I-027

Multi-touch Based Medical Image Visualization and Analysis System

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1. Introduction

Medical imaging plays a very important role in healthcare. As the imaging technologies develop the acquired image data sets become higher and higher definitions, and then allowing more detailed structure visualization for human's internal organs. How to analyze and visualize the 3D medical image, which is one of the fundamental processes in medical diagnostics, becomes a hot research topic. Y. Hu [2] explored a 3D visualization system for lung tissue and demonstrated its efficiency and lowered risk in surgical treatment of lung cancer. But full access to 3D rendering outside of the radiology department is still scarce even for many image-centric specialties. In the other hand, the popularity of touch-controlled smart devices demonstrates intuitively the convenience and easiness of using touch interfaces, which would be more efficient for selecting tasks than mouse, as shown by Kin et al. [3]. In the tasks of document-centered visual analytic, Isenberg et al. [4] show that the tabletop is very suitable for collaborative work.

Due to the advantages of Multi-touch based interaction there are many multi-touch based medical visualization systems that have been developed recently.

The Multimodal Virtual Anatomy learning Tool for Medical Education, developed by Lu et al. [5], successfully integrates the 3D anatomy models and other common materials such as video, images with different formats, animation and so on, in the related fields, and provides online and mobile learning interfaces. With the multi touch tables, the user interface of the Learning Tool is easy to use and intuitive.

The FI3D: Direct-touch interaction for the exploration of 3D scientific visualization spaces, developed by Yu. et al. [2], provides touch interaction with 3D scientific data spaces in 7 Degree of Freedom (DOF). FI3D can be used on hardware that supports dual- or even single- touch input and allows for full 7 DOF manipulations using only single-touch by the Frame Interaction technique.

The Multi-Touch Table System for Medical Visualization, developed by C. Lundstrom et al. [1], enables the orthopedic surgeons to achieve insights that are important for their clinical task and assists in constructing the accurate mental 3D model of the patient's anatomy that is necessary to comprehend before going into surgery.

From the literature review, we realize that most touch based systems in medical field only focus on the visualization and there are few functions in these systems that can analyze the medical images. In this study, we aim to develop an easily interactive system that can not only analyze the raw medical image but also visualize the required information and easily interact with users.

In the proposed system, we analyze the medical images and visualize the analysis result immediately. The system provides several organ models to indicate the common shape of each organ. The users can choose to visualize the organ models provided by the system and any interested region using surface rendering. For easily controlling, we apply the tabletop to integrate multi-touch for human interface interaction. With the easily controlled touch operation, the user can simply select any interested organ and a part region (pathology zone) for visualization, and freely control the visualization view points for achieving useful information. With our developed system, it is promising to be applied to not only education and doctor-training sites for giving the users a global view of organ structures from different subjects and detail pathology zones, but also clinic sites for showing the normal and abnormal organ structures, which can explore the deformation degree of organ structure due to diseases.

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2. Overview of the Designed System

The designed system can import the raw medical CT image, and understand and analyze the raw data. The raw input and organ models provided by the system can be displayed by 3D visualization technique, which interacts with the user under an environment with multi-touch operations. As illustrated in Figure 1, the designed system mainly includes three modules:

1) Visualization module: user can get a vivid view of the given dataset in volume rendering, surface rendering and slice by slice view. More detailed information and deep exploration of the dataset is also accessible in visualization module. In the visualization module, the system integrates single-/dual- touch inputs and direct touch, two-touch interaction technique (RST), frame interaction method. A simple but sufficient 6 Degree-of-Freedom (DOF) visualization, including x-/y- translation, rotation around x-/y-/z- axis and zooming under the environment of touch interaction is realized. Thus full access to a 3D object is possible. What’s more, the slices are extracted from the volume data to give insight of the data-set. The slices are extracted in 3 directions, axial direction, sagital direction and coronal direction. 4DOF operation is enabled on the extracted slices since the slices are 2D images and rotation around x-/y- axis becomes useless. The interface of the designed system is shown in Figure 2.

2) Processing module: the system supplies an interactive segmentation of medical images based on the Graph Cuts algorithm. To achieve good segmentation result, some pre-processing is used to enhance the contrast in the interested region. Then the Graph Cuts algorithm is applied to calculate the optimal segmentation that satisfying the hard constrains (user inputted seed points). The hard constrains are enabled only on slices in axial

direction. It’s better to place hard constrains on several slices so as to achieve a more accurate segmentations. For the processing module, there are much work remains to do. For example, we want to add some registration and diagnosis functions to the system to make it serve as a Computer-Aided Diagnosis (CAD) system. Currently these function are not realized yet and that would be the future work for the designed system.

3) Control module: the multi-touch control is used as the main interaction method to control the translation, zooming, view-ports in visualization and put hard constrains (seeds) in the interactive segmentation.

3. System Platform

The device used is Samsung SUR 4.0 as shown in Figure 5. It was an all-in-one computer that had an AMD-powered CPU (AMD Athlon X2 245e 2.9GHz Dual Core), a GPU (AMD Radeon HD 6750 1GB GDDRS, and 4GB DDR3 RAM. The OS was Windows 7. The device used PixelSenseTM technology to detect and respond to fingers and other objects with optical tags. It can detect more than 50 contact points simultaneously, which supports multi-users interaction.

4. Conclusion

A multi-touch based medical analysis and visualization system is introduced in this paper. The system allows the user to interact with 3D medical images with a set of multi-touch gestures and menus, aiming to help the user to view and find the desired medical information with ease and high efficiency. The present work provides a solid foundation to employ multi-touch interaction in medical analysis and visualization system design.

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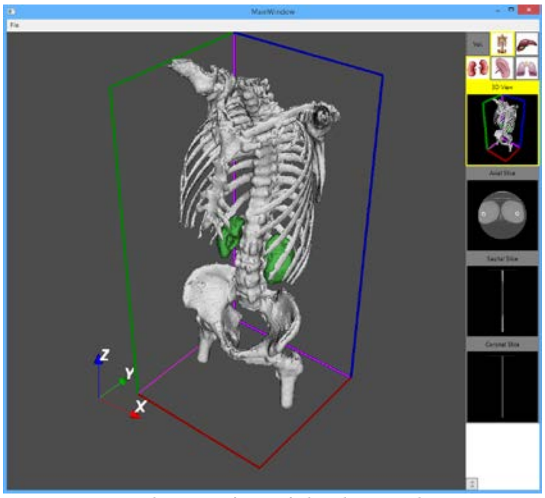

Figure 2. The interface of the designed system

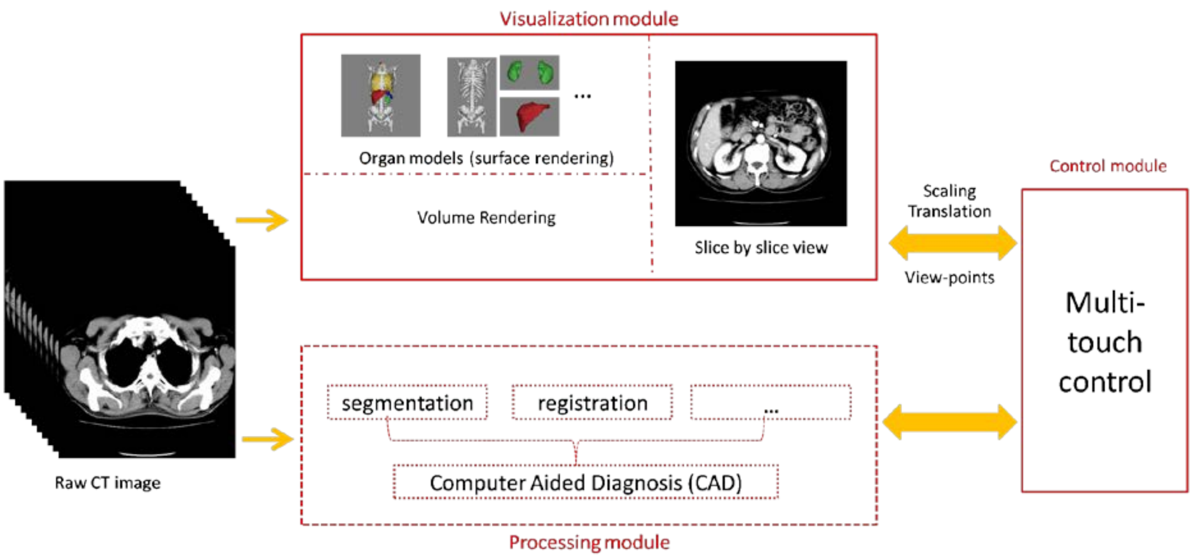

Figure 1. System framework