Anatomical Region Identification in USG image with Preoperative CT 3D Model using optical tracking system

Atul Kumar[1], Seng-Lieh Yan[1], Yen-Yu Wang[2], Kai-Che Liu[1], Shih-Wei Huang[3]

[1]Chang Bing Show Chwan Memorial Hospital, [2]National Changhua University of Education, Changhua, [3]Show Chwan Memorial Hospital, Changhua

***Abstract*-- In USG-guided interventional procedures, the surgeons need to mentally register the reference data set (computed tomography [CT] or magnetic resonance [MR] images), and the working data set of USG (real-time). This study presents a system to combine real time USG information with preoperative 3D CT virtual model using landmark registration. The future goal of this system is to apply for radiofrequency needle tracking during the surgery.**

I. INTRODUCTION

In USG-guided interventional procedures, the surgeons need to mentally register the reference data set (computed tomography [CT] or magnetic resonance [MR] images), and the working data set of USG (real-time). Fusion imaging can help surgeons in conducting interventional procedures with higher confidence and accuracy[1,2]. This study presents a system to combine real time USG information with preoperative 3D CT virtual model using landmark registration. The future goal of this system is to apply for radiofrequency needle tracking during the surgery.

II. METHOD

A. CT and 3D model of Phantom:

An intraoperative abdominal ultrasound phantom (IOUSFAN, Kyoto Kagaku Co. Ltd., Kyoto, Japan), made specifically for ultrasound and laparoscopic applications, was used in this study. The CT scan images of the human torso phantom was acquired with radiopaque markers placed on it. A 3D virtual model reconstruction of the segmented regions was done using ITK-SNAP.

B. The tracking system:

An NDI Polaris tracking system was used to track the TO (Target object), VO (virtual object) and the USG probe. The NDI Polaris consists of an infrared camera system and tracking tools, which are mounted, on the objects to be tracked. It wirelessly detects and tracks tool's position and orientation in six degrees of freedom.

C. The visualization software:

The software interface provides a visualization of the CT 3D model (VO), the real time USG image (TO), and the movements of USG probe.

D. Combined visualization:

A landmark registration technique was used to register 3D CT model. A tracking tool was mounted on the USG probe. The USG image was visualized in the software as image plane with physical dimension of the image in millimeter. The transformation between the mounted tool and the image plane was also calculated with a landmark registration technique. USG image and the CT model section was visualized in a rendering window of VTK.

III. PRELIMINARY RESULTS

A. Fusion of CT model and USG image

A C++ with CUDA based software for the system was run in a computer with Intel® Core™ i7 960 @3.20GHz, 6.00RAM 64 bit Windows 7 and graphics card of NVidia TESLA C2075. The SectionModel and USGPlane visualized in a single image is shown in Figure 1.

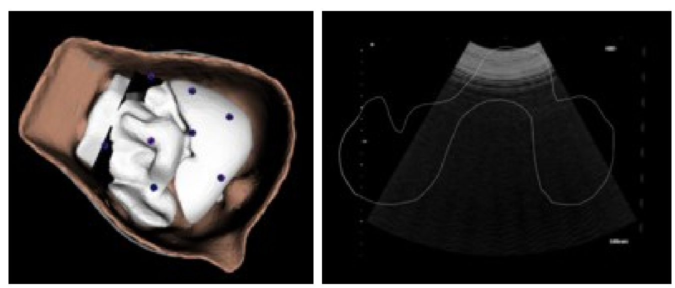

Figure 1: CT scan model with USG image (left). USG image with a section from CT model

IV. CONCLUSIONS

*T*his work presents a system to combine the information from 3D CT model and the USG image using landmark registration. In future study a radiofrequency tracking system would be included and visualized.

References:

1. Mauri, Giovanni, et al. "Real-time US-CT/MRI image fusion for guidance of thermal ablation of liver tumors undetectable with US: results in 295 cases." *Cardiovascular and interventional radiology* 38.1 (2015): 143-151.
2. Wein, Wolfgang, Barbara Röper, and Nassir Navab. "Automatic registration and fusion of ultrasound with CT for radiotherapy." *International Conference on Medical Image Computing and Computer-*

Assisted Intervention. Springer, Berlin, Heidelberg, 2005.