Digital Smile Design

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I. Introduction

Digital smile design is a unique dental treatment planning tool that strengthens a dental provider's diagnostic vision, enhances predictability, and improves communication between dental providers and their patients. We've designed a simple software that everyone can use that can detect 5 of the 21 principles of smile design.

II. Methods

The software was made using **Python** and **PyQt**. The software can detect the following defects in someone's smile:

1) First of all, the mouth is cropped from the original image using 8 point surrounding the mouth using **Dlib**'s facial landmarks detector.
2) Teeth Discoloration: using a an algorithm which that can detect whether the color of the teeth is within the acceptable shades of white.
3) Midline Shift: using **Dlib**'s facial landmarks detector, the facial midline can be detected from the eyes center points. Moreover, the dental midline is detected by picking random pixels along the upper teeth with equal distances, then the pixels close to each other are eliminated. In addition, the darkest 3-pixels are chosen, and the distances between each pixel is calculated. If the distances between the 3-pixels are equal, then the dental midline is in the intermediate space between them. Hence, the distance between the dental midline and the facial midline can be calculated.
4) Diastema: The intermediate distance between the central incisors is calculated by measuring how many dark pixels between the facial midline and the two central incisors.
5) Gummy Smile: The ratio between the teeth and gum is calculated in an image by using color masking for the gum and the teeth.
6) Template Matching: The user can choose between 4 pre-rendered smile templates based on their facial structure.

III. Results and Discussion

The software was tested on 34 images and had the following results. (The ✓means that the principle was detected successfully, and the ✗ means that the software showed wrong results).

	Gummy Smile	Teeth Discoloration	Midline Shift Detection	Diastema
8004	☑	☑	☑	☑
8010	☑	☑	☑	☑
Adel	☒	☑	☑	☑
Fatma Gad	☑	☑	☑	☑
Fatma Osama	☑	☑	☒	☑
Img2	☑	☑	☑	☑
Img3	☑	☒	☑	☑
Img4	☑	☑	☑	☑
Img7	☑	☑	☑	☑
Img111	☑	☒	☑	☑
Img122	☑	☑	☑	☑
Img133	☑	☑	☒	☑
Img144	☑	☑	☒	☒
Img155	☑	☒	☑	☑
img166	☑	☑	☑	☒
Karin	☒	☑	☑	☒

Fig. 1. Results table 1.

	Gummy Smile	Teeth Discoloration	Midline Shift Detection	Diastema
Img177	☑	☑	☑	☑
Img188	☑	☑	☑	☑
Img199	☑	☑	☑	☑
Img200	☑	☑	☑	☑
Mariam	☑	☑	☑	☑
Moheb	☑	☑	☑	☑
Ehab	☑	☑	☑	☑
Test	☑	☑	☑	☑
Toka	☑	☑	☑	☑
Youssef	☑	☑	☑	☑
White	☑	☑	☑	☑
Ideal	☑	☑	☑	☑
Sedky	☑	☑	☑	☑
Yellow	☑	☑	☑	☑
Mostafa	☑	☑	☑	☑
Mohanad	☑	☑	☑	☑
Moaaz	☑	☑	☑	☒
Yasser	☑	☑	☑	☑
Mo'men	☑	☑	☑	☒

Fig. 2. Results table 2.

Principle	Successful cases	Accuracy
Gummy Smile	33/35	94.3%
Teeth Discoloration	32/35	91.4%
Midline Shift	30/35	85.7%
Diastema	29/35	83/

IV. Future Work

The accuracy of the program can be improved by using advanced and improved algorithms to detect the defects. Furthermore, more features can be added to the software such as:

1) Horizontal Plane Detection

2) Golden Proportion Ratio
3) Vertical Dimension
4) Smile at Rest

V. Conclusion

Dentists can use the software to diagnose the mentioned defects and use the solutions that the software offers to fix them. Moreover, anyone can use the software as it is has a very simple UI that can detect all of the mentioned defects with the press of a button.