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Study on A Mechanical Data Glove

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Abstract: Visual recognition, point tracking recognition and micro-sensor technology can be used to monitor the hand posture, but they all have some shortcomings, such as expensive system, complex algorithm and difficult processing. To solve these problems, this paper designs a mechanical data glove based on variable resistor. The finger bending information is collected through the relationship between the output of potentiometers and hand posture, and the finger bending information is converted into digital signal, which can be displayed again after processing. The data glove not only has simple structure and low cost, but also can effectively monitor the hand posture.

Keywords: Mechanical data gloves, Man-machine interaction, Gesture monitoring.

1. Introduction

Technology makes machinery serve human beings, but controlling machinery to do some simple actions may require complex commands. The human hand is highly flexible and can complete various complicated tasks. Controlling the machinery by gestures can not only make the machinery more flexible, but also simplify the control commands[1]. In this era of intelligence, the field of human-computer interaction is developing faster and faster. Gesture recognition methods are constantly improving. Installing bending sensor and gravity acceleration sensor in wearable data gloves is widely used in gesture algorithms[2]. Gesture recognition plays an important role in the field of human-computer interaction. In automatic production, it interacts with users in real time, and it is widely used with accurate and efficient development[3].

The principle of hand posture monitoring based on computer vision technology is to obtain background information, color information, depth information, etc. through the camera and Judgement gesture of human hands through various algorithms[4]. However, when using computer vision technology to monitor hand posture, the algorithm of this technology is usually complicated because of the complexity of objects, the diversity of posture and the complexity of background information[5]. Hand posture monitoring based on point tracking recognition technology is to wear marks on each joint of human hand, and Acquire hand posture by identifying and tracking the marked points[6], which has some disadvantages such as easy loss of marked points and low resolution. The main principle of hand posture monitoring based on micro-sensor technology is that the micro-sensor is used to track the movement of each part of the hand and extract the movement trajectory, and the hand posture is reconstructed by the subsequent algorithm[7]. However, when using micro-sensor technology to monitor human hand posture, it takes a long initialization time, and the monitoring error will accumulate with time, so it is not suitable for long-term continuous work[8].

According to the characteristics of each hand joint, this project designs a flexible mechanical structure of glove joint, and monitors the bending angle of each finger joint with a variable resistance device. Design and study the matching scheme of the variable resistor, so that the bending parameters of each finger joint can be converted into the resistance change of the variable resistor. A gravity acceleration sensor is installed on the back of the data glove to monitor the information of the hand in all angles, so as to monitor the directional posture of the hand. Through the data acquisition system and signal processing system, the collected data are processed to realize the monitoring of hand posture model.

2. Mechanical Data Glove Structure

According to the joint design of human hand, the mechanical data glove adopts connecting rod, slider, potentiometer, spring, signal processor and other devices, and adopts a simple mechanical structure, so that after wearing, people can drive the mechanical movement according to the wearer's hand bending, causing the change of the variable resistor connected with it. The signal processing module corresponds the resistance change with the hand bending situation, and monitors the hand bending posture. Its structure diagram is shown in figure 1.

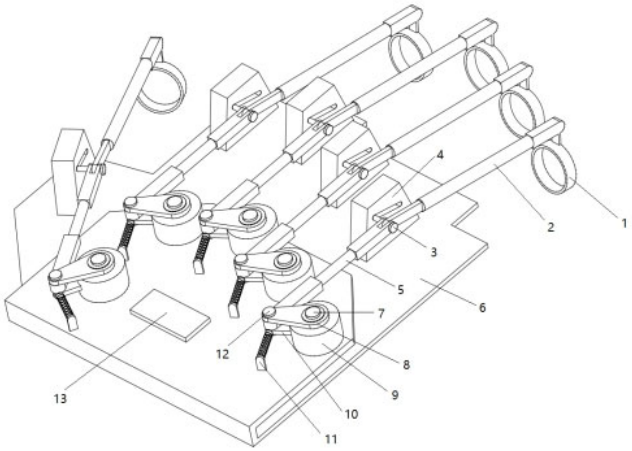

Figure 1. Structural Diagram of Mechanical Data Glove

1—finger tip; 2—First connecting rod; 3—The first connecting rod fixing piece; 4—Chute 5—Second connecting rod; 6—Glove shell; 7—Potentiometer fixing piece; 8—Connecting rod force transmission piece; 9—potentiometer; 10—Sliding end; 11—spring; 12—Second connecting rod fixing piece; 13—Signal processing module

Mechanical data glove uses the output of potentiometers to establish contact with hand posture, so as to monitor hand posture. First, make the shell of the glove, which is convenient to add machinery to the glove. The finger gloves are designed to be round and elastic, simple to make and easy to wear, and have wide adaptability. Then connect the finger sleeves with the first connecting rod. A spout block is fixed on the glove shell, processed into a trapezoidal structure, and a spout is arranged at the side. The first connecting rod is provided with a processed circular through hole which can be connected with the spout block, and is fixed with the spout block by an in-use fixing piece. In this way, the first connecting rod can reciprocate with the fixing piece in the spout. The second connecting rod, like the first connecting rod, is machined with circular through holes, and they are connected by fasteners. And the second connecting rod and the first connecting rod is fixed in the spout by a fixing piece to reciprocate. Determine the position of the spring on the glove shell and fix the spring. The potentiometers are fixed on the glove shell through a fixing piece, and the fixing piece of the potentiometers can rotate freely.Its sliding end is connected with the glove shell, and its one end is connected with the spring. One end of the connecting rod force transmission piece is connected with the potentiometers fixing piece and the potentiometers, and the other end is connected with the second connecting rod fixing piece, the second connecting rod and the sliding end. Such that the force transmission link can rotate with the second link and the potentiometers fixing piece. The second connecting rod can rotate around the second connecting rod fixing piece and the sliding end on the potentiometers. The signal processing module is fixed on the glove shell and electrically connected with the potentiometers. The mechanical data glove can monitor the hand posture by establishing the relationship between the hand posture and the potentiometer through the movement of the sliding of the potentiometers, and has the characteristics of compact structure and low cost. It has the characteristics of compact structure and low cost.

3. Working Principle of Mechanical Data Gloves

The glove shell is placed on the back of the hand, and the fingers are fixed in the corresponding finger sleeves. When the finger bends, the finger sleeve will drive the first connecting rod to move, and the second connecting rod connected with it will move in the spout together. It can only do reciprocating motion in the spout, and the degree of bending is in direct proportion to the amplitude of motion. The motion amplitude of the second connecting rod connected with it is the same as that of the first connecting rod. The driven second connecting rod drives the sliding end to move, and the movement of the sliding end changes the output voltage of the potentiometers. The designed spring prevents the sliding end from moving too much, and ensures that the driven second connecting rod can accurately drive the potentiometers to move accurately, thus avoiding errors. The movement of the sliding end is ensured, and the change of the output voltage of the potentiometers caused by the sliding end can accurately reflect the movement amplitude of the first connecting rod. The signal processing module on the glove can calculate the bending amplitude of the finger according to the detected output voltage of the potentiometers and the relationship between the voltage and the bending amplitude of the finger, so as to monitor the bending posture of the hand.In addition, a gravity acceleration sensor can be arranged at the back of the data glove, which is used to monitor the information of the hand in all directions and angles, and the collected information can be processed and transmitted by the signal acquisition system, so as to realize the monitoring of the position and posture of the hand. Real-time hand posture monitoring is realized by combining the data of hand bending posture and turning state.

4. Advantages of Mechanical Data Gloves

As the most commonly used interactive tool of man-machine intelligent control, hand gesture monitoring and reconstruction equipment are usually realized at home and abroad based on inertial sensor, computer vision technology, point tracking and recognition technology and optical fiber sensing technology. However, using computer vision technology for hand posture monitoring lacks the method of hand posture monitoring, and the algorithm is more complicated because of the high complexity of objects, the diversity of postures and the complexity of background information. Point tracking technology, marked points are easily blocked, and the system is expensive and complicated to deal with. Inertial sensors need a long initialization time, and the errors will accumulate with time, so they are not suitable for long-term operation.

This project is based on the variable resistance device to develop the data glove, which has the advantages of low cost, simple system and high resolution, solves some shortcomings of the existing technology in the market, has stable mechanical structure and simple algorithm, and can accurately reflect the hand bending posture. Adding a gravity acceleration sensor can monitor hand movements such as turning, lifting and putting, and comprehensive processing can monitor hand posture in real time, provide gesture for control, and simplify some complicated commands in human-computer interaction. Real-time monitoring of hand posture can be applied to hand rehabilitation and robot remote control, which is widely used and practical.

5. Conclusions

The wearable man-machine interactive gloves proposed in this project can capture the hand movements in real time, and the combination of the external mechanical structure of the gloves and the variable resistance device solves the problems of low precision and complicated algorithm in the traditional technology of hand capture and monitoring. Mechanical data glove has the characteristics of simple structure, high accuracy, low cost, simple system and high resolution. It can not only provide gestures for control, but also be used in technical fields such as virtual reality technology, animation production, sports, hand rehabilitation and robot remote control. It has a broad application prospect and strong practical significance and application value.

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References

[1] Wang Yue, Dong Xibin. Design and dynamic simulation of timber transportation equipment. Forest Engineering, 37(2021): 59-64.

[2] Liu Lanxin. Muti-sensor gesture design and recognition method based on wearable devices. XiDian University(2019).

[3] Tang Leisheng, Hou Jing, Cui Yifan. Research and development of tree trunk whitening device based on Man-Machine cooperation. Forest Engineering, 37(2021): 38-44.

[4] V. Adithya, R. Rajesh. A deep convolutional neural network approach for static hand gesture recognition. Procedia computer science, 171(2020): 2353-2361.

[5] Tayyip Ozcan, Alper Basturk. Transfer learning-based convolutional neural networks with heuristic optimization for hand gesture recognition. Neural Computing and Applications, 31 (2019): 8955-8970.

[6] Aristidou A, Lasenby J. Real-time marker prediction and CoR estimation in optical motion capture. The visual Computer, 29(2013):7-26.

[7] A lberto Olivares, J.M. Gorriz, J. Ramirez, et al. Using frequency analysis to improve the precision of human body posture algorithms based on kalman filters. Computers in Biology and Medicine, 72(2016):229-238.

[8] Su Y, Allen C R, Geng D, et al. 3-D motion system ("data-gloves"): application for Parkinson's disease. IEEE Transactions on Instrumentation and Measurement, 52(2003): 662-674.