3D Structure-guided Network for Tooth Alignment in 2D Photograph

Yulong Dou[1], Lanzhuju Mei[1], Dinggang Shen[1,2,3], Zhiming Cui[1,*]

[1] School of Biomedical Engineering, ShanghaiTech University, Shanghai 201210, China

[2] Shanghai United Imaging Intelligence Co., Ltd., Shanghai 200230, China

[3] Shanghai Clinical Research and Trial Center, Shanghai 201210, China

* cuizhm@shanghaitech.edu.cn

上海科技大学 ShanghaiTech University

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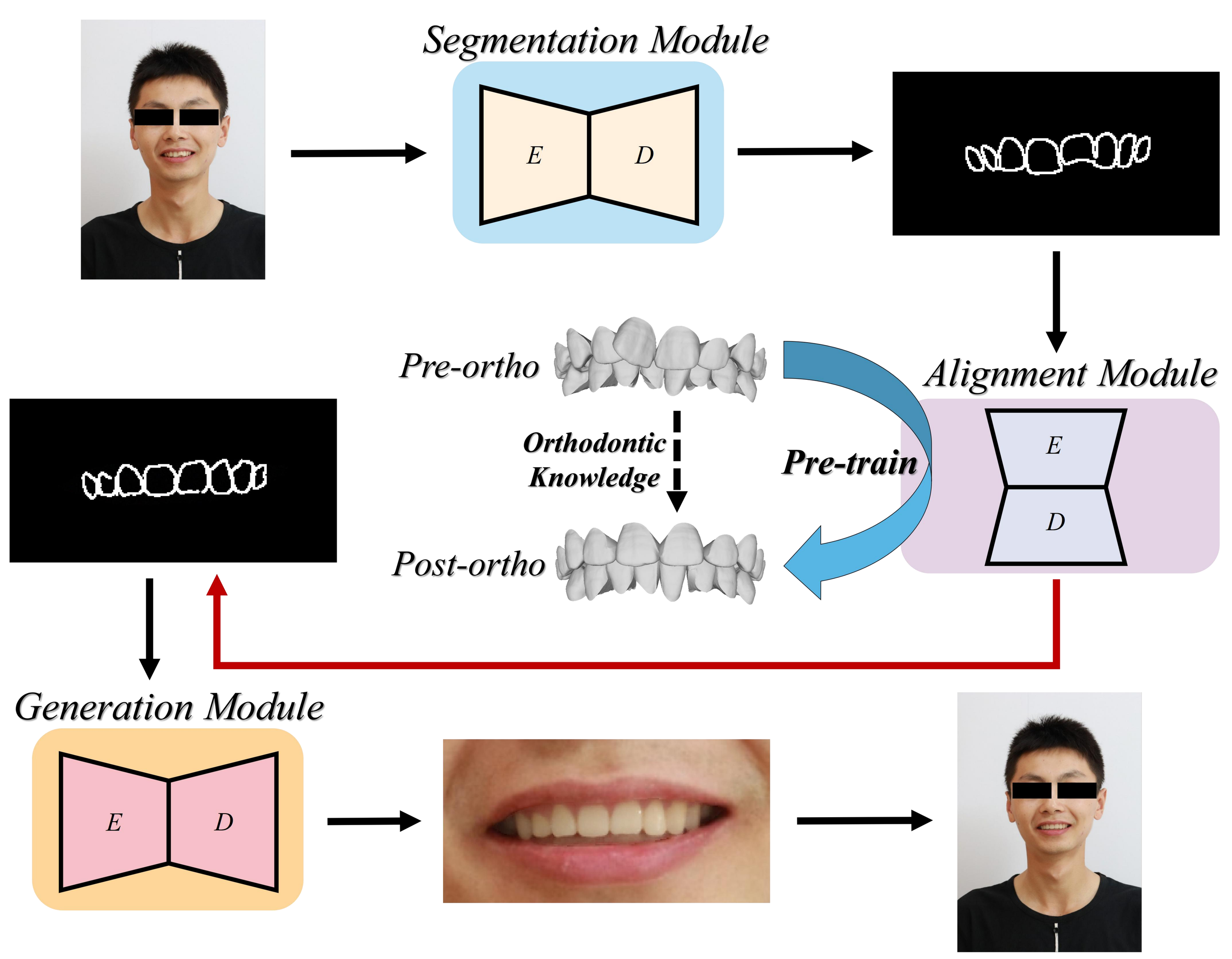
MOTIVATION

Problem:
Orthodontic procedure spans a long duration. Hence, visualization of potential post-treatment facial appearance is a crucial task to facilitate doctor-patient communication.

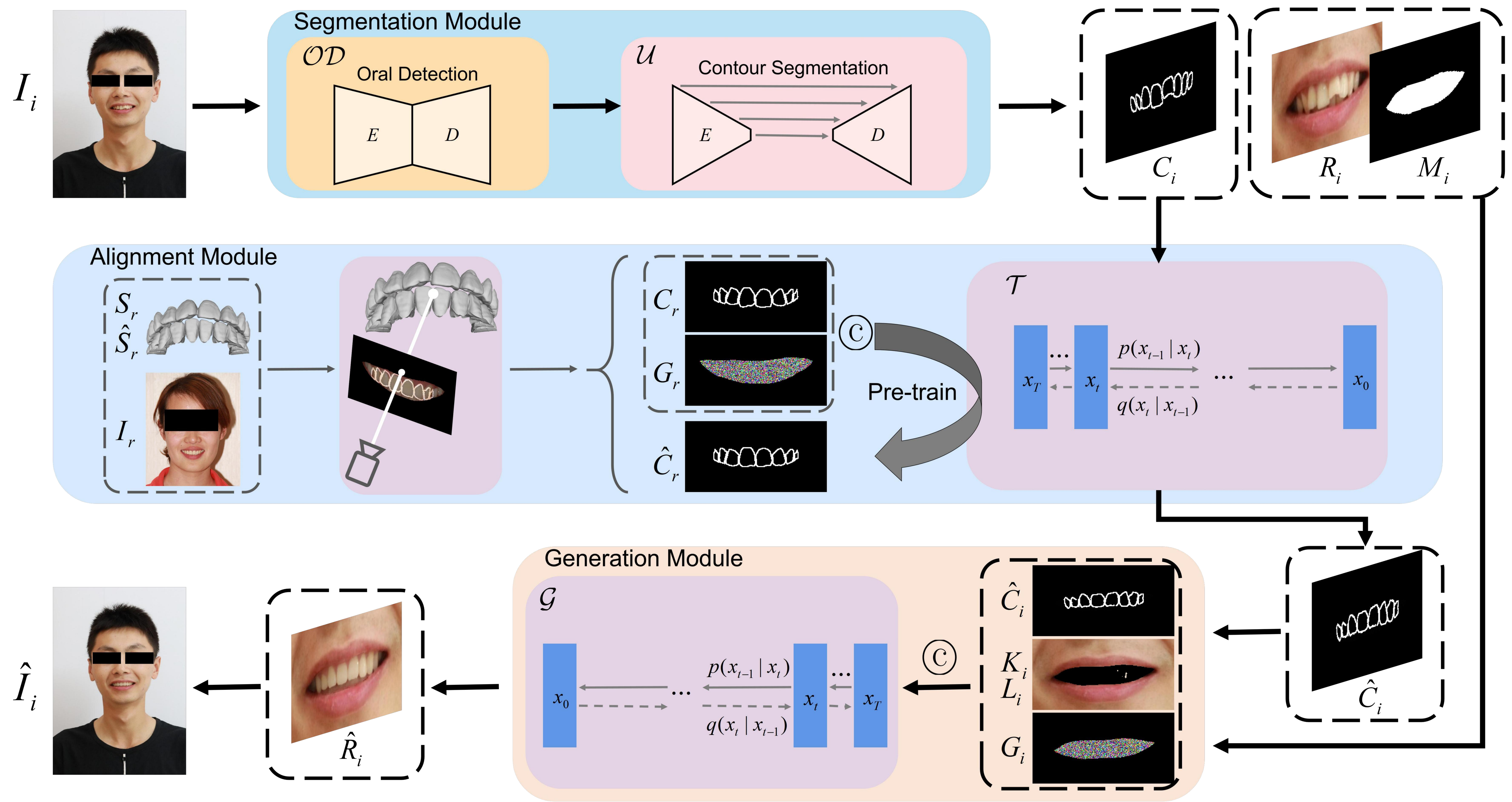
Related works:
Either require patient-specific tooth models, or need paired data for training.

INNOVATION

- No longer rely on paired pre- and post-treatment facial photographs which are hard to be collected due to the long-term orthodontic procedure.
- Clinical orthodontic knowledge defined on 3D tooth models can be applied to guide 2D photos.
- Outstanding Diffusion Model helps complete the task.



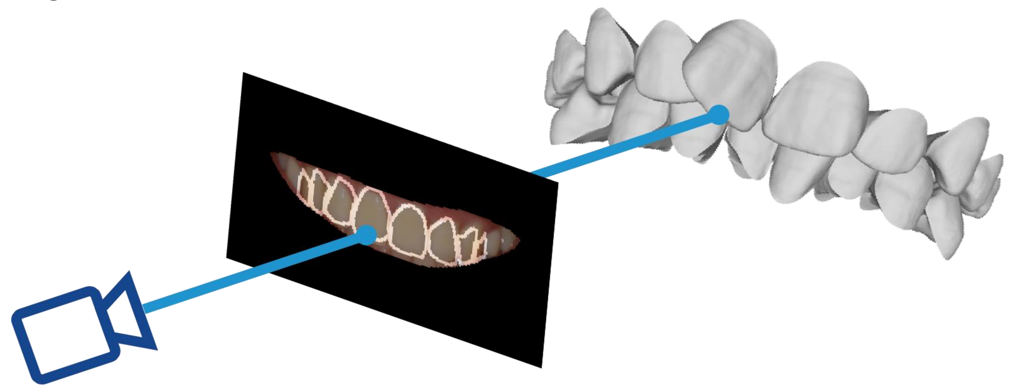
METHOD



➢ **Alignment Module:**

- Employ a **3D-to-2D Render** to project the 3D tooth models into the 2D space of tooth contours.

$$\rho m = (KR^T \mid -KR^T C)\begin{pmatrix} M \\ 1 \end{pmatrix}$$



- Construct a **Diffusion Model**-based network to learn the clinical orthodontic knowledge in the space of tooth contours derived above.

$$\hat{C}_i = \mathcal{T}(C_i \copyright G_i)$$

➢ **Segmentation Module:**

Employ **U-Net** to detect the position of mouth and then segment tooth contours from the facial photographs.

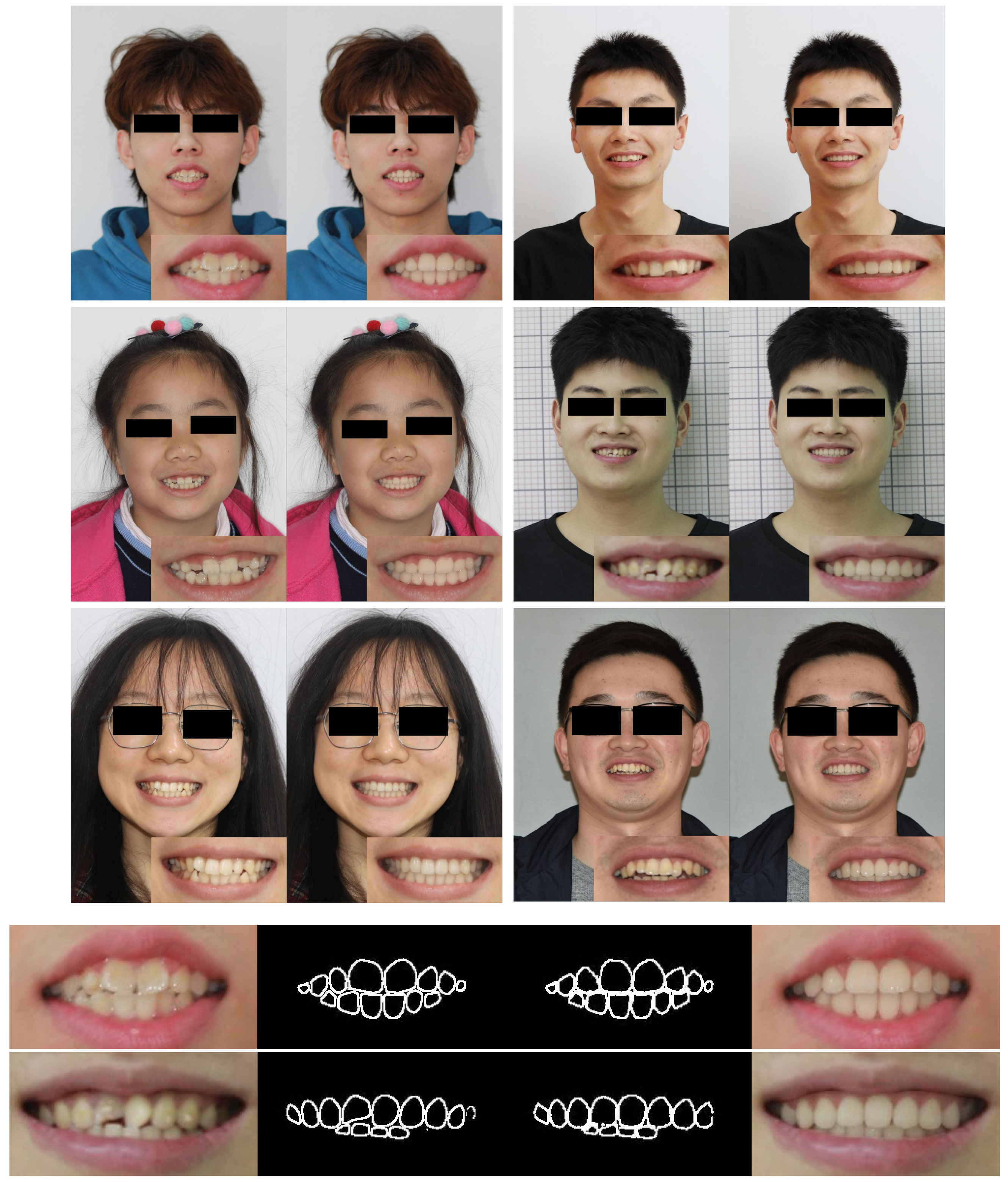
$$R_i,\ M_i = \mathcal{OD}(I_i)$$
$$C_i = \mathcal{U}(R_i,\ M_i)$$

➢ **Generation Module:**

Build a **Diffusion Model**-based network to generate realistic tooth image with the guidance of well-aligned tooth contours through the orthodontic knowledge.

$$\hat{I}_i = \mathcal{G}(\hat{C}_i \copyright G_i \copyright L_i \copyright K_i)$$

RESULT



CONCLUSION

Our method stands out from existing approaches as it can learn the clinical orthodontic knowledge based on 3D tooth models, making our method highly reliable and potentially applicable in clinical practice.

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