World Scientific Research Journal (WSRJ) ISSN: 2472-3703
www.wsr-j.org

Single Hand Gesture Recognition Device

Depeng Zhu[1, a], Ranran Wei[1, b] and Yong Tian[2, c]

[1]National Demonstration Center for Experimental Electrical and electronic technology,

Chanchun University of Science and Techonlgy, Changchun, Jilin, China

[2]National Demonstration Center for Experimental Electrical and electronic technology,

Chanchun University of Science and Techonlgy, Changchun, Jilin, China

[a]depeng_cust@163.com, [b]1603409002@qq.com, [c]939948962 @qq.com

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Abstract: The traditional gesture recognition technology can't meet the individual combat needs in a specific environment. A device is designed to use sensor to collect gesture information to establish gesture database. The device extracts the gesture information collected by each sensor through the microprocessor to data processing, obtains the characteristic information of the gesture, and finds out that the data with the highest matching degree in the database is the information of the gesture. The experimental results show that the device has better real-time performance and high accuracy than the traditional gesture recognition device, which can meet the needs of special combat gesture recognition.
Keywords: Gesture recognition, data analysis and fusion, feature information, correlation coefficent.

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1. INTRODUCTION

Under complex operational conditions, combatants can't directly communicate face-to-face with gestures, so they can't achieve the unity of the combat plan and the coordination of the action, which will cause the combatants to be injured or even sacrificed. Currently, gesture recognition technology is mainly based on computer vision, ultrasound and inertial sensors. [1]. the object of dynamic gesture recognition is a set of continuous gestures. The dynamic gesture corresponds to a trajectory in the model parameter space, consisting of a series of static gestures over a period of time, and includes the rotation and displacement motion of the hand in space. Individual dynamic gesture recognition requires a high real-time recognition rate when the system is identified, which can resist all kinds of possible interference from the outside world.

The device collects gesture information through bending sensor, gyroscope and acceleration sensor, and establishes gesture recognition library for gesture recognition to complete gestures under combat conditions. Traditional gesture recognition mostly uses the camera to collect gesture information, which can't be applied under the combat conditions, the device uses inertial sensor to collect gesture information, establishes gesture base recognition gesture, and calculates the correlation coefficient to find the most matching data in the database is the information of the gesture.

2. SYSTEM DESIGN

As shown in Figure 1, the gesture recognition device consists of a gesture recognition module, a system function module, and a communication module. The gesture recognition module includes bending sensor, acceleration sensor and gyroscope sensor, and the system function module includes system power supply module, microprocessor, data acquisition module and storage module, communication module data transmission module and data receiving module.

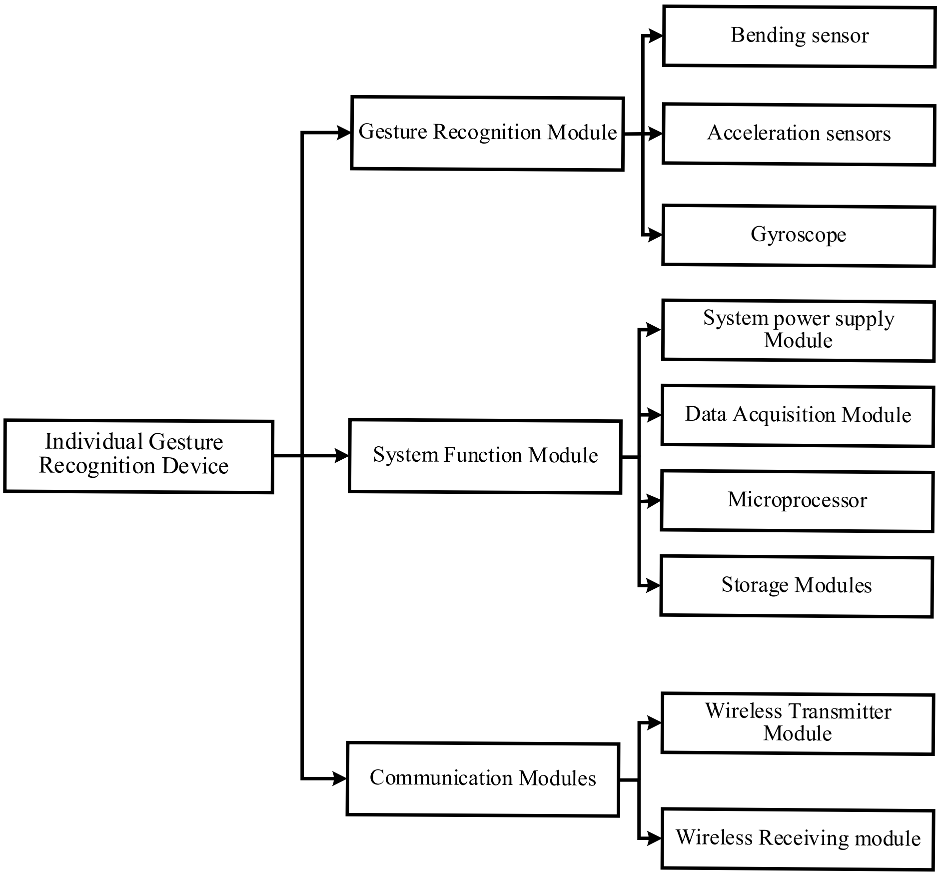

Fig 1. General block diagram of gesture recognition device

The gesture recognition device uses bending sensor, acceleration sensor and gyroscope to collect gesture action information, the microprocessor will receive the sensor information for data processing. The microprocessor calculates the characteristic information of the gesture and calculates the maximum correlation coefficient with the data in the gesture library, that is, the meaning of the gesture. The communication module sends the gesture meaning to the team member in the cooperative operation, or can receive the gesture information sent by other combatants through the data receiving module.

3. GESTURE RECOGNITION

3.1 Gesture acquisition

Collect gestures from bending sensors, acceleration sensors and gyroscopes. The basic movements of gestures consist mainly of finger movements, wrist movements, and arm movements. Table 1 according to the basic actions of the gesture, through analysis, to determine the form of collection.

Table 1. Gesture actions and acquisition methods

motion form	action content	capture method
finger action	five finger bending	bending sensor
wrist movements	flip and bend	gyroscope
arm movements	spatial displacement	acceleration sensors

The bending sensor shown in Figure 2 consists of a variable resistor. According to the bending degree of each finger output different resistance values, through the resistance voltage conversion circuit, the bending sensor output resistance value to the voltage values collected by the central control system. Each finger is equipped with a sensor, the microprocessor collects the voltage value of each conversion circuit output, which can accurately detect the bending degree of five fingers.

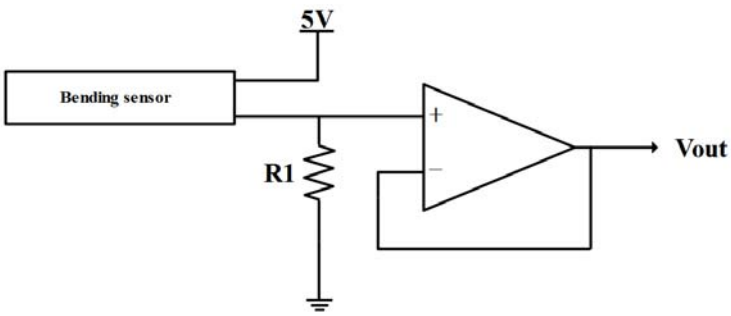

Fig 2. Flexural sensor resistance voltage conversion circuit

Acceleration sensor is an inertial sensor that measures the size and direction of acceleration. MEMS Acceleration sensor has the advantages of small volume, low power consumption, good linearity and stable performance, and is widely used in aerospace, medicine, automobile industry and other fields[2]. Based on the MEMS acceleration sensor, the voltage output of the sensor can be converted to its motion acceleration, according to the size and direction of the acceleration, different displacement algorithms are used to calculate the displacement of the object movement, the error of the object displacement measurement is about 3 percent, and the accurate measurement of the motion displacement is well realized [3].

Based on the above research, the spatial displacement of the object can be measured accurately by using the acceleration sensor, that is, the displacement of the arm space motion can be completed in the whole gesture recognition part. The structural block diagram of the acceleration sensor for the space displacement detection of the arm is shown in Figure 3.

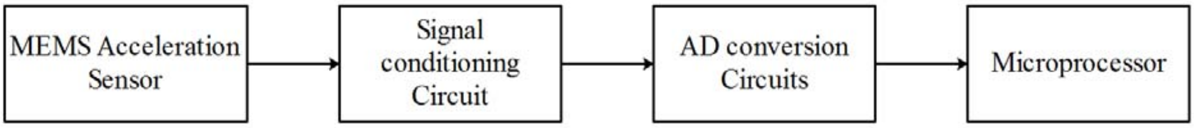

Fig 3. Displacement detection structure block diagram

A gyroscope is a sensor that measures the rotation angle or angular velocity of a moving object in an inertial space, and the gyroscope is usually used, together with an accelerometer, as an inertial sensitive element to measure the position, speed, posture, and other parameters of the carrier [4]. Therefore, it can be used to measure the motion angular velocity of the hand on three axes in space by converting four yuan to the spatial angle, and to measure the angle information of wrist flip and bending in gesture recognition.

The output of the gyroscope is a triaxial angular velocity signal, and the angle value can be obtained by the integral of the diagonal velocity signal. The gyroscope itself is susceptible to the interference of external noise, because the change of external temperature is easy to make the gyroscope produce temperature drift, and the integral of temperature drift error will be more and more large over time.

Therefore, the triaxial acceleration sensor data and gyroscope angle data need to be fused to correct the temperature drift error of the gyroscope. Based on the attitude detection system of MEMS accelerometer and gyroscope, the data fusion of accelerometer and gyroscope is adopted, and the influence of accelerometer error on measurement accuracy is effectively suppressed. The measurement error of the system can be controlled between -1.5°~+1.5° and can meet the needs of gesture recognition. The structure block diagram of the gesture recognition module is shown in Figure 4.

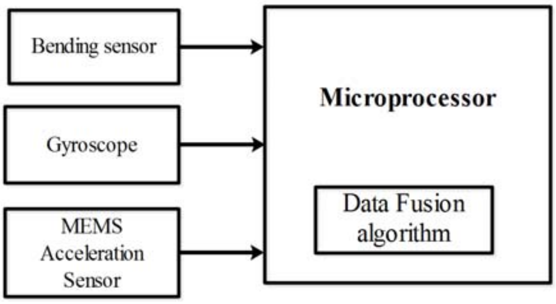

Fig 4. Gesture recognition Module Structure block diagram

3.2 Gesture recognition

The data acquisition module collects the data of each sensor, carries on the corresponding algorithm processing to the collected data, extracts the characteristic information of each gesture, encodes it according to a certain format, and stores it in the storage module. The characteristic information of each gesture is collected many times, and a complete information base of gesture recognition is established.

In the process of gesture recognition, the data acquisition module collects the sensor data and carries on the algorithm processing, extracts the characteristic information of the gesture to code, and calculates the correlation with the gesture database code in the storage module. The code with the largest correlation coefficient can be calculated, and the information represented by the gesture can be obtained after decoding. The block diagram of the system function module is shown in figure 5.

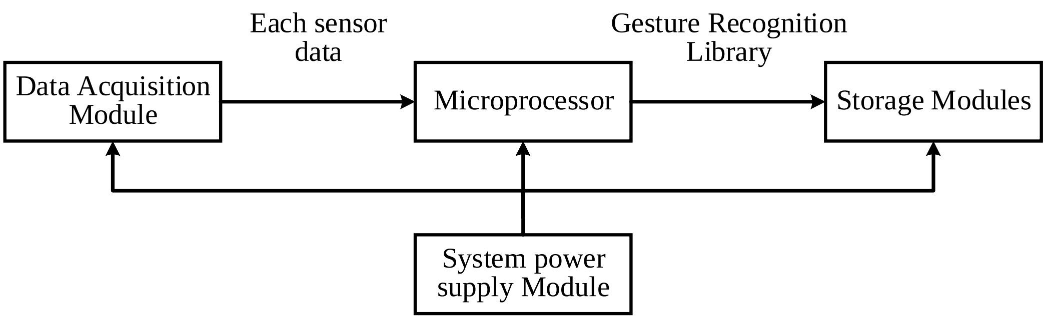

Fig 5. System function module structure block diagram

4. ACTION PARAMETER ANALYSIS

Three axis gyroscopes, three axis accelerometers and a curvature sensor located at the thumb are used to collect gesture data. The microprocessor extracts and fuses the features of seven sets of data output by the sensor. Complete the encoding of the gesture and store it in the storage module. The device gesture information recognition process is shown in figure 6.

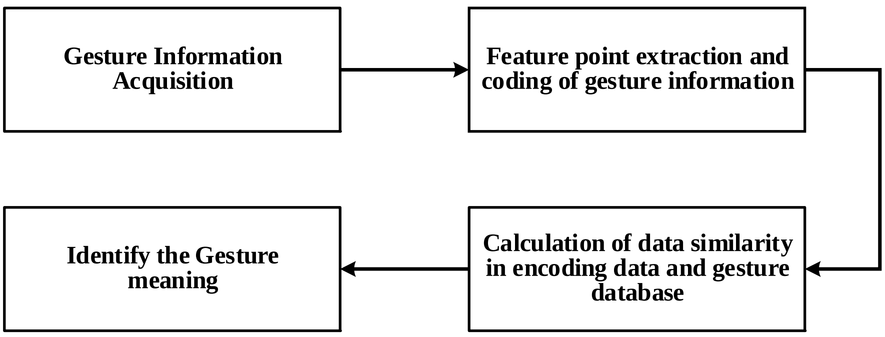

Fig 6. Recognition process of gesture information

Simulation process:

(1)Make a gesture according to a specified action.

(2)Microprocssor reads data from curvature sensors, accelerometers and gyroscopes.

(3)Process data and turn it into data that is easy to express and analyze.

(4)Sending processed data to PC host computer via microprocessor serial port.

(5)The host computer saves the received data in real time and converts it into a waveform display.

(6)The actual action of the gesture is compared with the data of the waveform graph.

(7)Statistical analysis to obtain gesture characteristic parameters.

Here are two simple gestures for data extraction and analysis, as shown in Figure 6 Chinese sign Language basic gestures. The axis is based on the sensor mounting direction, the horizontal front and rear direction is Y axis, the left and right direction is x axis, the vertical direction is Z axis. The bending sensor takes the horizontal expansion state as the minimum resistance value, and the 180° is the maximum resistance value. Data waveform curve color is shown in table 2.

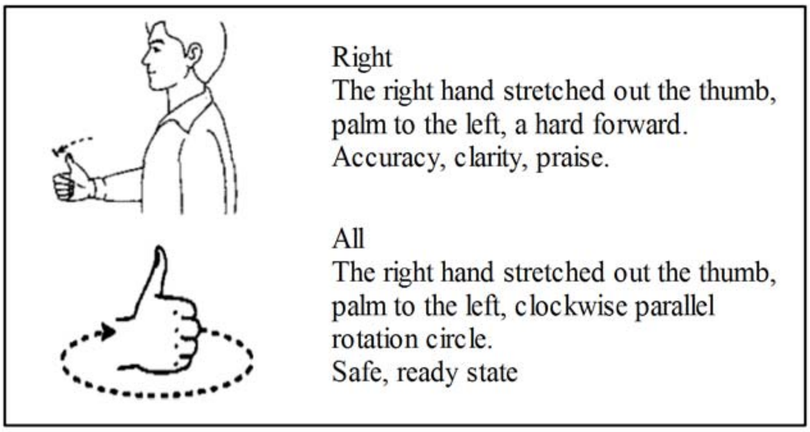

Fig 7. Chinese Sign Language basic gestures

Table 2. Curve Color representation

co	curve meaning
re	thumb bending sensor voltage display number
w	rolling angle (enlarged)
ye	heading angle (enlarged)
pi	pitch angle (enlarged)
cy	x-axis acceleration
br	y-axis acceleration
gr	z-axis acceleration

Through the changing trend of each curve in Figure 7, the hand is reflected from the horizontal straightening state to the lateral state (z-axis acceleration decreases, the X-axis acceleration increases in reverse, the rolling angle increases), and then to the lateral and finger bending state. In Figure 8, the gesture is more rotated than the gesture in Figure 7, and the change of the new action curve can also be seen on the waveform (the z axis begins to rotate by force).

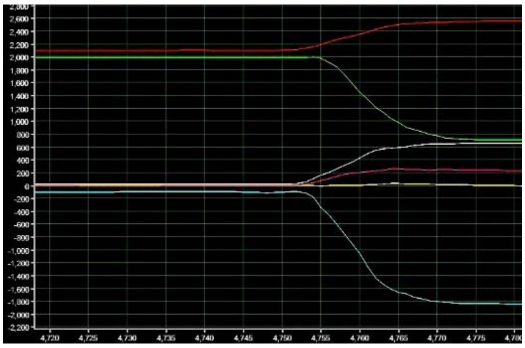

Fig 8. "Correct" gesture waveform diagram

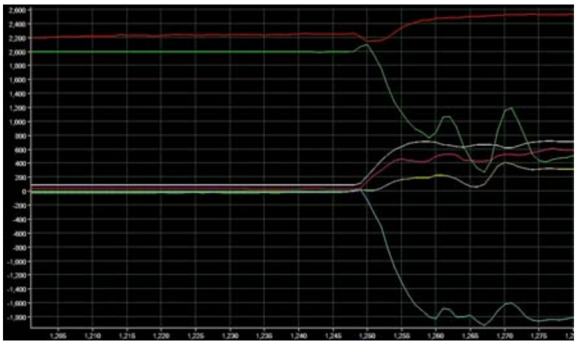

Fig 9. "Full" gesture waveform diagram

5. CONCLUSION

With the development of gesture recognition technology, by the use of inertial sensors to collect gesture information, the establishment of gesture database for gesture recognition technology will be faster to identify, more accurate direction of development. This gesture recognition technology can be widely used in military, industrial production and other fields. In order to achieve faster recognition speed and higher accuracy, subsequent research and exploration will be made on the establishment of the database and data correlation.

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