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Comparison of haptic feedback for OMS drilling training simulator using haptic device in sagittal split ramus osteotomy

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***Abstract*— Sagittal split ramus osteotomy is the most commonly performed surgery for jaw deformity patients in oral and maxillofacial surgery (OMS). The purpose of this study is to develop an OMS drilling training simulator with graphical and haptic assistance for avoiding drilling the tissue which should not be damaged. In this paper, we propose haptic assistance methods which enable users to feel the unique reaction force for each tissue including cortical bone and cancellous bone, and penetration reaction force. As the results, we confirmed the usefulness of the proposed method.**

I. INTRODUCTION

Sagittal split ramus osteotomy (SSRO) is the most commonly performed surgery for jaw deformity patients in oral and maxillofacial surgery (OMS) [1]. In recent years, virtual reality-based surgical training simulators have been developed for reducing the cost of simulated bone [2], however, effective assistance methods for improving surgical skills have not been well studied. Therefore, the purpose of this study is to develop a haptic assistance method for OMS training simulator. Since surgeons recognize the penetration of cortical bone with the reaction force of the drill, we propose haptic assistance methods which enable users to feel the unique reaction force for each tissue including cortical bone and cancellous bone, and penetration reaction force.

II. METHODS

In pre-processing, three-dimensional volume data of cortical bone, cancellous bone and canal of mandible are reconstructed with manual segmentation. In the interactive processing of OMS drilling training simulator, unique reaction force for each tissue and penetration reaction force are generated with following methods: 1. HSSE-w/VE: haptic stick and slip effects [3] for each region with viscosity effect [3] for penetration reaction force. 2. HSSE: only haptic stick and slip effects [3] for each region. The processing flow is shown in Fig. 1.

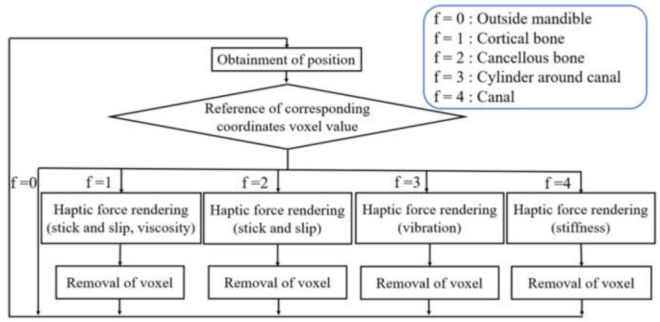

Figure 1. Processing flow of OMS drilling training simulator.

III. RESULTS

Geomagic Touch (3D Systems, Inc.) was used as the haptic device, and CHAI3D was used as the haptic library. In the evaluation experiments, 4 testees of engineering students performed the surgical training for 1 jaw deformity patient. The training consisted of 3 sets of 5 repetitions.

Fig. 2 left shows the average time of the trials and Fig. 2 right shows the box plot of the drilled voxels.

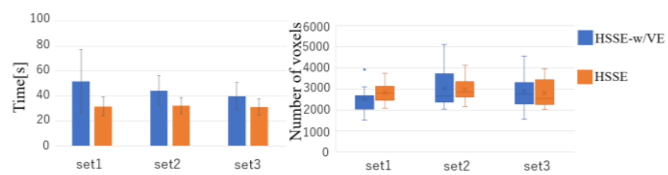

Figure 2. Experimental results of removed voxels for each trial.

IV. DISCUSSION & CONCLUSION

As shown in Fig. 2, the average time of HSSE-w/VE tended to decrease as the trials repeated. The average number of drilled voxels in set 1 was comparatively small when compared to other sets. This is considered that penetration reaction force made the testees more careful for drilling cortical bone. Therefore, we consider that HSSE-w/VE is suitable for OMS drilling training.

Future work will include adaption to the novel haptic device which could generate larger reaction force.

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