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Capture and analysis of the motion data parameters in sports training

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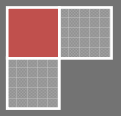
ABSTRACT

In the process of sports training, the effectively capture of data parameters for technical motion can get more scientific analysis process for the standard of technical motion, so that people can carry out the problems in a more comprehensive reflection and provide powerful data support for the athletes and coaches. In this paper, the research and the discussion part mainly explore software of lower computer based on motion capture system and have a discussion on its components and its important role, and combine the human body model analysis with system modeling studies on human body structure to make the data parameter that get in the process of motion capture maintain a high level of accuracy. The next part is to effectively determine the position of the sensor by model establishment, which makes the accuracy of the motion data parameter, can be effectively improved. Finally, it is the corresponding research and exploration for the error analysis and algorithm to make the causes of error more clear and make an effective summary of specific method for eliminating the error. This makes the process of motion data parameters capture more reasonable, at the same time guarantees the sports training process together with the normative of athletes' technical movements continuously improve. This is the main idea of the paper through the process of study and discussion, while its purpose can also get fully reflected, and effectively provide a solid theoretical and practical foundation for further in-depth research.

KEYWORDS

Sports training; Motion data; Parameter capture; Explore and research.



INTRODUCTION

For the characteristics of sports training, the motion requirements also have certain differences on athletes' different special training, as for the technical motion standards should be continuously improve the effective use of information technology. This paper combines software of lower computer in motion capture system, the human body model analysis and system modeling, error analysis and algorithm research these aspects to effectively build system of the sports training motion data parameters capture, furthermore to provide strong scientific foundation for athletes to effectively improve the technical motion, at the same time to provide effective support for the situation of coaches to control athletes' technical motion.

SOFTWARE OF LOWER COMPUTER IN MOTION CAPTURE SYSTEM

In the process of building a motion capture system, the software of lower computer is an important part of building the whole system. In the process of carrying out relevant design, it should mainly consist of driving circuit, wireless communication module and design of transfer station software these three aspects. The specific flowchart about the three-part software is shown in Figure 1.

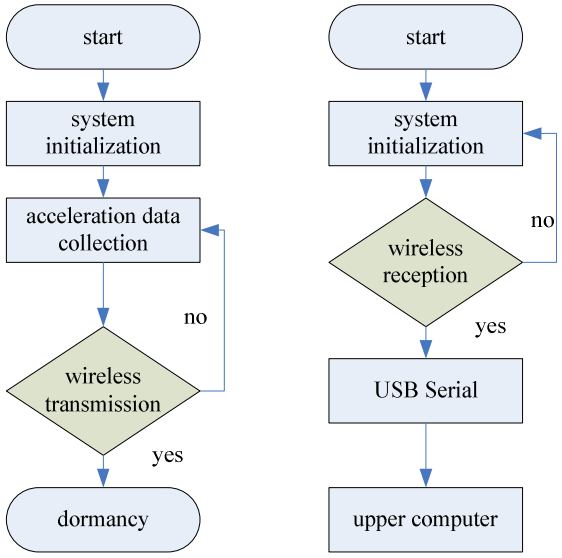


Figure 1 : General flow chart of software of lower computer programming

Single chip microcomputer analog I^{2}C bus

In the process for the design of driving circuit, Single chip microcomputer (SCM) analog I^{2}C bus and Acceleration sensor are connected. There are many advantages of I^{2}C bus which mainly reflected in the relatively simple structure, high effectiveness and so on. In terms of the using frequency of the driving circuit, I^{2}C can expand the using space for a certain extent, which can maximize the electrical accessories. These accessories all have the automatic replying function, which maintains a high degree of patency for communication lines of SCM data transmission, at the same time for the use of pin number to get better control it provides a good foundation. This will have a positive impact for SCM to expand space, and the data transmission speed will be greatly improved[1]. In I^{2}C bus, however, the master function is relatively powerful, it can support multiple master at the same time, so that the main line can get effective control by any one of the of electrical accessories, thus achieving the signals and outgoing frequency of data can be effectively monitored. I^{2}C bus for sending and receiving process of data and information needs SDA and SCL to connect to each another. Between chips of bus and IC there will generate a two-way channel for communication, thus making it possible to form positive and negative way data transmission between two IC and the highest frequency can reach and exceed 100kb per second. And the connection form between the main line and various electrical accessories is mainly the parallel circuit, where each module has its own address, which enables each address can work independently after connection. However, during the process of relevant information transmission, these appliances accessories can consolidate into controller of the bus, at the same time it can also be used as a controller. And whether it is used as a controller or is controlled need to be decided by data acquisition from the bus and specific tasks. The control signal consists of two parts, of which the first part is the address code, and the second part is the controlled variable. The two parts will produce certain effect on corresponding adjustment process of the geological heritage controlling setting, which makes every control circuit can form independently. During the effective data transmission, the signal transmission process of the bus is complex, and the concrete will be shown clearly in Figure 2[2].

First, during the process of sending starting signal, the SCL will maintain at a high electric level, so that it can be made into a starting signal.

Second, termination signal is the tip of ending data sending, the SCL will maintain at a low electric level, through the corresponding shift so as to become a termination signal.

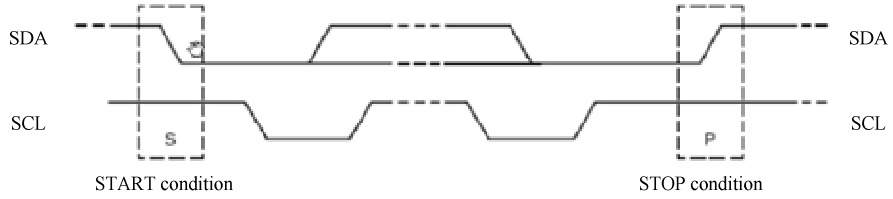


Figure 2 : Schematic diagram of I^2C bus data transmission

Wireless communication module

Transmitter and receiver modules are important parts in SCM communication system, in which there are two 64-knots data caches in CC1100, also includes a RX FIFO for data receiving and TX FIFO for data sending. For its procedure, the first step should be to keep its program in an initialization state, to undertake the appropriate settings, to send and receive data through effective reading and writing of RX FIFO and TX FIFO. During this process, SPI is the main communication mode, its main properties are making synchronous serial of corresponding interface to communicate effectively, and data transfer of effective series by several telecommunication lines and the SCM. But if the ports are respectively UCLK, SOMI and SIMO, so the definition of the port still can be fully expressed in TABLE 1.

TABLE 1 : Port definition table of CC1100

Port	Definition	Sending Mode	Receiving Mode
SIMO	In when receiving, out when sending	For data read-out	For writing data
SOMI	In when sending, out when receiving	For writing data	For data read-out
UCLK	USART Clock	For clock output	For clock input

In the process of constructing this module, it can be mainly divided into two parts. The first part is to launch the program, and the second part is to receive the program, the specific process of the launching part is clearly shown in Figure 3.

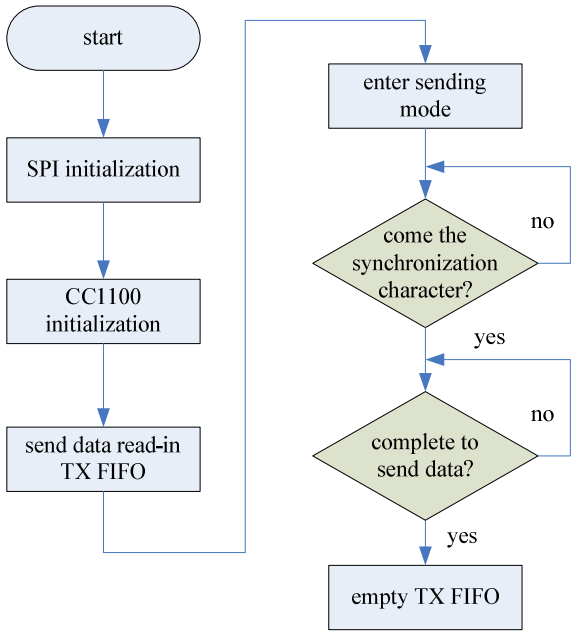


Figure 3 : Program flow chart of wireless emission

During the process of applying the wireless transmitting program, the first step should be to set the procedure initialized, and this setting process mainly includes the SPI interface and different registers[3]. This makes the launching program proceeds into the interruption acquisition phase, so that after the completion of information data collection it will automatically jump out of this phase, which enables the data information can be effectively transmitted in the form of

wireless communication. At the end of the transmission process it will be converted into standby mode and prepare to effectively accept other data and then to collect and send the data. The cycle will form a circle, and the specific process is shown in Figure 4.

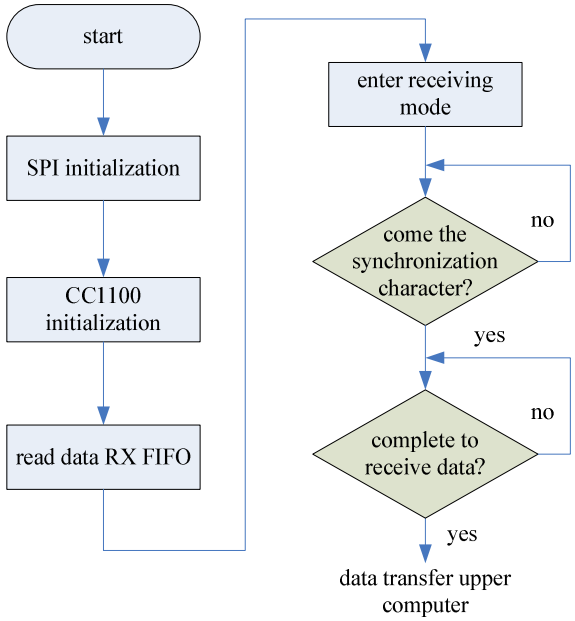


Figure 4 : Program flow chart of wireless emission

HUMAN BODY MODEL ANALYSIS AND SYSTEM MODELING

In the design process of human body modeling, the method is that the specific joints will be effectively fixed by sensors so that the motion information of the human body can be effectively collected. However, the body structure is complicated, and the trajectory in the process of the motion is complex, so in the process of body motion capture needs for appropriate understanding of the body structure. By this way the human body motion way can get more effective analysis and on this basis the motion data can get effective collection through the sensors. The next step is to set the sensor node effectively. The complexity of the structure determines the quantity of the sensor nodes, more complex, more nodes to set. At the same time, the quantity of the node will have a corresponding impact on the accuracy and precision of the capture of sensor information, the more nodes can get better ensure for the subtle precision of the sensor data acquisition.

Human body structure

In the structure of the human body, there are two main components, namely limbs and joints. Therefore, in the process of human body motion capture, these two aspects are selected as a direction, which play a decisive role for the magnitude and the rules of body motion. The human body structure is shown in Figure 5.

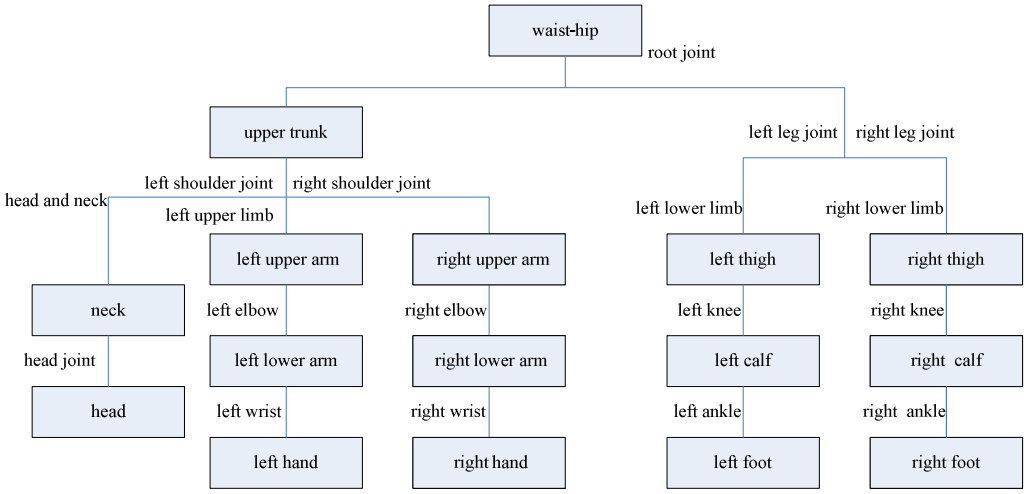


Figure 5 : Schematic diagram of the human body structure

Human body model analysis

In the process of building geometric image of the human body structure, the first step is the corresponding construction of the human body model which is as the basic carrier of motion capture and research process. In this process, the computer simulation technology can have positive effects on it, which makes the system dynamic theory can get more effective application on the process of human body model construction, at the same time the computer simulation technology becomes the primary means of the human body model construction[4]. In modern society, when the motion system of the computer and human body interaction is analyzed, it is obvious to found that the application scope of the human body model continues to expand, which makes the study of human body motion trajectory become more systematic and scientific.

System modeling

In the process of system construction, the more intuitive human body two-dimensional stick-like model is chosen as the method that is according to the specific needs in the process of human body motion capture in the movement, a total of ten human acras are selected as the object. The front and side of the model is shown respectively in Figure 6.

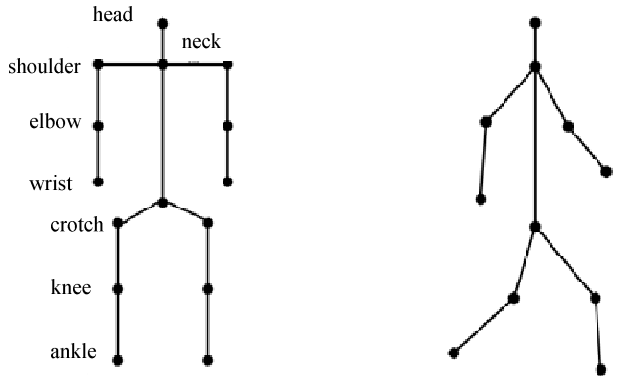


Figure 6 : Human body two-dimensional stick-like model

General placement of sensor analysis

In the process of motion capture, put corresponding number of sensors into the body, which will make the acceleration sensor get the specific information of the human body motion in first time. This is an important part of the system construction project. However, there are some problems in this process. The first problem is the specific position of the sensors, for the different methods of motion capture, the placement of the sensor is also different, what's more there is a big difference between humans and animals, and its complexity is bigger, which makes the placement of sensors keep the corresponding number. The second problem is the existence of the different accuracy of motion capture and the different number of sensors, and the way of data collection will also have corresponding effect on the specific number of sensors placement[5].

In the process of human body model construction and system construction, the placement of the sensors is shown in Figure 7. The placement of the sensors is mainly distributed in neck, elbow, wrist and other ten parts, and then forms a two-dimensional motion image.

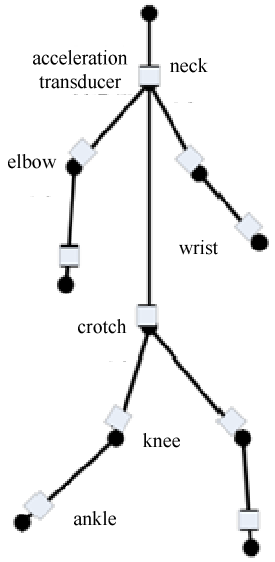


Figure 7 : Schematic diagram of the placement of sensor

Partial placement of sensor analysis

In carrying out the process of the associated movement, the acceleration sensor will also produce the corresponding motion, so for the data collection there will produce the inevitable influence, which makes a big error on the result of data collection. In order to continuously reduce the error, a corresponding provision for the placement of the sensor location was made that is the placement should be where muscles do not produce deformation in the process of movement, or placed between the muscle and skin where the deformation is much smaller. For example, the placement of sensor on the right upper arm can choose on the outside of the right upper arm, the distance between the elbow joint and the sensor should maintain between 1 to 2 cm, and the placement of sensor on the right lower arm can be chosen at a distance of 1 cm to the wrist joint. The placement of the sensor and sight can choose the place where on the right side near the trapezius muscle. The specific location will be shown in Figure 8 and Figure 9.

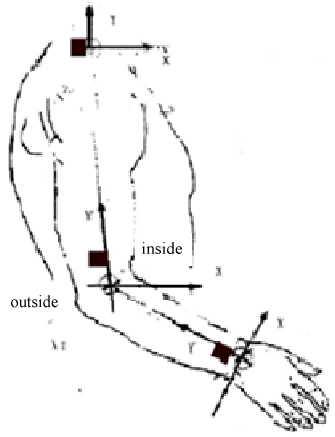


Figure 8 : The sensor partial locations on upper limb

The placement of the sensor on thigh can be chosen at a distance of 3 to 4 cm to the outside of knee joint, and for the placement of acceleration sensor on shank, it can be put at a distance of 1 cm to the lateral ankle joint, so that the accuracy of the sensor can be maintained in the process of data collection, as is shown in Figure 9.

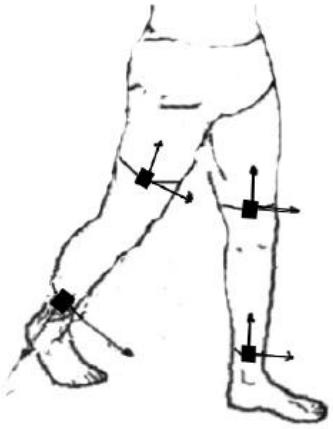


Figure 9 : The sensor partial locations on lower limb

THE ERROR ANALYSIS AND ALGORITHM RESEARCH

The error analysis

The system works as follows: first of all, to measure the motion parameters of moving object in two-dimensional space, then to calculate the relevant data, so the error in the calculation results is mainly from one or more groups of biased acceleration data collected from the system. The errors of this method mainly have following several components:

(1) The system random noise

The noise produced by the acceleration sensor in mechanical domain and in the circuit constitutes the random noise. The production of acceleration sensor elastic system Brown noise is the main cause of the noise in mechanical domain. While the main cause of the production of the noise in circuit is the related fluctuation in exothermal process, the fluctuation in stray

particles phase shift and the fluctuation of acquisition and release generated in the process of particles flow. Thermal noise and flicker noise and shot noise form the main part of the random noise existing in the circuit.

(2) The manufacturing error of acceleration sensor, like this kind of error which generated from the production process, is the error due to the design process.

(3) Errors produced from the data collection process and the errors produced by the sensors own characteristics, sensitivity and capacitance conversion efficiency are the main influencing factors of this kind of error.

(4) Errors generated by the environmental factors

This kind of error is non-linear error, and the main related factors are the change of temperature in the environment, the influence of the magnetic field and so on.

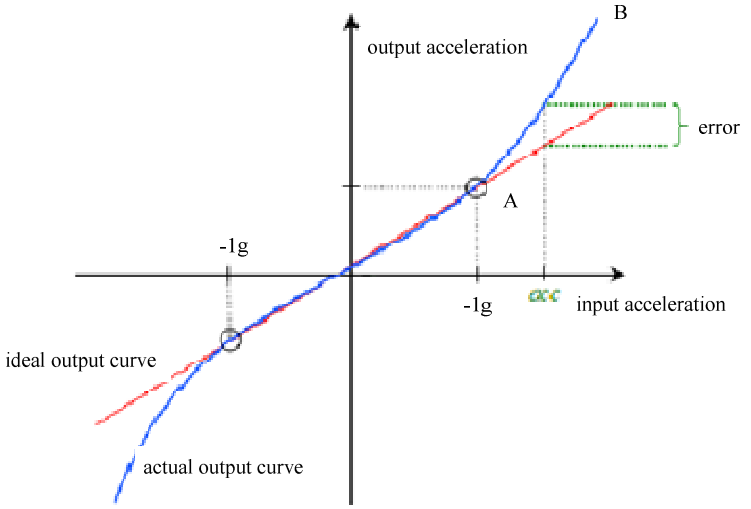


Figure 10 : Acceleration curve

Error Solution

In order to filter out the system random errors, the system revised the acceleration data and the digital filter. The specific error solution is shown in Figure 11.

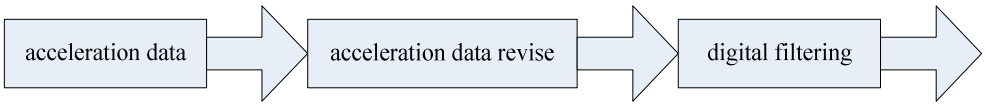


Figure 11 : Schematic diagram of error solution

Processing of acceleration data software

In the process of human data parameters capture, the sensor itself will also have some errors, and because manufacturing process of the sensors, the welding position can't maintain a high degree of balance. Therefore the primary method to decrease the error is to carry out corresponding processing to returned data and to reduce the data error by software, so that the output data can maintain standardization.

Filtering algorithm

The software filtering is an important means to deal effectively with the information collected by the sensor, its main theory is that the noise and interference signal collected from the data will be filtered effectively, so that the collected data signal can be restored effectively and the system construction can reach the specific requirements[7].

The characteristic of hardware filtering is that its cost is significantly higher than software filtering and its application specific scope is not very wide. For data information collected by sensor, it can filter effectively the noise and interference signal through the key filtering. In this process software filtering does not have the real-time characteristic, but hardware filtering has a relatively simple way to collect data and to filter, at the same time it has a strong real-time characteristic.

CONCLUSION

This study mainly has corresponding research and discussion on the capture and analysis of motion data parameter in sports training process, what's more the software of lower computer based on motion capture system and human body

model analysis with system modeling the two aspects are two main parts. Through the discussion of its function and characteristics of the corresponding process, enables the core part of the system construction to be further explicit.

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