Case Report

An Open Source Framework for Free Precise Digital Facial Analysis

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ABSTRACT

In the dynamic landscape of digital healthcare and facial aesthetics, there is a rising demand for tools combining precision and accessibility. This article explores an innovative approach emphasizing accuracy and accessibility in facial aesthetic procedures through individualized planning and open-source software utilization. Digital facial analysis was conducted using facial photogrammetry capturing 16 simultaneous images in 0.4 seconds. The images were 3D reconstructed with Blender® software, incorporating selected points, angles, and measurements for facial analysis. Customizable points allowed individualized protocols, and additional measurements, such as the cervicomental angle, were included. Combinations of measurements were automated for comprehensive analysis. The data enabled the generation of a detailed digital facial analysis report, providing a precise and objective assessment. The approach demonstrated potential applications in maxillofacial surgery, plastic surgery, and simulation of dermal fillers and facial implants. Photogrammetry proved comparable to CT scans, eliminating human interference and enhancing accuracy. In the context of high patient expectations and evolving beauty standards, digital facial analysis offers valuable insights for aesthetic procedures. The integration of data into virtual surgical planning software enhances accuracy, but careful individualized planning and informed consent are crucial to manage expectations and legal considerations. This study underscores the role of open-source software, specifically Blender®, in democratizing access to advanced facial analysis tools. Blender's combination of precision and accessibility represents a paradigm shift, fostering innovation and personalized outcomes in facial aesthetic procedures.

KEYWORDS
Orthognathic Surgery; Digital Planning; Esthetics; Dermal Fillers; Virtual Planning; Prostheses and Implants; Software

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INTRODUCTION

In the contemporary landscape of digital healthcare and facial aesthetics, the world is witnessing a growing demand for sophisticated tools that possess the dual qualities of precision and accessibility[1]. Within the expansive realm of medical and aesthetic procedures, the environment is characterized by a continuous state of evolution,

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compelling practitioners to embrace cutting-edge methodologies to meet the evolving needs of their patients[2]. While facial procedures depend on a series of factors, most notably individual surgical skills, new software solutions continue to emerge daily, aiding surgeons in achieving even more predictable and exceptional outcomes in addition to decreasing the incidence of intercurrences[3].

This article delves deeply into an innovative approach that places the utmost emphasis on achieving accuracy while ensuring ease of access. Central to this approach is the recognition of the critical importance of individualized planning strategies, particularly in the context of facial aesthetic procedures. By harnessing the potential of open-source software, the framework outlined here aspires to democratize access to advanced facial analysis tools. This democratization seeks to create a more transparent and informed landscape for both surgical and non-surgical facial procedures, ultimately opening up exciting possibilities for groundbreaking research and novel clinical applications within the expansive domain of facial aesthetics.

INNOVATIVE CASE PRESENTATION

Patients underwent facial photogrammetry, involving the capture of a total of 16 pictures simultaneously in 0.4 seconds (Cloner ®, Done 3D, Brazil). Three-dimensional (3D) photogrammetry allows for the simultaneous capture of multiple images with patients in precisely the same position and facial expression, thereby avoiding any kind of distortion. These images were imported into free and open-source software, and the face was 3D reconstructed using Blender® by Blender Foundation. Blender is a sophisticated computer graphics software used for a wide range of 3D applications, featuring additional add-ons that can facilitate complex tasks across various domains, such as soft body simulation, 3D modeling and printing, virtual reality, and motion graphics, among others.

A series of facial analysis points, angles, and measurements were thoughtfully selected and incorporated into the 3D facial volumetric digital reconstruction (Table 1). These points can be customized, allowing for the creation of an individualized protocol for each professional and specific case (Figure 1 and 2). Beyond these analyzed points, others may be included, such as the cervicomental angle and frontal protuberance. Other measurements were added as Supplemental material. In addition to these, combinations of different measurements can be performed in an

Table 1: List of facial analysis measurements that was added to 3D photogrammetry in alphabetic order.

Bigoniac distance
Bizygomatic distance
Face shape
Face symmetry
Horizontal facial thirds ratio
Interalar distance
Mandible angle
Nasolabial angle
Soft chin proeminence



Figure 1: Facial frontal analysis demonstrating horizontal thirds ratio

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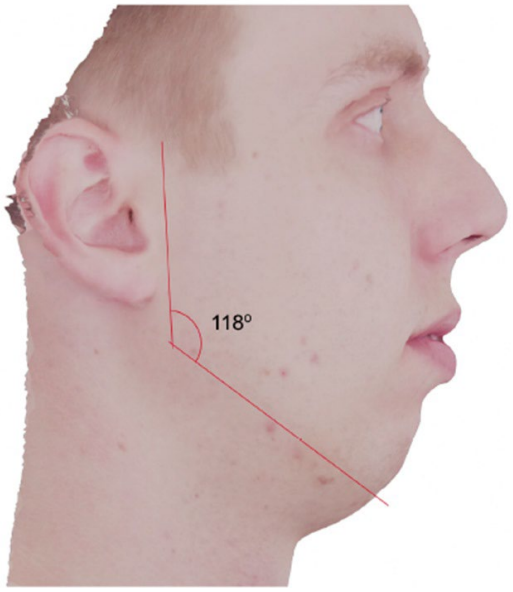


Figure 2: Mandible angle

automated manner, such as the ratio between the bizygomatic width and the bigoniac width.

Armed with this data, it became feasible to generate a comprehensive digital facial analysis report. Besides to conventional facial analysis, individual additional anthropometric points can be included to digital facial analysis.

DISCUSSION

The demand for aesthetic procedures has always been high. However, in today's times, with new procedures emerging every day and greater accessibility, patient expectations are becoming increasingly high[4]. Even with beauty standards changing over time, the objective analysis of what is attractive should not be altered because these standards are not related to current fashion[5].

Digital facial analysis could be very useful in a wide variety of health applications such as maxillofacial surgery, plastic surgery, dermal fillers and facial implants simulation. Due to Virtual Surgical Planning (VSP), orthognathic surgery has evolved from being exclusively functional to also serving aesthetic purposes. Many patients undergoing orthognathic surgery seek other surgical and non-surgical forms of supplementation or refinement[6]. It is possible to simulate a very close to ideal volumization of facial implants and dermal fillers quantity. Dermal fillers exact precision cannot be achieved since every brand, texture and even injection technique varies widely. Further researches are being studied to include this information in the software, targeting a more and more precise outcome regarding dermal fillers. In addition to the precision in orthognathic surgery, a broad range of facial aesthetic surgeries can benefit from an open-source digital facial analysis [3]. Rhinoplasties, facial implants, and facelifts are just a few of the alternatives.

Photogrammetry can be considered as accurate as CT scan[3]. An overlay of images demonstrates that the exactly same patient profile is obtained with both examinations. Performing a digital facial analysis subtract any human interference, including cultural and personal preferences, light incidence, and human errors. Final outcomes can be considered as precise as being performed only by human observation and measurements. Data obtained from this digital facial analysis can be added to VSP softwares such as Dolphin, Nemocef and Mimics, achieving a more accurate analysis. It is possible to add these data to other free VSP softwares including Blue Sky and own Blender.

Carefully due to legal reasons and patients' expectations, cases can be personally planned with more clear information with patients. The authors recommend that the planning should be discussed individually, but an individualized consent form explaining any and all individual and personal variations is mandatory in all cases to prevent future legal complications[7]. Even with

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precise planning, surgical complications can occur, and the final outcome may not be identical to the planned one.

Blender can indeed be regarded as an immensely valuable and virtually all-encompassing software tool. Remarkably, despite its open-source nature and the fact that it is freely available, Blender stands out as an exceptionally comprehensive and intricate software solution[8]. Its vast array of capabilities and functionalities can be quite formidable, even for the most seasoned users[3]. Navigating Blender's expansive domain necessitates a significant investment of time and effort, even for those who come to the software with a wealth of experience. The multifaceted nature of Blender means that mastering its intricacies is a continuous learning process, and as such, it remains a valuable resource for facial surgeons, dermal fillers injectors, dentists and forensic scientists seeking to explore and push the boundaries of their craft. The union of open-source softwares, artificial intelligence and new algorithms will bring new possibilities to maxillofacial surgeries, reaching extremely precise simulation levels[9,10].

CONCLUSION

This work highlights the crucial role of open-source software in democratizing access to advanced facial analysis tools, offering a promising pathway to enhance the precision and accessibility of facial aesthetic procedures while fostering innovation in the field. Blender's role in the realm of facial analysis is instrumental, providing a powerful combination of precision and accessibility. It represents a paradigm shift in the field by democratizing advanced tools and catalyzing innovation, ultimately leading to more precise and personalized outcomes in facial aesthetic procedures.

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CONFLICT OF INTERESTS

Henrique Tostes is co-founder of Voxels Image Center. The other authors declare no conflicts of interest to disclose.

SUPPLEMENTAL DATA

Complementary images were added as supplemental material.

PATIENT CONSENT

Written consent was obtained from all individuals included in the images.

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