A WEARABLE GLASSES SYSTEM DEVELOPMENT FOR SPINAL IMAGE FUSION AND SURGERY BY USING MIXED REALITY TECHNOLOGY

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INTRODUCTION

In this paper, an efficient wearable glasses system is proposed for the application of preoperative spinal surgery. The technology is essential to generate a virtual space with a 3D model of the patient from CT images while marker attached [7]. The 3D model is then used to fit the poses of the phantom during surgery by using the PnP method. The patient's preoperative 3-D image model is registered by projecting it onto the phantom such that the synthetic 3-D model merges with the real patient image, enabling the surgeon to see-through the patient's anatomy. Glasses with camera are then used to capture the relative pose between patient's body and viewing direction of the surgeon by marker detection [4] and localization. Experimental results validate on a phantom, and shown the effectiveness of the proposed method. The foremost objective is to assist the surgeons to see-through the vertebral and surgical planning for a minimally invasive spinal surgery.

MATERIALS AND METHODS

This paper tackles the problem of establishing pre-operative surgery simulation for assisting spinal surgery by using custom made glasses [5] with a camera attached. Various methods were established for solving the pose estimation problem for perspective imaging devices, where the imaging rays are assumed to intersect at a common point. In this paper, the PnP problem has been applied to calibration of camera and screen views, especially for their geometrical location transformation [1,2,3]. The closed-form solutions have been formulated if three or four 3D/2D correspondences are adopted [6]. We mainly discuss about 3D model to preoperative image registration method which uses a 3D modelling from CT pre-interventional images. We examine the problem of using augmented reality technologies for orthopaedics surgery and applied the PnP method for 3D-3D pose registration. Once the pose registered, the augmented reality is then considered as a hybrid of virtual and real environment spaces to simultaneously visualize the information of the patient. For applying PnP to the image registration [2], assume at least four non-coplanar 3D points located in virtual space (marker positions) and the corresponding 2D points, which are the markers attached on the patient's back torso, are extracted from the 2D image captured by the video camera. Suppose there are n points (markers) in the world coordinate (the real patient's torso in the operating room) and their corresponding n points in the virtual space (3D model of the patient). A phantom with a 3D model is used in our experiment, as showed in Fig. 2 is shown the glass view of motion in simulated spinal model and PnP registration method and for surgical planning of a spinal surgery.

In spinal surgical procedure, the image registration between preoperative 3D and intra-operative scene for therapy is of particular importance. The images which used to physical transformation are utilized to track the surgical probe or needles to the surgical target and guide the surgeons to understand the relationship of the spinal vertebral and the patient's body. Image of physical registration is performed using geometric features of spine. Anatomical landmarks or surfaces can be utilized to registration in open image guided surgeries of the spine and orthopaedics. In point based registration, the bony landmarks such

as tip of the spinous or transverse process or a prominent facet or osteophyte are identified and marked in pre-operative 3D model and in physical world they are localized using a tracking probe, then the corresponding point pairs are aligned using least square method.

RESULTS

The proposed approach has been implemented and shows the results on a phantom for pre-operative spinal surgery. The surgeon can adopt the system to assist surgical planning, and then check the accuracy during the vertebroplasty surgical procedure. Figure 1 shows the flowchart of the proposed image processing method by using the wearable glasses. Figure 2 demonstrates a spinal surgical simulation on a phantom.

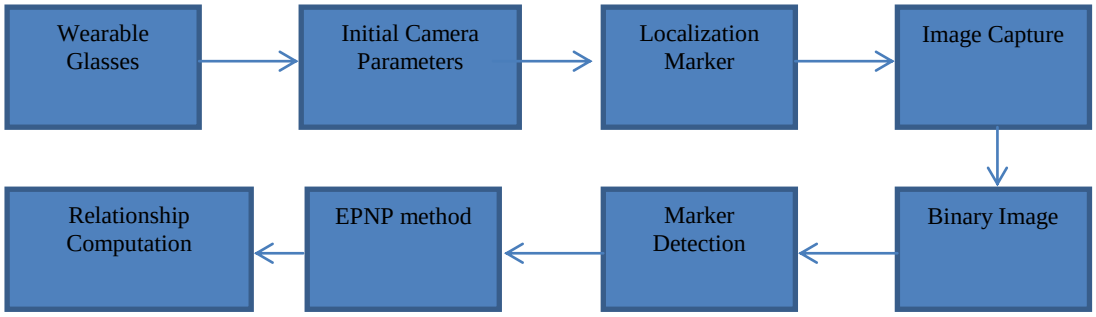

Figure 1: The flowchart of the proposed image processing method. The geometrical relationship between glasses and marker is computed for mixing the spinal image to a phantom.

Figure 2: The mixed reality to interact with the spinal image from a real patient. The image demonstrates the proposed MR and poses tracking work in permit results. The surgeon adopts the assisted system for surgical planning, and then checks simulation steps of the vertebroplasty surgical procedure.

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DISCLOSURES

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