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A PointNet based Method for Automatic Design of Implant Crowns

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***Abstract*— To design a patient-specific implant crown, it needs to consider the patient-specific tooth position, tooth angle, and occlusion between maxilla and mandible, etc. In this study, we proposed a modified PointNet to automatically detect the position of the missing tooth. As the result, we expect that our method is applied to perform the automatic design of patient-specific implant crowns.**

I. INTRODUCTION

As dental CAD/CAM has been developed, it has become possible to produce customized implants for patients with time-saving and cost. It needs to consider that tooth position, tooth angle, and occlusion between maxilla and mandible to design a patient-specific implant crown. However, this is a time-consuming and labor-consuming task both in the design and fabrication step due to it is often performed manually [1].

In this study, we proposed a method for an automatic design of patient-specific implant crowns using deep learning, which detected the position and angle of the missing teeth from remain teeth of the patient.

II. METHODS

We used maxillary clinical teeth scan dataset acquired from 30 adult males. We converted teeth scan data into point clouds with 1024 points and normalized it into [-1, 1] space for deep learning input.

We proposed a modified PointNet to directly detect the centers of mass and the main axis unit vectors of the missing tooth from the dentition. The output layer of PointNet [2] was modified to detect the centers of mass and the main axis unit vector from input point clouds of dentition. The input point clouds are point set of the dentition with one missing tooth, and the outputs are coordinates of the main axis unit vectors and the centers of mass from each tooth.

To evaluate the performance, we used absolute errors of the x, y, and z axes of the center of mass coordinates, the mean redial error (MRE) values of the center of mass coordinates, and difference of the scalar angle.

III. RESULTS

Table 1 shows the performance of centers of mass and main axis using modified PointNet. Absolute errors of the x,y and z axes of the center of mass are 1.04 ± 0.82, 0.61 ± 0.52, 0.57 ± 0.53 each, and MRE is 1.5 ± 0.86. The scalar angle difference of main axis is 1.17 ± 1.25.

TABLE I. PERFORMANCE OF CENTER OF MASS AND MAIN AXIS PREDICTION USING POINTNET

	x (mm)	y (mm)	z (mm)	MRE (mm)	Angle (°)
Mean	1.04 ± 0.82	0.61 ± 0.52	0.57 ± 0.53	1.5 ± 0.86	1.17 ± 1.25

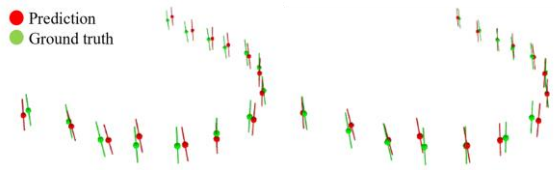

Figure 1. Ground truth and prediction : center of mass and main axis

IV. DISCUSSION & CONCLUSION

In this paper, we proposed a modified PointNet that could automatically detect the centers of mass and main axis of each tooth in dentition with a missing tooth. We expect that our method is applied to perform the automatic design of patient-specific implant crowns.

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