technique's success is using a perioral scan that includes lips, nose, forehead, and teeth. The accuracy and time scan of the IOS (TRIOS 3, 4, or 5; 3Shape A/S) [22,23] allow for simple and reliable perioral scanning, avoiding any involuntary patient movements that would affect the accuracy of the perioral scan.

Compared to the technique proposed by Lo Russo, et al. [12] scanning the posterior teeth also allows for the correct sagittal and horizontal alignment of the arches during the superimposition with the facial scan. Furthermore, thanks to the CAD-CAM software

program (Dental System; 3 shape A/S) cross-sectional tool, it is possible to assess the accuracy of alignment and correct it by slightly shifting any of the 3 superimposed scans, reducing the risk of mismatching.

Creating a 3-D virtual patient representation could help dentists and dental technicians improve diagnosis, facially driven treatment plans, and prosthetic treatment outcomes. Even if most of the scanners available on the market exhibit accuracy values that are acceptable for clinical application, [24] the 3-D virtual patient accuracy and trueness could be influenced by techniques used and operator skill [25]. The proposed technique simplifies the superimposing procedures to align intraoral scans with facial scans, making the creation of the virtual patient repeatable and reliable without using skin landmarks or scan abutments.

Summary

A technique that allows clinicians and dental technicians to obtain valuable information regarding the relationship between patient smile and patient face is presented. Intraoral, perioral, and facial scans are superimposed easily without any scan abutment,

aligner, or skin landmarks, with a CAD software program and an alignment point tool. Furthermore, the spatial alignment of dental arches on facial scan could be more precise than other techniques proposed, thanks to the perioral scan that should include the upper premolar and molar teeth surface and not only incisors.

Declaration

Patient consent

Written informed consent was obtained prior to capturing any face scan or images and published.

Conflict of interest

Authors declare no conflict of interest.

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