The Design and Implementation of Sports Sprint Training Monitoring System

Yang Zhao
Shaanxi Institute of International Trade & Commerce, Xi’an 712046, China

Abstract

The purpose of this paper is to study the relevant issues of the design and implementation of sports sprint training monitoring system. The current sports sprint training not only focuses on speed, strength and skill, but also emphasizes the coordination between lower limb training and upper limb action. In this way, the demand of current sports sprint training can be satisfied. To this issue, the design of sports sprint training monitoring system can be optimized based on STC89C51RC single chip technology. The results demonstrate that the optimization of sports sprint training monitoring system design can help coaches discover negative movement habits and correct wrong sprint action of athletes timely in actual sports sprint training process. The strength data of athletes in sports sprint training acquired through the monitoring system can improve the precision of strength data acquisition in sprint training, and the value of improvement is 30.2%, displaying system application benefit. The results indicate that the optimization of sports sprint training monitoring system design can positively develop the realized value. This system design scheme to be popularized in practice.

Keywords: sports, monitoring system, sprint training, design.

1. INTRODUCTION

In current sports sprint training. To improve the training requirements of athletes in practical teaching, sports sprint training monitoring system is developed and designed. This system can help coaches know about the backward stroke strength (Jiang, 2013) of athletes timely in sports sprint training, thus providing effective theoretical foundation for the formulation of sports sprint training planning for athletes at a later stage and exerting positive influence in practical sports training monitoring. Concrete analysis of this issue is conducted in this paper.

2. DEMAND ANALYSIS

In the sports sprint training in our country, with the increase of age, the negative movement habits of athletes in the sprint will not only obstruct the improvement of sprint skills, but damage the normal growth of limbs (Xie and Luo, 2013; Bao et al., 2014; Du and Yang, 2013; Li et al., 2013; Yu et al., 2012). The negative movement of athletes and lack of standard movement in sports sprint training will impede better performance of athletes. To improve the competition level, the adverse movement of sprinters should be corrected. The optimal design of sports sprint training monitoring system can monitor and regulate the movement of athletes in time and simplify the workload of manual monitoring training achievements, thus realizing the modern informative monitoring of sports sprint training (liu and Li, 2010; Du et al., 2013; Zhu, 2013; Li, 2013; Wang, 2015; Wang and Li, 2015). The optimal design of sports sprint training monitoring system can take advantage of modern information technology to achieve the real-time monitoring and analysis of physiological workload intensity during the whole sports sprint training, which bears great significance on fully excavating potential, achieving the optimization of sports training, challenging human physiology and limit of sports and reducing sports injuries. The design of sports sprint training monitoring system can ensure the electronic management of sprint training in athletic field for athletes. In sprint training monitoring, it is easy to make mistakes applying manual record mode and the correctness of results obtained can not be guaranteed. The design and application of sports sprint training monitoring system can reduce the erroneous judgments of sprint physical ability tests and result errors caused by referees’ mistakes. Besides, the design of this system enables sports sprint training to be carried out at any time and data acquisition to be conducted without the presence of referees. Therefore, the data acquisition of competitive sports events can be carried out with the presence of athletes. The results of athletes can be recorded precisely and monitoring data of sprinters can be provided more effectively and fairly, which can exert positive
impact. Moreover, in this systematic design, because of the uniqueness, reliability and fairness of electronic system, the optimal design of sports sprint training monitoring system can give play to its application advantage and produce positive impact in the optimal management of the sports sprint training monitoring of athletes. The design of sports sprint training monitoring system is also combined with advanced science and technology, including single chip, computer and sensor. When the athlete finishes the full distance and reaches the end, the antenna located near the finishing line will receive the signal sent by the card reader carried by each athlete. After the processing by control system and confirming the identity of each athlete, the corresponding moment will be recorded and sent to control computer. The result and corresponding ranking of each athlete will be calculated after the automatic processing by the computer. In the systematic design, data information of athletes in sports sprint training is acquired and thus the data of specialized training can be acquired and analyzed in time, which is beneficial to the formulation of sprint skill training schemes for sprinters by coaches, making sure that the systematic design satisfies user demand.

3. OVERALL DESIGN OF SPORTS SPRINT TRAINING MONITORING SYSTEM

![Figure 1. Overall System Structure](image)

In designing the sports sprint training monitoring system, the basic requirements and special requirements on sprinters by coaches can be met in practical sports training teaching. The optimal design of overall structure of the system ensure that the sports sprint training monitoring system developed can achieve the monitoring and controlling of various movement data in sprint training. In this designed system, dual-CPU controlling will be adopted in the overall design scheme. In the designed sports sprint training monitoring system, modularized systematic design method is applied to realize the function of each module in the system easily. In the system, single chip A is applied to acquire the monitoring data of athletes in the sprint training; single chip B is responsible for system keyboard process, liquid crystal display and data storage of the sports sprint training. What’s more, serial interface can be applied between the single chip A and the single chip B, achieving the communication between two computers within the system. The overall system structure is shown in Figure 1.

In this designed sports sprint training monitoring system, make sure that the modularized system overall structure design idea is adopted in the control sections in the system. In the system, based on the requirements of different function modules, system control schemes are programmed by the optimal selection of assembly language and C language to achieve the real-time monitoring of athletes in the sports sprint training, making the designed system meet practical application demand.

4. DESIGN AND IMPLEMENTATION OF SPORTS SPRINT TRAINING MONITORING SYSTEM

4.1 System function design

The data acquisition function, data memory function and input/output function should be equipped in this designed sports sprint training monitoring system, as is shown in Figure 2:
In the data acquisition function, personal data is generated and portable cards are received at registry when athletes arriving at the athletic field. If this is the first arrival of athletes, ephemeral data will be generated in the database and the event conducted today is selected on the computer. Based on the initial position prompted by the computer, when athletes cross the initial position, the results can be recorded. Moreover, personal sprint information record is generated in the database when athletes complete all training sessions. Besides, real-time data information acquisition of athletes in the sprint training can be conducted through the tension data and time produced by the tension sensor and clock module. In this way, sprint training information can be monitored in real time according to system interrupt signals. Filed monitoring devices are composed of laser emitter and laser receiver, which are installed at the starting point and the terminal point on every track. The filed monitoring device installed at the starting point is responsible for the false start judgment while that installed at the terminal point is responsible for sending the result signal of the athlete to the console. Control signal devices is made up of signal lamp and audio equipment. Red, green and yellow signal and audio equipment are installed at the staring line of each track so that the starting signal is fairly obtained by every competitor. Display device is responsible for displaying game time and the result of each competitor and the track of false start after the game. A series of buttons are equipped on console and controlled by controllers. When the system is turned on and in ready condition, only red signal is on and “AA” is displayed on the status bit of display, waiting for the starting signal from the staff on the console. In the first round, when the operation staff press the “command” button, “BB” is displayed on the status bit of display and the audio equipment will give out “beep” for three times. Similarly, in the designed sports sprint training monitoring system, sprint training data of athletes can be inquired by inputting information of athletes in the system interface.

As for the data memory function, when the control system starts to acquire sprint training data of athletes, the data acquired each time can be given a serial number and stored in the system database. In the system, the stored sports sprint training data enable the system to calculate out the starting and finishing moment, laps completed, fastest lap time and the ranking of each athlete and the report card can be printed, which is convenient for future statistic analysis of data and the calculation of the sports sprint training results of different athletes. When athletes carried with dual-frequency electronic tags pass the timing coil, the 125K low-frequency activation antenna can immediately activate the information of dual-frequency electronic tags and the dual-frequency electronic tags will send the data to nearby card readers. The card readers in the system will then transmit the data received to the computer. Relevant information of athletes is obtained and the computer will also record the corresponding moment of each athlete. Finally, the statistical disposition of relevant information can be conducted by special software. The starting time of running can be acquired by the “timing start” button introduced by the reader and then transmitted to computer background system software. The background system software records the starting time, card information and corresponding information of athletes. In the process of sports sprint training monitoring, sprint monitoring data are generated in background software in real time when a group of athletes complete their training sessions. In this way, training staff can export the data of these athletes to EXCEL in real time, directly print the results and ask athletes for a confirmation. Meanwhile, as for the data storage in the system, through the interface connection system, U disk can be applied to store the sports sprint training data originally stored in the system database, preventing the loss of data.

In the designing process of sports sprint training monitoring, aiming at the input/output module, the main function is to guarantee that the users can display information based on the button and screen in the input/output module. The live sports sprint training of athletes can be formulated based on the relevant sports sprint training information inputted in the control panel of system. In the field of sports training, temporary database is established in the monitoring system for every athletes under sports sprint training monitoring. The results of
athletes will be stored on the data logging terminal hard disk, which can ensure that athletes can inquire previous results and compare them with present results to see whether they have made progress through individual index. Displaying and alarming functions can be found in the output module in the system. In other words, it can display the monitoring data of sports sprint for athletes and can give out alarming signal. It will also send out alarming signal to improper movement and training of athletes, making the designed sports sprint training monitoring system meet the demands of users.

4.2 Hardware parts in the designing of sports sprint training monitoring system

In this designed system, for the hardware design of the system, STC89C51RC single chip is adopted as the data acquisition module of host A in the system and AD678, TJI-1F sensor, RW-T739 electronic tag, RW-R910 triggered reader and PCF8583 clock are also adopted to acquire the real-time backward stroke strength data of athletes during sprint training. The STC89C51RC single chip is equipped with built-in 4K Flash program and memory watchdog circuit as well. The application of this single chip in the design of sports sprint training monitoring system can not only contribute to simplifying the hardware circuit structure, but reduce the power consumption of system single chip, exerting positive impact.

In the systematic design, TJI-1F tension sensor is applied, a kind of resistance strain type sensor, which can transform physical signal into measurable electric signal; in practical monitoring of sports sprint training, continuous and constantly changing analog electric signal can be transferred based on the tension of the waist during the sprint process, as is shown in Figure 3:

![Figure 3. Tension Sensor](image)

In the design of monitoring system, STC89C51RC single chip is taken as the data storage module in the system B and AT28C256 is adopted as external memory. In this way, system monitoring data can be redeposited in the U disk through external memory, enhancing the portability of sprint data in the sports sprint training monitoring system, as is shown in Figure 4:

![Figure 4. STC89C51RC Single chip](image)

In this designed sports sprint training monitoring system, RW-T739 electronic tag is applied to identify the sprint training data of sprinters. Each athlete in the field is given an RW-T739 electronic tag which can give out different characteristic information. When the starting gun goes off, the antenna located near the finishing line will receive the signal sent by the proximity card carried by athletes each time when they pass the finishing line. After the processing by the reader, the identity of the athlete is recognized and laps completed by each athlete is also recorded. The specific technical parameters of RW-T739 electronic tag are shown in Table 1.

Meanwhile, parameters of the RW-R910 triggered reader applied in this systematic design is shown in Table 2.
Table 1 Parameter Information of RW-T739

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recognition distance</td>
<td>Adjustable between 0 to 100m</td>
</tr>
<tr>
<td>Recognition speed</td>
<td>200 km / h</td>
</tr>
<tr>
<td>Recognition ability</td>
<td>Anticollision performance of 200 shots per second</td>
</tr>
<tr>
<td>Recognition means</td>
<td>Omnidirectional recognition</td>
</tr>
<tr>
<td>Variable gain</td>
<td>0 to 3 level to be selected based on demands</td>
</tr>
<tr>
<td>Working frequency</td>
<td>2.45GHz, 125KHz</td>
</tr>
<tr>
<td>Anti-interference performance</td>
<td>Security</td>
</tr>
<tr>
<td>Channel isolation technology</td>
<td>Encrypted calculation and security certificate, preventing link detection</td>
</tr>
<tr>
<td>No-interference among various devices</td>
<td>Average operating power, microwatt level</td>
</tr>
</tbody>
</table>

Table 2 RW-R910 Technical Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recognition distance</td>
<td>0 to 150m</td>
</tr>
<tr>
<td>Recognition speed</td>
<td>200 km / h</td>
</tr>
<tr>
<td>Recognition capability</td>
<td>Recognizing more than 500 pieces of tags at the same time</td>
</tr>
<tr>
<td>Recognition angle</td>
<td>Orientation (vertical 30° horizontal 30°)</td>
</tr>
<tr>
<td>Interface standard</td>
<td>RS232, WiFi, GPRS etc.</td>
</tr>
<tr>
<td>Power consumption standard</td>
<td>Operating power, microwatt level</td>
</tr>
<tr>
<td>Timing precision</td>
<td>±10 milliseconds</td>
</tr>
<tr>
<td>Storage space</td>
<td>Onboard 2M Byte, support 8G Micro SD card</td>
</tr>
<tr>
<td>Real-time clock</td>
<td>GPS automatic timing</td>
</tr>
<tr>
<td>Communication mechanism</td>
<td>TDMA and synchronous communication mechanism based on HDLC</td>
</tr>
<tr>
<td>Antenna gain</td>
<td>14dBi</td>
</tr>
<tr>
<td>Working frequency</td>
<td>2.4GHz, 125KHz (can be expanded to three low-frequency antennas)</td>
</tr>
<tr>
<td>Security</td>
<td>Encrypted calculation and security certificate, preventing link detection</td>
</tr>
<tr>
<td>Anti-interference performance</td>
<td>Channel isolation technology, No-interference among various devices</td>
</tr>
<tr>
<td>Polarization mode</td>
<td>dual polarization</td>
</tr>
<tr>
<td>Expansion I/O</td>
<td>Three input and output of on-off signal</td>
</tr>
<tr>
<td>Power source standard</td>
<td>DC7.5<del>24V800</del>3000mA</td>
</tr>
</tbody>
</table>

Figure 5. A/D Circuit
Similarly, the input/output module in this designed sports sprint training monitoring system is to provide a visual and humanized interface for human-computer interaction in the system. Then, the parameters of sports sprint training system can be adjusted through the input module of the system and the LED and LCD can be applied as the output module of the system. Besides, in the systematic design, A/D converter can output the analog signal of 0-+5V and convert the analog electronic signal acquired by sports sprint training monitoring into effective digital signal through tension sensor, whose actual range is 300 kg. The AD678KN conversion chip will also be adopted in this systematic design, which is a single channel 12-bit conversion chip and can satisfy the hardware design demands of practical system. The systematic A/D conversion circuit of the designed sports sprint monitoring system is shown in Figure 5:

4.3 Design and Implementation of System Software

Modular software designing methods will be used in this designed sports sprint training monitoring system, which benefits future maintenance and upgrade of the system. In systematic design, software parts mainly contain the regulation of monitoring system LCD driver, serial driver and each communication module. The software design flow of its host and slave is shown in the design of systematic software main programs (Wei, 2011).

After the initialization of the host of single chip A in the sports sprint training monitoring system, laps of sprint training time can be inputted following the prompts in the monitoring LCD. Then, the number of laps needed to be completed by the athlete is inputted in the system using keyboard. After pressing the confirmation button, the host A will send the number of laps to slave B, which can achieve the monitoring of sports sprint training (Zhang, 2014). Through radio technology and information transferred by the system, we need to stick a bar code on the gym suit of every athlete and then the monitoring can be achieved by simply placing the laser scanning gun respectively next to the starting line and finishing line. When the laser beam scans the bar code of athletes, the monitoring devices in the sports sprint training monitoring system can transmit the information to system over the radio. The system can then recognize the identification information and exercise some real-time control. Firstly, various initialization operations of parameters can be conducted on the single chip A in the system, including the initialization of single chip special function register settings. Set the communication information of 1-bit and 8-bit data in its serial mode, the timer at 50ms T0 and the baud rate generator at 9600 T1. Initialization can be conducted on PCF8583 and then flag bit of each function can be cleared, as is shown in Figure 6.

![Flow Chart of Single chip A](image)

**Figure 6. Flow Chart of Single chip A**
As for single chip B, initialization of each parameter in single chip B can be conducted, which mainly includes setting the practical working manner of serial port, setting timer at 50ms T0, eliminating transferring flag and initializing the information of alarming pins; this scheme has good timeliness and reliability and is easy to be implemented. Besides, ordinary running tracks can accommodate at most 8 athletes at the same time, which means that this scheme can meet the timing requirements of the majority of sprint competitions. The flow chart of single chip B is shown in Figure 7.

Some codes of system interrupt:
void Int0 Key1(void) interrupt 0 using 1
{ uchar ms,ms1;
  ms=100;
  do
  { ms-=1;
    ms1=200;
    do
      { ms1-=1;}
    while(ms1);
  } while(ms);
  if(INT0==0)
    set_flg+=1; while(!INT0)
}

Some codes of transmitted information:
void Send_Data(uchar type,uchar len,uchar *buf)
{ /* sending data */ for (i=0;i<len;i++)
  { Send(*buf);
    CheckSum = CheckSum + *buf;
    buf++;
  }
Send(CheckSum);
// sending checksum byte
/* transmitting frame end byte */
tmp = 0x2A;
Send(tmp);
}

5. ANALYSIS OF APPLICATION EFFECT

Based on STC89C51RC single chip technology, optimal design of sports sprint training monitoring system can help coaches discover the negative movement behavior and correct the wrong movements of athletes timely during the training, which enables athletes to master the correct way of running. The strength data of athletes during the training acquired by the system improves by 30.2%. The sports sprint training monitoring system is an important equipment of sports informatization. It achieves the automation and intellectualization of timing in sprint competitions and makes the monitoring and timing of sports sprint training more convenient, precise and effective; meanwhile, this system can automatically monitor the image data and information of athletes during the training, thus achieving the remote control of sports sprint training. It is undoubtedly that the application of this system in practice can improve precision of sports sprint training monitoring, raise the science and technology content of sports sprint training monitoring equipment and enhance the development of sports sprint training monitoring industry, realizing information management and exerting positive impact. Meanwhile, the design and implementation of this system can enhance the specialized training of step length and step frequency and improve the precision of strength data acquired in sports sprint training, exerting system application effect.

6. CONCLUSION

In conclusion, optimal design and implementation of sports sprint training monitoring system is in favor of the enhancement of specialized training aiming at step length and step frequency, thus improving the coordination of movements of upper limb and lower limb during the training, promoting the quality of sports sprint training. This system can exert positive design realized value and the design scheme of this system is worthy of popularization and application in practice.

REFERENCES