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Automation for Virtual Surgery

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Abstract:
Virtual surgery in general is a virtual reality technique of simulating surgery procedure, which help the surgeon improve a surgery plan and practice surgery process on 3D models. The development of robotics and virtual reality technology, virtual surgery simulator has become the most effective way of training the doctors, in which soft tissue deformation technology is a key technique of virtual surgery simulator. Simulator surgery results can be evaluated before the surgery is carried out on real patient. Thus, helping the surgeons to have a clear picture of outcome of the surgery. If the surgeon finds some errors, he can correct by repeating the surgical results.Virtual surgery is based on patient model, so when real surgery takes place, the surgeon is already familiar. The robot-assisted surgical systems that allow minimally invasive surgery have a diverse advantages compared to conventional open surgery. Virtual surgery system in the preoperative planning, teaching, communication between doctors and patients has an important application value. To solve the problem, an assisted system for the precise surgery based on medical image computing and VR is design.

I. INTRODUCTION

Virtual surgery is one of the important applications of virtual realitytechnology; it is mainly used to simulate a variety of surgical phenomenon during the real surgical operation, the main simulating preoperative, intraoperative and postoperative three stages. Virtual Reality (VR) is a technology that simulates three-dimensional virtual world by computer technology, so that users can perceive things in virtual space without limitation. With the progress of science and computer technology, the maturity of VR technology has been greatly improved. But most of the virtual surgery systems are the simulation platform to simulate human structure, which are basically used 3D software Human tissue model simulation. The lack of these systems is un-authenticity, unpractical and lost immersion sense. To obtain the true maximum, immersive and interactive surgery and surgical scene of human tissue and screen freshness in signal transmission HTC VIVE equipment is used. The training and the education of the doctors place a great role in virtual surgery system. At the same time, when using the virtual surgery system, medical practitioners can learn more immersive and closer to reality than traditional videos and books when learning operation process, equipment usage and interaction between doctors and patient. The robot-assisted surgical systems that allow minimally invasive surgery (MIS) have made great advances with many advantages compared to conventional open surgery. Virtual Reality (VR) is getting high attention in various applications including medical field. Therefore, adoption of VR vision system has been proposed for more intuitive control of the endoscopic system using natural head movement. Our purpose is to develop an interactive real-time surgical simulator with high fidelity to further achieve efficient training and low-cost medical education.

II. VIRTUAL OPERATION SYSTEM DESIGN

Based on the practicability and generality of the system function, the virtual auxiliary surgery system is designed. In the aspect of interface design, the user of virtual surgery assistant system is the medical people. As a small white user, good and humane interface design is the key to ensure the operability of the system. This system provides a start-up UI, starts UI, provides the corresponding start button and operation hint, and tells the doctor's operation scenario corresponding to the system through the background wall of the interface.In behaviour operation, medical staff can use this system to achieve common operation operations, including human body tissues and organs, surgical instruments, rotation, and tissue organ cutting operation. At the same time, after an experimental operation, the operation scene can be reset to carry out repeated operations, thus improving the system's versatility. As a result, the interface of this article is added with the functions of grabbing, rotation, looming, cutting, and reset. Figure 1 gives the structure of the software design.

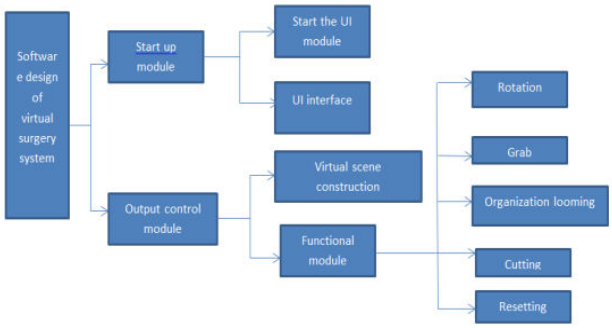

Figure.1.Software system structure diagram

Virtual surgery system is designed in this paper is the modelling of human tissue image data based on the real human body (the human tissue data have included lung, pulmonary vascular, bone), implementation and testing and then based on virtual surgery, virtual surgery system in order to ensure the reality and immersion the quality of human tissue, model quality plays a decisive role, therefore based on the data of human body modelling has become a key auxiliary system of virtual surgery.

III. VIRTUAL SURGERY APPLICATION

Based on clinical trial data, we propose a new treatment of liver tumors puncture simulation process, so that trainees can gain experience and practice to simulate puncture procedures in the virtual world. Figure 2 shows the soft tissue deformation simulation process of our liver puncture surgery based on clinical trials. In the soft tissue deformation, this study combines the traditional viscoelastic mass spring damper with position-based dynamics to simulate soft tissue deformation in real time.

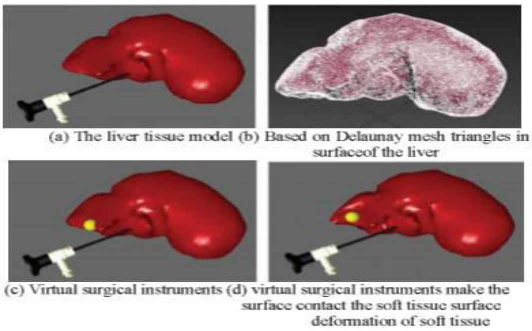

Figure.2. Simulation of soft tissue deformation for liver puncture surgerybased on clinical trials.

Figure 3 (1) shows the initial setting of our simulator. The sheath in gray is first navigated into the atrium and a steerable catheter is then advanced through the hollow tube of the sheath to perform further procedure. As the blue marks with circle in Figure 3 (2) indicates, with proper cooperative manipulation of the virtual devices, the trainee can navigate the tip of the catheter to any desired position of the atrium wall to make scars for the treatment of AF

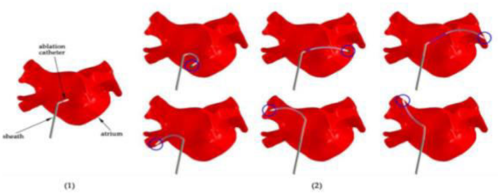

Figure.3.Simulation results of our VR-based surgical simulator. (1) The initial settings of the simulator. (2) The tip of the catheter navigated to any position with proper manipulation.

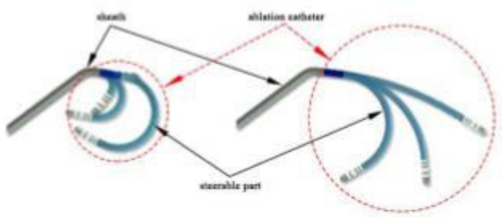

Figure.4. the interaction between the sheath and the steerable catheter.

Figure 4 shows the simulated interaction between the sheath and the steerable ablation catheter. As indicated in the left of Figure 4, the catheter shows more and more its curved tip part as the trainee advances the catheter out of the sheath. Meanwhile, by handling the controller at the distal end of the catheter, trainees can change the curvature of the steerable part of the catheter to make its tip capable of touching the desired spot of the atrium wall, as shown in the right of Figure. A VR goggle, Oculus Rift® (Oculus VR, Inc., Irvine, CA, USA) shown in Fig. 5 is used in the study. The Oculus Rift® hardware contains a number of micro-electrical-mechanical (MEMS) sensors including a gyroscope, accelerometer, and magnetometer. The system also contains a sensor for tracking goggle position. The information from each of these sensors is combined through the sensor fusion process to determine the motion of the user's head in the real world and synchronize the user's view in real-time.

Figure.5. Coordinate system

Direction of represented rotational arrow is positive. Orientational Data In the earlier study, the AHRS sensor was mounted on the VR goggle to receive orientational data for controlling the 4-DOFs ECS. For simplifying the hardware system data were acquired from the built-in sensor of the VR goggle in this research as illustrated in Fig. 6.

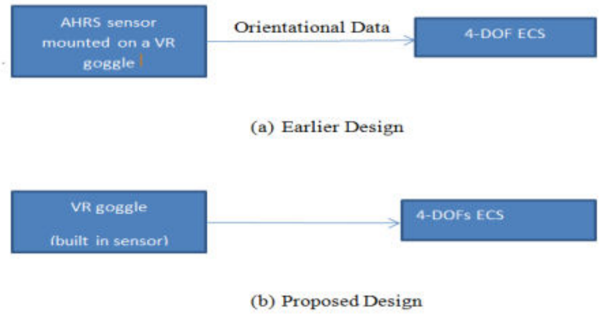

Figure.6. Concept overview:
(a) Earlier Design,
(b) Proposed Design.

IV. CONCLUSTION

Novel interaction methods are proposed to simulate the interactive behavior between the interventional devices and human vascular system including the bumping heart. The preliminary results and user emulation demonstrate that our simulator is qualified for providing a realistic, effective, and stable environment for trainees to acquire essential surgical skills. To extend the versatility of our simulator, several improvements can be further made, such as providing more types of virtual surgical devices and simulating the complication occurred in real surgery process. The ranges of available thresholdfor orientational head motion are provided as preliminary results.

V. REFERENCE

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