



Research Status of Key Technologies of TCM Intelligent Acupuncture Robot

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Abstract. Chinese acupuncture and moxibustion technique is an important part of traditional Chinese medicine, which is widely favored by the people because of its good effects in preventing and treating diseases. With the development of modern science and technology, the inheritance of expert acupuncture and moxibustion operation with high-level intelligent acupuncture and moxibustion machine technology and system has become another way to cultivate outstanding acupuncture and moxibustion talents, and also a feasible solution to solve the shortage of outstanding acupuncture and moxibustion talents. However, as a new field, the research and development of intelligent acupuncture and moxibustion robot needs to build relevant technical modules. However, the key technologies for the development of intelligent acupuncture and moxibustion robot of traditional Chinese medicine have been studied at home and abroad to a certain extent, such as automatic acupoint finding technology, three-dimensional body scanning technology, acupoint calibration technology, target tracking technology, etc. This paper summarizes and analyzes the key technologies in the research and development of intelligent acupuncture and moxibustion robot, in order to enhance the understanding of the research and development status of intelligent acupuncture and moxibustion robot.

Keywords: intelligent robot · Acupuncture treatment · Stereo vision · Artificial intelligence

1 Introduction

Acupuncture and moxibustion is an ancient treatment in China with a history of more than 3,000 years. Acupuncture and moxibustion is not only one of the characteristic techniques of traditional Chinese medicine, but also can talk with modern medicine. Acupuncture and moxibustion needs to be completed by professional medical personnel according to the patient's disease and their own conditions, and there are some problems, such as long time of acupuncture and moxibustion process, repetitive labor, medical personnel can not accurately locate after a long time of operation. The use of acupuncture robot instead of medical staff in acupuncture can reduce the repetitive labor of medical staff, reduce the burden of medical staff, and make the distance between inch needle and human acupuncture point in the process of acupuncture accurately controlled, and the

effect of acupuncture treatment is better. With the development of modern science and technology, it has become possible to use intelligent equipment to fix the operation techniques of acupuncture experts and reflect their thinking and perception.

The research and development of intelligent acupuncture robot is still in the preliminary preparation stage and laboratory stage, but the key technologies of intelligent acupuncture robot research and development are gradually becoming mature. This paper mainly discusses the research status of key technologies such as 3D human modeling technology, automatic acupoint finding technology and point cloud trajectory planning in the research and development of intelligent acupuncture robot.

2 3D Human Body Modeling Technology

Most medical robots need the aid of machine vision, especially Chinese medical robots, which need to complete a series of basic tasks and auxiliary tasks with the help of machine vision. Therefore, machine vision plays a pivotal role in Chinese medicine robots. For example, in the intelligent acupuncture robot, the method of machine vision is used to determine the location of acupoints, so as to achieve the role of “locating and tracking acupoints”.

Liu Lijin [1] used the independently developed XTBodyScan 3D body scanning system to obtain 3D color human body models. This technology can keep the pattern with high clarity and even brightness, which facilitates the search of subsequent feature points and improves the matching rate, but when it comes to the parts that cannot be measured by light, it will cause data loss and thus form holes.

Fixed scanner cost is high, it is difficult to reach the popularity, Kinect depth camera reduces the cost of human modeling, practical application effect is better. Kinect consists of a multi-array microphone, infrared camera, RGB camera and infrared transmitter, and is not affected by external conditions such as illumination and temperature. The Kinect depth camera is shown in Fig. 1.

Wang Huan et al. [2] proposed an automatic registration algorithm based on point cloud features for point cloud registration in 3D reconstruction. Firstly, the image collected by Kinect sensor is converted into three-dimensional point cloud, and the original point cloud data is filtered. Then the algorithm is used to extract the feature and find the corresponding point set. The initial transformation matrix between the corresponding point pairs is estimated. On the basis of the initial registration, the algorithm is used to do the fine registration. This method reduces the computational complexity and has high operability and robustness. The specific algorithm flow is shown in Fig. 2.

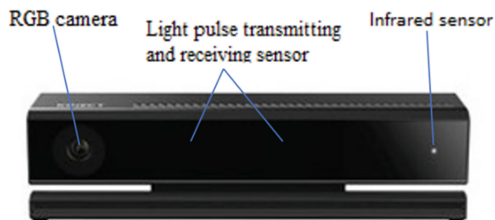


Fig. 1. Kinect depth camera

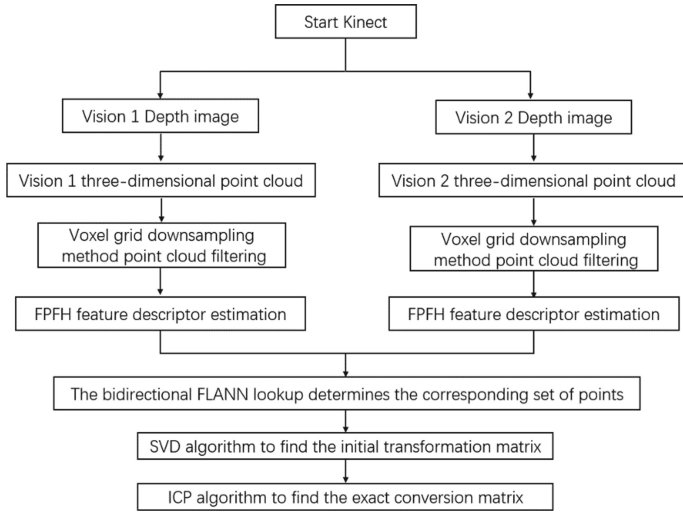


Fig. 2. Flow chart of automatic registration algorithm based on point cloud features

3 Automatic Acupoint Finding Technology

In 2007, Xie Shusen, Yang Hongqin et al. summarized previous studies and proposed the concept of “meridians optics” [3], and obtained human thermal imaging based on infrared thermal imager. Through the analysis of thermal imaging, they explored the meridians of human body and verified how the meridians of human body acted on and controlled human body. In 2014, Zhong Huiqing et al. [4] invented an automatic acupoint searching optical instrument, realizing the first household intelligent acupoint searching device, which can also be applied to teaching experiments in colleges and universities, massage therapists, acupuncture experience places, etc., as shown in Fig. 3.

Liu Zhen et al. from Nanjing University of Chinese Medicine put forward the intelligent acupuncture robot acupoint selection principle based on graph theory, and formed the intelligent acupuncture and moxibustion acupoint selection software based on the result based on the graph theory and the topology rule of the excavation acupoint-attending network [5].

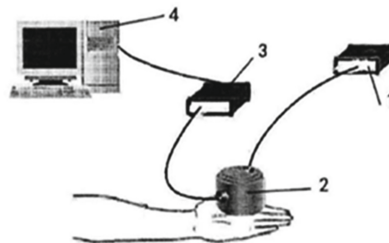


Fig. 3. Schematic diagram of an automatic cavitation optical instrument

Yan Rui [6] et al., Fuzhou University, based on the theory of “Basic circulation distribution of low resistance points of skin on human body surface”, combined with modern electronic technology and modern information technology, studied a new method that can accurately locate human meridians and acupoints, and improved the accuracy of the whole human meridians visualization system.

Xu Tiancheng et al. from Nanjing University of Chinese Medicine used fractal theory to realize the digitization of channels and collaterals [7]. On the basis of traditional meridian theory, the concept of digital meridian is put forward by using fractal geometry. The program is written in C++ language, drawing the digital map of fractal meridians and six meridians, six meridians realize the digital and have the traditional meridians do not have the details.

In Graz Medical University, Professor Gerhard Litscher et al. [8] used near infrared brain local spectrum method to identify acupoints on human head, and used different bio-electrical methods such as Doppler ultrasound detection and nuclear magnetic resonance imaging to explore the identification of acupoints.

At present, automatic acupoint selection is still in the stage of research and exploration, with few clinical examples and certain difficulties. But there are also a large number of people have reached a certain formula, in the exploration of science and modern technology, will continue to be a lot of research. In addition, the study of automatic acupoint searching will provide a certain treatment basis for national acupuncture experts, and eventually make TCM acupuncture more practical.

4 Point Cloud Trajectory Planning Technology

Since the surface of the human body is undulating, after obtaining the three-dimensional model of the human moxibustion site and the corresponding coordinates of the acupoints, it is necessary to obtain the manipulative trajectory through trajectory planning. In the process of moxibustion, the techniques required to be used can also carry out corresponding “ups and downs” according to the ups and downs of the human body surface, so as to ensure that the moxibustion trajectory is highly consistent from the human body surface in the process of movement. In addition, the planned trajectory needs to be converted into the trajectory based on the robot coordinate system.

There are many ways to generate trajectories on 3D models. Guifang Zhang [9] et al. have proposed a new method that uses online measurement data to build robot paths for 3D grinding of complex surfaces. In this method, an octree based point cloud data slicing algorithm is proposed to calculate the intersection line between point cloud data and plane. Then, the grinding path with smooth curvature was discretized by the equal-step method, and the normal direction at the contact point was estimated by local plane fitting. Liu Lifeng et al. [10] used 3D laser scanner to reconstruct complex objects, extract characteristic surfaces or surface defects, and carried out robot processing or defect repair through off-line programming system. Chen Ying et al. [11] obtained the point cloud data of the cladding surface by using a three-dimensional scanner, applied the slicing method and the non-uniform rational B-spline surface fitting method, and obtained the trajectory points of the gun head by bias a certain distance, so as to plan the robot trajectory when laser cladding surface. Wang Xinlong et al. [12] used the

point cloud data obtained by the three-dimensional scanner to reconstruct the surface, obtained the three-dimensional model, and proposed a path generation method based on the tangent plane according to the model. Masood et al. [13] proposed an efficient tool path generation method directly from point cloud data. The method of three-dimensional laser scanner to measure the generated point cloud has high equipment cost, which is not suitable for engineering applications, and the point cloud data processing algorithm is complex [14]. In the design of acupuncture robot, depth cameras can be used to obtain surface point clouds to reduce equipment costs, and trajectory planning is carried out in a similar way to using three-dimensional scanners.

5 Conclusion

To sum up the relevant research status at home and abroad, there is no research report on the fully intelligent acupuncture robot in the market at present, and there is no standard of supporting medical industry at home and abroad. The existing automatic acupuncture and moxibustion schemes do not use robots as the execution mechanism, but use simple mechanisms as the carrier, and lack of personalized and intelligent schemes. The future development direction of intelligent acupuncture robot in clinical application should be to improve the accuracy of intelligent acupoint selection and acupoint calibration, so as to ensure the treatment quality of intelligent acupuncture robot. In the way of realization, we can focus on improving the accuracy of the algorithm, make full use of computer information processing technology, increase the amount of detection data, seek the regularity of information, organically combine clinical, scientific research and teaching, look for new ideas, and pay attention to the practicability and humanization of developing instruments, so as to promote the research and development and promotion of intelligent acupuncture robot.

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