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High Precision Measurement of Motion Objects

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Abstract: Driven by the Olympic spirit of "higher, faster and stronger", the development of sports is also getting better and better. Common way to measure distance and speed is not able to guarantee is very fair and accurate areas, points out the various the grade of the athlete requires high precision motion measurement method at this time to more accurately distinguish between each player, in order to ensure that sports events of fairness and justice. By studying the velocity, displacement and acceleration of motion with high precision, the trajectory of motion is detected. And this program can guarantee high precision and high efficiency. Movement of body high precision detection system based on microcontroller STC89C52 is the use of infrared distance sensor or ultrasonic sensor range, and the use of acceleration sensor measuring motor speed, acceleration and angular velocity of the body, so as to achieve the purpose of accurate measuring motion trajectory.
Keywords: High precision, Micro motion, Single chip microcomputer, STC89C52

I. INTRODUCTION

With the development of the quality of the people, the sport has become a necessary thing in daily life, so people are paying more and more attention to various sports related events, so higher, faster and stronger is not just a slogan[1][2]. The sports meeting must also be fair, just and open, so the requirements for displacement and position measurement of sports events and occasions are getting higher and higher. For example, in the various projects of the Olympic Games, the athletes' performance measurement needs to be identified with very high precision. It can be seen that some high-precision measurements can fully guarantee the fairness of the results of each event.

The measurement of sports body motion has not only been applied to sports, but also has a wide range of applications in many occasions[3]. It is only the measurement of displacement between moving bodies that has been applied by scientists to various aspects such as electricity, water conservancy, construction, communication, and environment. The hottest driverless industry is now the same. In the driverless industry, the biggest difficulty to overcome is to detect and grasp the speed of the front and rear vehicles and the control of the distance between the front and rear vehicles, and the research on the high-precision measurement of the moving body studied in this subject is exactly the same[4]. The development status of the future automobile manufacturing industry. With the development of science and technology, smart phones and the like have become a must-have item in our daily life. Today's devices need more powerful functions for consumers to use. Consumers like good-looking, ultra-thin and practical mobile phones[5]. Therefore, various components in the mobile phone require more powerful functions and smaller size. In addition, such a high performance, the battery will be unbearable, so various original devices must be more highly integrated, with more Low power consumption[6].

This project investigates the trajectory of moving body motion by studying the velocity displacement and acceleration of the high-precision motion of the moving body, and the program can ensure high precision and high efficiency. In addition to various events, the subject can also be applied to the automatic driving of the vehicle. The auto-driving vehicle will face the possibility of collision when reversing or advancing, but through the research of this subject, if the vehicle can be accurately measured before and after distance, I believe that all troubles can be solved. The high-precision detection system of the moving body based on the single-chip STC89C52 uses the infrared distance measuring sensor or the ultrasonic sensor to measure the distance, and uses the acceleration sensor to measure the speed, acceleration and angular velocity of the moving body, thereby achieving the purpose of accurately measuring the moving track of the moving body.

The global trend is the global measuring instrument industry, and the development of the measuring instrument industry is changing with each passing day. Some people who specialize in this industry pointed out that the technical field of measuring instruments is constantly expanding and improving on the basis of the original measuring instruments. Countries are now setting the development and industrialization of a new generation of sensors and measuring instruments as the country's primary goal, and countries are competing to develop and competition is becoming increasingly fierce. The future sensor market will be redefined by the development of new technologies, such as the emergence of new measuring instruments such as wireless measuring instruments, optical measuring instruments, intelligent measuring instruments and metal oxide measuring instruments, and the expansion of market share.

This project designed a mobile body measurement system based on single-chip microcomputer. The system is controlled by STC89C52 single-chip microcomputer. It consists of LCD liquid crystal display, infrared distance measuring sensor module and ultrasonic sensor module. It can measure the speed, acceleration and motion displacement of moving body. Or measure the angular velocity of the moving body that performs the circular motion to measure the motion trajectory of the moving body. It is in line with the accurate measurement in the future sports, and the prospects are very broad. Due to technical limitations, this topic only shows ultrasonic ranging and infrared ranging. The measurements of velocity, acceleration and angular velocity mentioned in the paper are not designed, so the program display only shows infrared ranging and ultrasonic ranging. This measurement system is suitable for various sports of various large-scale sports games. For example, in a shooting competition, the device can be placed near the shooting target, so that the trajectory of the bullet can be measured, and each trajectory can be more accurately determined. The performance of each athlete makes each person's grades and rankings more fair and fair.

II. SENSORS FOR MOVING BODY MEASUREMENT AND APPLICATIONS

In addition to the single-chip microcomputer and LED, the modules used in the research of this subject need to use the three sensors mentioned above.

A. Infrared ranging sensor

In terms of ranging, infrared distance measuring sensor is a very important type. It is an important module in the industry of measuring distance between ultrasonic sensor and laser ranging sensor. Figure 1 is the infrared distance measuring sensor. Since the emission of infrared rays is also speedy, the method of calculating the distance is very simple, that is, displacement = speed × time, so the data we need to collect is the time required for the infrared rays to be emitted and then folded back. Infrared ranging sensors also have their own advantages and disadvantages. The advantages are long measuring distance, wide measuring range, short sensing time, and compact design and easy to use, but its shortcomings are obvious, that is, only linear displacement can be measured. There should be no obstacles on the way.

Fig. 1 Infrared range finder

B. Ultrasonic sensor

The ultrasonic sensor is a sensor that converts an ultrasonic signal received by the original itself into a digital signal or an electrical signal. Ultrasonic is a special kind of sound wave. Its special feature is that its frequency is higher than 20KHz, so the human ear can't hear the ultrasonic wave, but it can also spread in the medium. In nature, animals such as bats can transmit and receive ultrasound. Ultrasonic sensors are very sensitive to receiving signals due to their high ultrasonic frequency, short wavelength, and strong propagation direction. At present, ultrasonic sensors are widely used in various industries such as medicine, military, and mechanical manufacturing. Various characteristics of the ultrasonic sensor are used to collect motion information of the object, and FIG. 2 is a physical map of the ultrasonic sensor.

Fig. 2 Ultrasonic sensor

C. Acceleration sensor

An acceleration sensor is a sensor that measures acceleration. It is usually composed of masses, dampers, elastic elements, sensitive components and adaptive circuits. During its acceleration, the accelerometer is obtained by measuring the inertial force of the mass and using Newton's second law. Common acceleration

sensors include capacitive, inductive, strain, piezoresistive, piezoelectric, etc. Figure 3 is an acceleration sensor. Most accelerometers work according to the principle of piezoelectric effect. The so-called piezoelectric effect is that "the external force applied to the crystal for a heteropolar crystal without a symmetry center will change the polarization of the crystal in addition to deforming the crystal. In the state, an electric field is established inside the crystal, and this phenomenon of polarization of the medium due to mechanical force is called a positive piezoelectric effect.

Fig. 3 Acceleration sensor

III. INFRARED RANGING SENSOR AND ULTRASONIC SENSOR HARDWARE DESIGN

A. Infrared ranging sensor and ultrasonic sensor circuit diagram

Due to technical limitations, this topic only shows ultrasonic ranging and infrared ranging. The measurements of velocity, acceleration and angular velocity mentioned in the paper are not designed, so the program display only shows infrared ranging and ultrasonic ranging, such as shown in Fig. 4, the infrared distance measuring sensor selected in this subject is a subject of infrared range finder which is carried out by Sharp 2Y0A02 infrared distance measuring sensor and HC-SR04 ultrasonic sensor combined with STC89C52 single chip microcomputer. The circuit is composed of STC89C53 single-chip microcomputer, infrared module, ultrasonic module, LED display, crystal oscillator and AD conversion module. The signal is received by the ultrasonic module or the infrared module, and the collected analog signal is converted into a digital signal by the AD conversion module. Then it is operated and processed by the single chip microcomputer.

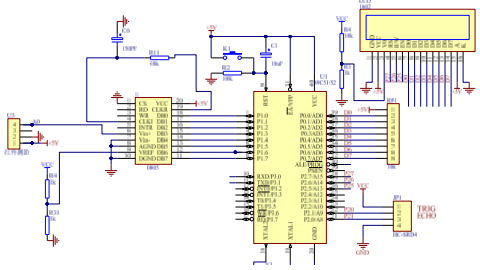

Fig. 4 Circuit diagram of precision measuring instrument

B. Infrared ranging sensor hardware design

Sharp 2Y0A02sensor is mainly composed of infrared emission tube, PSD and corresponding calculation circuit. Sharp's PSD has unique characteristics, which can detect the fine movement of moving body, which can be accurate to micrometer. This feature can make it competent for high precision. To measure this work, the infrared emission tube emits a light. If the light encounters an obstacle and does not return, it will fall on the PSD. It will form an isosceles triangle. By measuring the height of the isosceles triangle, it is the distance of the moving body displacement. Through actual measurement, infrared ranging can reach an error of 0.01cm.

C. Ultrasonic sensor hardware design

The choice of ultrasonic sensor is the HC-SR04 sensor. The sensor uses the IO port TIG trigger range, and the module automatically sends a 40 kHz square wave to automatically detect if the signal is returned. When the signal returns, it will output a high level through the IO port echo, and the high level of the duration is the time that the ultrasound returns to the transmission. At this time, the distance between the sensor and the moving body can be obtained.

D. Physical display and function

As shown in Figure 5, the whole original consists of STC89C52, crystal oscillator, AD conversion module, LED display, infrared ranging sensor and ultrasonic sensor. It can complete the function room ultrasonic ranging and infrared ranging.

Fig. 5 High precision range finder

IV. CONCLUSION

The high-precision measuring instrument for moving body motion studied in this paper is inexpensive and easy to use, and is suitable for various occasions involving measuring the state of moving objects. This subject is designed based on the STC89C52 single-chip mobile body high-precision measurement system, which can accurately measure the speed, angular velocity and initial position of the object. The data is measured by the sensor and calculated by the single-chip microcomputer, which is displayed on the LED display screen. This is convenient to operate, the measurement result is accurate and intuitive, and the prospect is very broad. Through research topics, this paper studies the development prospects and market of measuring instruments at home and abroad, and understands various sensors. Although the entire graduation design has encountered many difficulties, such as the code cannot run successfully, the circuit board welding error, etc., but the whole work process I learned a lot of knowledge that I didn't know before, so the whole process is very fulfilling.

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