BONE INTERFACE DELINEATION BASED ON FREE-HAND SONOGRAPHIC THREEDIMENSIONAL DATA SET

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INTRODUCTION

The main aim of this work was to invent algorithms form bone reconstrction. Basement of this concept was to use navigated ultrasound probe with developed system. The system enables reconstruction of bone surface, virtual osteotomy and measuring parameters. Heuristic algorithm for full automatic bone reconstruction was developed. Basement of each algorithm was data collection, segmentation and reconstruction. On these assumptions user friendly application for real time reconstruction was created. Developed system allows defining geometrical parameters like lengths or angles [1, 2].

METHODS

Ultrasound scanning is low invasive imaging method. Sonography provides low quality images. The low quality of scans is connected with angle of scanning, medium between probe and skin, and probe pressure on skin. Our work was to develop method to identify the bone surface on ultrasound scans. The main image features connected with bone imaging are: strong echo acquired from bone, continuous bone profile, specular echo, high contrast along the contour. Additionally ultrasound waves are stopped by bone-soft tissue border. We decided to identify the bone contour in two different ways automatically and semi-automatically. For the first method important task was to perform preprocessing of acquired images. The images were substracted and afterwards the median and mean filtration was performed. Developed algorithm uses two crossed images for contour recognition (Fig. 1). Diagram 1 shows algorithm of automatic reconstruction.

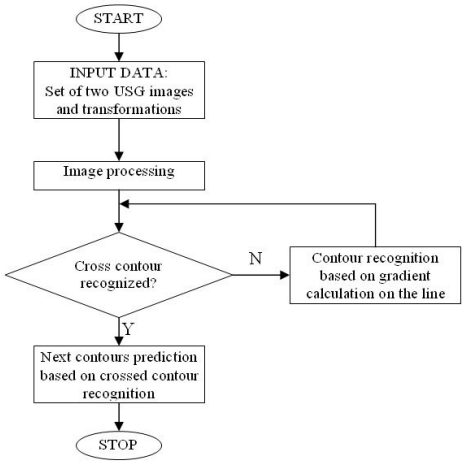

Diagram 1 Algorithm for automatically bone reconstruction.

Second algorithm allowed step by step selecting on each image bone contour but also there was possibility to select region of interest for one or all of them.

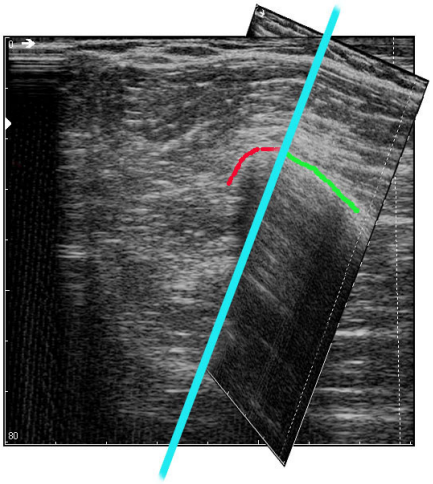

Figure 1: Example of acquired picture.

RESULTS AND DISCUSSION

We developed system consisting of computer, NDI Optical Tracking System and Ultrasound Portable System Echo Blaster 128 of TELEMED with linear probe. We acquired the ultrasound scans and the data from tracking system. At the beginning of acquisition procedure crossing scan was collected, which enabled real-time reconstruction of scanned bone surface. Applied algorithmus enables collection of data with speed 2 frames per second which allows to obtain very detailed bone surface on the distance of 20 centimeters in 60 seconds.

Developed system consisting of sonography and tracking system provides tool for bone surface imaging. Possibilities to use two different reconstruction methods allow for comfortable execute procedures. The data acquired from three dimensional shape reconstructions can be very useful to design correction procedure for complicated deformities. Presented algorithm for osteotomy provides new solution for bone deformities. State of the art imaging method applies only two orthogonal X-ray scans, whereas the complicated deformities seem to require advanced planning method.

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REFERENCES

1. Keppler P., Strecker W., Anselment K., Kinzl L.: Die sonographische Torsionwinkel und Langebestimmung der unteren Extremitaet, Springer Verlag, 1997
2. Świątek-Najwer E., Będziński R., Krowicki P., Krysztoforski K., Keppler P., Kozak J.: Improving surgical precision – application of navigation system in orthopedic surgery, Acta of Bioengineering and Biomechanics, Vol.10 (4), 2008