A Study on Automatic Assembly Method of Fractured Bone Fragments Based on Measured Point Clouds

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I. Introduction

In recent years, X-rays and computed tomography(CT) are used today to evaluate bone fractures, with the 3D models extracted from the CT images [1], the dislocation and displacement of bone fragments computed by an assembly simulation using 3D models are necessary for a successful surgical treatment.

This paper studies a method to assemble bone fragments automatically from point clouds which are segmented into original surface and fragment surface.

II. Related Works

A. Iterative Closest Point

Iterative closest point (ICP) is a registration algorithm employed to minimize the difference between two point clouds [2]. Since the ICP algorithm is sensitive to noise, the point clouds require high-quality data.

B. Region Growing

Region growing using the normal variation that merges the points that are close enough in terms of the smoothness constraint.

III. Proposed Method

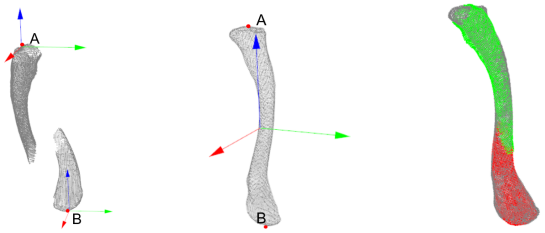
In our method, an intact bone was extracted from the other side of the body and reversed horizontally as the reference model. To improve the accuracy of the ICP algorithm, the bone fragments are required to segment into the bone surface point clouds and fractured surface point clouds by the following steps:

1) Segment the bone fragments into clusters by using Region growing.
2) The cluster with the highest number of points extracted as bone surface.
3) Reclustering the remaining points by their Euclidean distances.
4) The cluster with the highest number of points extracted as fractured surface.
5) Remaining points merge to the bone surface.

To determine the initial position, origin A and B of the bone surface is specified as shown in Fig.1. After that, the initialed XYZ coordinates are obtained through principal component analysis (PCA).

The bone surfaces are rotated from $0°$ to $359°$ centered on the Z-axis, and the average distance of point clouds at the corresponding angle is computed to evaluate the fitness. Then, the most suitable angle is selected as the initial position of the ICP algorithm.

Finally, the bone surfaces are registered to the reference model using the ICP algorithm.



(a) (b) (c)

Fig. 1. Experiment

IV. Experimental Results

Figure 1 shows the experiment on a fractured collar bone. (a) shows the bone fragments used as inputs. (b) shows the reversed intact bone use as a reference model, and (c) shows the result of applying our algorithm, the points of bone fragments indicated in different colors and reference models indicated in white.

V. Conclusion and Future Works

In this paper, an algorithm for assembling point clouds of bone fragments has been proposed. In the future, the algorithm assembles accuracy needs to improve.

References

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[2] P. J. Besl and N. D. McKay, "Method for registration of 3-d shapes," in *Sensor fusion IV: control paradigms and data structures*, vol. 1611. Spie, 1992, pp. 586–606.