http://ansinet.com/itj

ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Information Technology Journal 12 (20): 5756-5760, 2013
ISSN 1812-5638 / DOI: 10.3923/itj.2013.5756.5760

Research of the Virtual Acupuncture Training System VAMT

Chen Zhong-Bao, Fang Zhi-Gang and Wang Xiao-Chi
Zhejiang University City College, Hangzhou, 310015, Zhejiang Province, China

Abstract: The low efficiency of traditional acupuncture medical training not only embarrasses the development of acupuncture, but also brings troubles to the trainers. The Virtual Acupuncture Medical Training System (VAMT) combines the virtual reality technology and traditional medicine to establish virtual scene and simulate acupuncture training. It not only conquers the disadvantages of traditional training mode, but also enhances the immersion and interesting of training, furthermore, it can improve the trainers' enthusiasm and training effect.

Key words: Virtual reality, acupuncture medical training, virtual-hand

INTRODUCTION

With the development of medical acupuncture, the demand for qualified acupuncture therapists is also growing. Although the traditional acupuncture medical training make it possible for the students to observe the position of each acupuncture point closely, but to find the precise location of each point, students not only need the help of the traditional Chinese medicine language but also need to be familiar with the characters of the acupuncture points. VAMT, based on virtual reality technology conquers the disadvantages of traditional acupuncture medical training and the establishment of three-dimensional virtual points makes the trainees can find the acupuncture points easily. In this way, trainees can achieve the same effect as the physical model way with the help of virtual reality display technology (such as a helmet mounted display, etc).

Virtual human modeling studies were carried out at home and abroad from the end of the 20th century to the early 21st century.US-based research projects appeared or during this time (Brodlie *et al*., 2000), including America's Virtual Human Project Initivate, Korea's Visible Korean Human (VKH), Japan's Human Brain Project and so on. The reach programs in china include Shanghai Traditional Medicine University's Chinese Three-dimensional Acupoints (Yu, 2004), Institute of Tianjin Traditional Chinese Medicine University's Digital Virtual Acupoints, etc. The virtual human models are widely used in areas such as healthcare and education, but the application of virtual acupuncture training is still blank.

Virtual Acupuncture Medical Training (VAMT), based on virtual reality technology uses three-dimensional modeling technology to create a virtual acupuncture training scene with digital acupuncture points (Hashash and Ghaboussi, 2002) and also takes the advantages of tracking technology, collision detection technology (Cui *et al*., 2007) and gesture recognition technology (Li *et al*., 2007) to simulate acupuncture training which includes finding the position of the point, needle grasping, needle inserting and needle manipulating. Through the training, trainees can master different acupuncture's skill. VAMT not only conquers the disadvantages of traditional training mode, but also enhances the immersion and interesting of training.

VAMT SYSTEM DESIGN

System structure: The VAMT system design can be divided into three parts: the operator part, the virtual peripherals part and the virtual operating environment part. The triple play of these parts forms a closed loop. The block diagram of the overall system is shown in Fig. 1.

The operator is the main dynamic part in the system. With the help of data glove and position tracking device, system completes the mapping of real hand to virtual hand, do the corresponding operation and then transfers the refreshed virtual scene to the helmet display or LCD monitor in real time.

The establishment of the virtual scene is achieved by using 3D modeling tools: 3DMAX and OpenGL graphics interface. 3DMAX is used to establish the human body model with surrounding scene and OpenGL is used to control model and establish acupuncture point.

Data flow diagram of the VAMT system: The data flow of the system is shown in the Fig. 2.The hardware which is used in the system should be initialized before any operation. After getting the data of position tracking

Corresponding Author: Chen Zhong-Bao, Zhejiang University City College, Hangzhou, 310015, Zhejiang Province, China

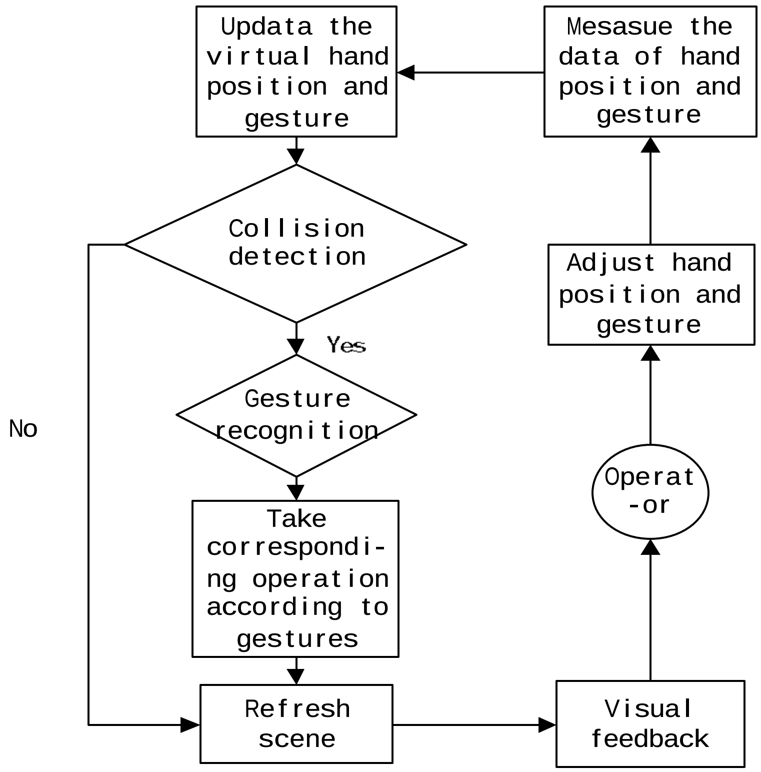


Fig. 1: Block diagram of system

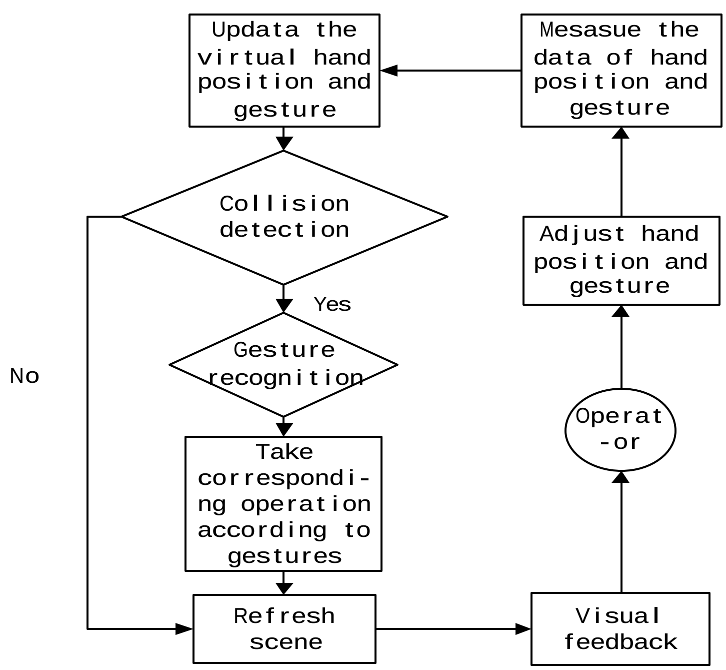


Fig. 2: Software flow chart of system

device and data glove, system turns it into the absolute space coordinates, direction value of the man's hand and the degree of curvature of mapping virtual fingers; according to the hand's space coordinates, direction value and the degree of curvature of mapping virtual fingers, system uses the virtual hand model to implement graphics conversion and calculates the new position and new orientation of the virtual hand in the virtual space. Then system detects whether there is a collision between virtual hand and virtual objects: if there is a collision, according to the different gestures recognized, different operation will be carried out, including needle scraping, roaming, acupuncture switching mode and virtual human rotation. After this, system will refresh the whole virtual environment and display the feedback information. If there is no collision, system will refresh the scene directly.

KEY TECHNOLOGIES

Mapping from human hand to virtual hand: System uses data glove (5DT Data Glove) and three-dimensional position tracking device (Flock of Birds, FOB) to complete the Mapping from human hand to virtual hand.

5DT Data Glove's five fingers is linked to five sensors and by getting the value of the five sensors, system completes the mapping between the corresponding curved finger and the virtual fingers. The position coordinates of human hand in virtual world is got by the three-dimensional position tracker device and system must obtain angle rotation values to track the rotation of the virtual hand in virtual space. Then, complete the mapping between the curvature degree of the hand and the angle of virtual hand.

Collision detection: Collision detection must be performed when virtual hand interacts with virtual objects. System is implemented in OpenGL software platform, using OBB collision detection method.

First of all, create a bounding box for every geometric node and show the position and posture of the every dynamic geometric node in real time. In our system, we add OBB bounding box in the virtual hand's palm and finger joints to detect the collision. In this way, the bounding box of the virtual hand is dynamic and the bounding of grasped object is static.

The management of collision detection is achieved by SOCollisionManager class. It controls the position data of one object and avoids collision with other objects in the scene. When there is a collision around bounding box or within the object caused by geometric primitives, the collision detection manager will calls the CollisionManager class's feedback function, automatic tracking the motion path of the object. Gesture recognition

Gesture definition is based on the comparison between sensor's default value and threshold values in a simple gesture recognition situation. The data glove we use is the 5DT Data Glove 5 and the sensor value is between 0-255.When the response of the sensor is below the lower threshold value, the return vale will be 1, indicating that the corresponding finger is straight; when the response of the sensor is above the higher threshold value, the return value will be 0, indicating that the corresponding finger is curved; when the response of the sensor is above the lower threshold value but below the higher threshold value, there will be no return value. According to every finger's condition, we can define 16 kinds of simple gestures and according to the methods of interaction, VAMT defines five simple gestures to control the virtual object. As shown in Table 1.

SYSTEM FUNCTION DESIGN

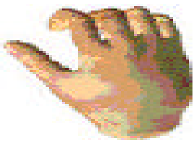
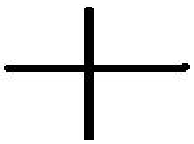
The main function of VAMT system is to simulate acupuncture training, including needle grasping, needle inserting and needle manipulating. According to different acupoints, trainees can master different acupuncture's skill, like direction, angle and depth, also be familiar with the location and the corresponding indication functions. Learning function of the system

Lookup point: Finding the right point position and selecting acupoints for illness is the aim of the acupuncture medical treatment. If we can't find the right point position, the consequence can be serious: as not treat the disease, the latter would injury the life. In such a condition, the VAMT system can be used to simulate acupuncture training to improve this condition. When trainees choose this function, the system would hide the information of all the acupoints and will not display until trainees find the right point. As shown in Fig. 3.

Display human meridian: The body's acupuncture points are connected by the meridians. In order to understand the links between various points, human meridian is embedded in the human body model. It will appear when trainees need to observe the meridian and will be hidden if there is no need. This function is realized by gestures.

Display acupoints name and their main treatment of illness: There are more than 700 acupuncture points in human body and through reading to remember these

Table 1: Gesture interaction

Gesture	Function
	Switching between roaming mode and acupuncture mode
	Needle grasping gesture: after detect the collision between virtual hand and needle, the virtual hand and virtual objects can be bound to the same coordinate system with such a gesture.
	Virtual object grasping gesture: after detect the collision between virtual hand and virtual object, the virtual hand can be bound to the virtual object with such a gesture.
	Control human model to turn left
	Control human model to turn right

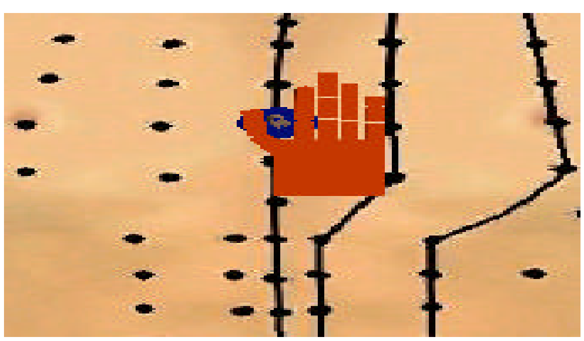


Fig. 3: Lookup point

points and their main treatment of illness takes a lot of work. The only way to remember these acupoints is training and practice. In our system, when the needle is close to acupuncture point, the name and its main treatment of illness will be displayed.

System training function analysis

Needle grasping and needle inserting training: There are many kinds of needle grasping ways in acupuncture medical treatment. Such as right hand needle grasping way: generally use thumb, index finger and middle finger to grip the needle and use ring finger to against the needle body. Additionally there are thumb, index finger grasping way, thumb, middle finger grasping way and so on. Different acupunctures require different ways of needle grasping. When the collision between virtual hand and needle is detected, trainees must do the corresponding gesture to grasp the needle, or even the collision is detected, the virtual hand and needle can't be bound together.

Needle inserting way can be divided into three ways: single hand needle inserting, both hands inserting and base pin inserting. Since, the equipment is limited, system just realizes the single hand needle inserting way. Single hand needle inserting way uses index finger and thumb to grasp needle, middle finger to against acupoint and finger pulp to be close to the needle's lower part. When trainees push down thumb and index finger, the middle finger buckling, insert the needle into the required depth. Gesture recognition technology should be combined in the training and in the process of needle inserting, trainees only follow the needle inserting rules above to make the corresponding gesture, can they insert the needle into acupoint, otherwise the needle will stop and the warning and reminder will be displayed.

Inserting depth training: The requirements for inserting depth is quite strict and too shallow may can't treat the disease and to deep may hurt the body's vital organs. For this reason, VATM system realizes the function of the depth detection, display the inserting depth in real time.

Inserting angle training: Different acupoints have different requirements on inserting angle. Vertical inserting need the needle and skin face at a 90° angle or nearly to be vertical; slant inserting need the needle and skin face at about a 45° angle; the angle of thwartwise inserting is about 15~25°. System has a set of program to deal with the angle required for different acupoints. Only the angle meets the requirement, can the needle insert the acupoint, otherwise the needle will stop and warning and reminder will be displayed.

SYSTEM TESTING AND EVALUATION

To test the system's reliability and availability, we have invited 12 students for testing. Testing mainly includes: the natural character and flexibility of the interaction and the reliability and availability of the system. The result is acceptable: the real scene meets the natural character and flexibility of interaction, has a certain practicality and has reached the expected goal. But the system still has some problems to be improved, such as excessive reliance on vision and a lack of force sense and tactile feedback.

CONCLUSION

Virtual acupuncture Medical Training System combined with computer technology, virtual reality technology, sensor technology, psychological physiology and traditional medicine, is provided for medical students to do acupoint training and also can be a way of teaching acupuncture theory.

VAMT system uses data glove as an input device and establishes date glove based virtual hand real-time interactive platform. We discuss and study the creation of virtual environment, the establishment of virtual hand model, tracking and mapping of the hand motion and the implementation technology of virtual hand operation and also combine traditional medicine to establish virtual reality based acupuncture training system.

The system which is lack of force sense and tactile feedback we realized at present is preliminary and need to be improved in the future.

ACKNOWLEDGMENT

Our Research Project was fully sponsored by Bureau of Hangzhou city science and technology project, Hall of Zhejiang province science and technology public welfare project and Zhejiang University City College cross research foundation project with grant number 20120633B32, 2012C21038 and J-13027. Thanks for the sponsorships.

REFERENCES

Brodlie, K., N. El-Khalili and Y. Li, 2000. Using web-base computer graphics to teach surgery. Comput. Graphics, 24: 157-161.

Cui, H.G., J. Chen and D.Y. Wang, 2007. Research on optimized OBB collision detection algorithm in virtual environment. Comput. Eng. Design, 11: 2524-2526.

Hashash, Y.M.A. and J. Ghaboussi, 2002. Discrete element modeling for the development of a real-time soil model in a virtual reality environment. Dis. Element Meth., 117: 112-117.

Li, K.B., S.Q. Wang and J.H. Shan, 2007. Research on virtual hand operation technology. Comput. Simul., 24: 227-229.

Yu, A.S., 2004. Basic research on three-dimensional acupuncture anatomical simulation. J. Shanghai Univ. (Natl Sci. Edn.), 1: 47-49.