A14-120

Embedded Laparoscopic Surgery Training System

嵌入式腹腔鏡手術訓練系統

隊伍名稱

貝斯特多多 / BEST MORE

隊長

盧毅鴻 臺灣科技大學電子工程系

隊員

陳栩茹 臺灣科技大學電子工程研究所
賴登義 臺灣科技大學電子工程研究所
陳偉豪 臺灣科技大學電子工程系

作品摘要

生醫科技發展日益蓬勃，微創手術是現今外科手術的趨勢。相對於傳統開腹手術，微創手術具有傷口小、出血少、恢復期短等優點，但因為外科醫生需透過螢幕觀看內視鏡傳出來的畫面進行手術，所以醫生的手術技巧、穩定度、手眼協調能力就變的很重要。比起傳統手術，微創手術的困難度相對較高，所以外科醫師除了需有大量的知識訓練，還需透過有效的訓練工具進行技巧練習。如此，才能有效地降低實際手術的風險。

現今的手術訓練工具又以虛擬模擬訓練器最為新穎，也是現在手術訓練工具的發展趨勢，虛擬手術模擬訓練器透過動畫的建置，訓練者可以依不同的需求而選擇不同的虛擬手術環境去訓練，比起一般的動物活體、人體實驗，它更具彈性、可重複練習且無道德問題。

而市面上的虛擬模擬訓練系統，礙於開發技術門檻高、定位儀器昂貴，售價居高不下，且開發平台多以PC based為主，故系統體積龐大、可攜性較低。因此，我們開始著手開發嵌入式腹腔鏡手術訓練系統。提供新手醫生進行手眼協調、器械操作和空間認知的手術練習，在操作的同時，也會記錄操作路徑與時間，給予客觀的評估回饋，且具有低成本、可攜性高等優勢。

本團隊所設計的嵌入式腹腔鏡手術訓練系統中，主要包含了三個部份，訓練箱、器械定位裝置和嵌入式平台。在嵌入式平台上我們以虛擬實境和3D動畫技術開發幾個虛擬訓練模組，希望提供不同難易度的訓練模組，並將訓練過程紀錄且分析評分。以平板電腦為嵌入式平台，結合器械定位裝置和空間位置裝置（X， Y， Z）擷取器械動作資訊，器械定位裝置需偵測出器械的開合、旋轉（Roll， Pitch， Yaw）。採用整合性慣性感測模組，來做操作器械的旋轉角度定位，該模組整合了加速度計、陀螺儀和磁力計，以提供可靠的器械定位資料。由於體積小，所以可以容易的整合到手術的器械上，且成本比其他系統更具有競爭優勢。空間位置部分則使用立體視覺方法，以FPGA把器械的座標藉由兩個相機將2D影像轉換成3D座標，進而控制虛擬動畫中的器械移動。

本系統的優勢特點可以歸納如下：

1. 以較低成本的硬體完成高準度的定位系統。
2. 以較低價且方便攜帶的嵌入式平台為顯示裝置，降低系統成本且提高攜帶方便性。
3. 完整記錄受訓者的操作軌跡，可以客觀分析且評估出受訓者的操作穩定性。
4. 為一套安裝與使用皆十分簡易的系統。

2014

指導教授

林淵翔 / 臺灣科技大學電子工程系

臺灣大學電機博士。曾任職於瑞昱半導體股份有限公司多媒體事業處，目前為臺灣科技大學電子系副教授，以及全國技能競賽電子 (工業電子) 職類裁判長兼國際裁判。

研究領域

嵌入式系統設計、生醫電子工程、FPGA 系統設計與應用、智慧型手持裝置在醫學工程上的應用、穿戴式裝置設計。

Abstract

The development of surgical operation has been gradually popular, and the minimally invasive surgery (MIS) is a mainstream nowadays. Comparing to the traditional open surgery, MIS has advantages of small incision, less blood and faster recovery. However, surgeons need to conduct operations by watching the monitor through the laparoscope, so whose skills, stabilization and hand-eye coordination abilities are vital. Compared to traditional operations, MIS is relatively difficult. Therefore, in addition to a large amount of knowledge practice, we need effective training tool to practice skills. And then, we can lower the risk of realistic surgery.

Among all the training tools, VR surgery training simulator is the latest, and also the mainstream. Trainees can choose different environments to practice according to different needs. Unlike usual animal and human bodies, it is more flexible, repeatable and moral.

The reason why the price of the commercial virtual simulation training system is so expensive is that the threshold of developing skills are high and the position instrument is costly. Besides, the platform is mostly PC based, so the volume is big, and hard to carry. Therefore, we started to develop embedded laparoscopic surgery training system, providing novice surgeons training such as hand-eye coordination, instrumental operation and the sense of space. When they are practicing, the executing time and track will be recorded by the system, giving objective feedback. Hence, this system has the benefits of low cost and high portability.

There are three parts in our embedded laparoscopic surgery training system: training box, instrument positioning device and embedded platform. We develop several VR training modes with virtual reality and 3D animation technology, hoping to offer different levels of training device; then, recording and scoring the training process. Using tablet PC as the embedded platform with instrument positioning device and space location device(X, Y, Z) to receive instrument movement information; instrument positioning device should detect roll, pitch and yaw. We use integrated inertial detective modules to locate the rotation and clip open/close angle of instrument, which puts accelerometer, gyroscope and magnetometer together to provide precise information of instrument location. Because the module has small size, it can be added to the surgical instrument easily, and cheaper than other systems. As for the space location, we use stereo vision technology to let FPGA platform sends instrument's 3D location to the 3D VR game on the table PC in real time.

The advantages of our system could be listed as following:

1. We have precise positioning system, yet the hardware is less costly.
2. Portable and cheaper embedded platform monitor can lower the system cost and raise the portability.
3. Recording the training results and giving the objective assessment.
4. This system is user-friendly, which can be easily installed and operated.

Fig.1 > Operational schema