



Study on a Footwork Training and Testing System [†]

Qi Hu *, Qi Chen, Yongqing Liu and Qingkai Zhen

Sport Engineering Center, China Institute of Sport Science, Beijing 100061, China; chenqi@ciss.cn (Q.C.); liuyongqing@ciss.cn (Y.L.); zhenqingkai@ciss.cn (Q.Z.)

* Correspondence: huqi@ciss.cn; Tel.: +86-010-8718-2541

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Abstract: In the sport science fields, for a long time there are various attempts to explore more advanced technology in order to collect kinds of information concerned during athletes training and matches. In the paper, a footwork training and testing system has been developed by adopting the advanced technology of Wireless Sensor Network (WSN). The system is comprised of some wireless sensor nodes and gateways, system control software and so on. By means of the system, the daily footwork training methods and modes will be simulated to automatically guide the training of the athletes, at the same time the training data concerned will be automatically recorded, including moving velocity, moving frequency and success average, moving exercise duration and so on, and it is facilitate to evaluate digitally the training and testing effects for coaches and athletes. The system will bring about an auxiliary means in sport science training and research, make coaches and researchers have more options for the technical and information forms, and provide the technology foundation for synchronizing and intermingling the training and testing smoothly.

Keywords: wireless sensor network; footwork; training and testing; technology implementation

1. Introduction

It is a long-standing task in sport engineering field that during the actual training state of athletes some non-stationary movement parameters are collected much more truly and tests are accomplished, then the data of tests and sport true state can form a one-to-one mapping furthest, furthermore the training effect is evaluated more accurately with digitized data. Developing practical sport instruments equipment with new technique to gradually realize the synchronization and integration of training and testing is the ideal and goal pursued in the field of sport engineering research.

The start speed of footwork, the ability of speed keeping, fast steering and quick turn while moving have a significant impact on the outcome in many sport events, such as table tennis [1], badminton [2], tennis [3,4], basketball [5,6], volleyball [7,8], football [9] and so on. Athletes must move quickly to hold a favorable position on the playing field and to gain time and space, then are able to gain tactical advantage and then win the match. In order to improve the ability of footwork, the duration, content and strength of footwork training have strict requirements in regular training. Moreover, Sprains and strains of the muscles of the lower and lower limbs of the athlete during the training and competition also occur in these footwork sections, such as stop and turn to the blast [10,11]. For enhancing the footwork training of athletes, improving the power level of lumbar and lower limb muscles, and raising the footwork ability and meanwhile avoid or reduce injuries, it is necessary to develop the relevant equipment to enrich and strengthen training means of pace mobility.

In this paper, technical application research have been carried out by focusing on the needs of the pace mobility training, and a footwork training and testing system has been developed, which

can complete the training and testing tasks and collect more accurate motion parameters at the same time.

2. Design Ideas and Key Technical Difficulties of the Footwork Training and Testing System

2.1. Design Ideas

Each sport has different characteristics for moving ability training. For example, the table tennis is characterized by a small range of rapid change direction movement in a short period of time; compared with the table tennis, the moving range of the tennis is bigger and the stalemate time is longer; there are jumps generally during fast moving in the badminton; moving ability and technical training of the basketball mainly include in situ step, turn, stop and start, change direction in the run, stop and turn urgently during moving, kinds of moving training with ball and so on; fast footwork of the volleyball mainly appears in the defense phase, and its training content mainly include step and slide, stride and stride step, cross step, comprehensive pace and so on; moving range of the football is big, its moving distance is long, and its direction and pace change greatly. Therefore, methods and requirements of footwork training for each sport are also different, some focus on localized, fast-paced and more directional moving training, some focus on abilities of fast start and turn movement, and some focus on a wide range of long distance endurance training.

In the paper, these different emphases of moving training are reduced to the following links:

- Moving start, which represents the rate of reaction to a moving indication;
- Footwork speed in movement;
- Rapid change in direction and rhythm of movement;
- Moving brake;
- Required strength and stamina for maintaining rapid movement in the race.

According to the characteristics of footwork, main function and performance of the footwork training and testing system have been defined.

2.2. Key Technical Difficulties

So far, many sport scientific tests are carried out under the laboratory environment or specific experimental conditions, and athletes must carry large or small device and sensing device. In this state, athletes feel different certainly from normal training or competition and the movements must be affected including intensity, amplitude, frequency, rhythm and so on. Therefore, mastering footwork characteristics in accordance with the sport requirements, achieving the transmission and management of the pilot signal according these characteristics, and collecting and calculating related data during footwork training are the keys to solving the above problem. WSN technology can be used to realize wireless and wide-range real-time data collection, which just solves the problem.

WSN has the characteristics of digitization and wireless communication, and ways and means of its signal transmission forms a network, which is able to achieve two-way signals transmission. Its nodes are intelligent and internally programmable, and WSN can implement computing, communications and other tasks in addition to data acquisition. The network can be automatically organized and managed without human intervention.

3. Technology Implementation of the Footwork Training and Testing System

3.1. Function Characteristics and Technical Indicators

3.1.1. Function Characteristics

By investigating training requirements, the footwork training and testing system have the following main functional features. Firstly, it can realize setting free guide device in the field and guide athletes to move quickly. Secondly, the direction change of movement is random, so that the players prejudge impossibly the next movement. Thirdly, the rhythm and frequency of the signal can be changed, and the rhythm of the actual race can be simulated. These function characteristics makes the system be able to farthest simulate footwork requirements in real race situations. Figure 1 is a sketch map of footwork training.

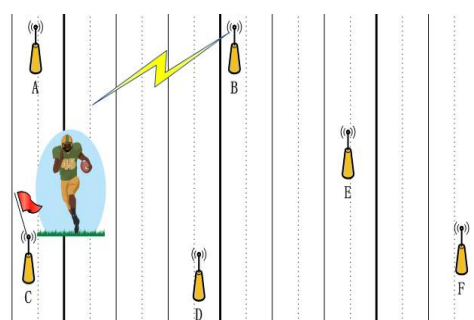


Figure 1. Sketch map of footwork training.

Coaches can compile training programs free and edit the cadence and frequency of moving the pilot signal and the total training duration, and then can store training programs and use them repeatedly when needed. And then coaches can train different athletes for the same intensity and duration, at the same time the system may record many data of athletes' movement training, such as the number and success number of moving, the total training duration, and the success rate of the whole training course and so on. Coaches can use these data to evaluate training effectiveness and intensity

3.1.2. Technical Indicators

According to above characteristics, the key technical indicators of the system are as follows:

- The total number of guide signal points: 10 currently (The wireless system theoretically supports 65,535 nodes. Considering the reliability factor, the number can increase to 50 according to the sport requirement) ;
- The setting range of guide signal points: being able to meet the site requirements of all ball games;
- The setting mode of guide signal points: coaches can display arbitrarily in the field range;
- The node operation modes: the random cycle model and the customized cycle model (determined by the prepared cyclic sequential file). Coaches can increase or decrease arbitrarily the number of nodes within the total number under the random cycle model, and coaches can set the number, cycle order and placement of nodes under the customized cycle model.

3.2. System Constituent

The footwork training and testing system consists of three parts, such as nodes, wireless network gateway and system software, as shown in Figure 2. Nodes are the basic function unit of the system, and are responsible for the occurrence of guide signal, the transmission of system control signals and the calculation of distances between nodes. Meanwhile, the sensors set in nodes record the singles whether athletes complete moving successfully or not, and then send the singles back to system

software. The wireless network gateway is equivalent to nerve centre of the system, and the nodes and system software transmit control signals and collect data interactively through the gateway. The data collected and calculated by nodes are uploaded to system software by the gateway, and control singles of system software are uploaded to nodes accordingly.

In order to satisfy the needs of different sports, the decoration form of nodes can be divided into bracket type, carpet type and suspension type, and athletes can activate the senor switch by touching, stepping and striking and so on. For example, table tennis adopts the bracket type, and nodes are set up in the height area where athletes often move their hands regularly during the match, and then athletes complete a moving after touching the nodes by hands during movement training; Tennis adopts carpet type, and athletes can activate the senor switch by stepping; Hockey athletes can trigger nodes by striking with a club. The decoration form of nodes with bracket type is shown in Figure 3.



Figure 2. Sketch map of system constituent.



Figure 3. Sketch map of the decoration form of nodes with bracket type.

3.3. Succinct Training and Testing Process

The succinct training and testing process is as follows:

- The battery are loaded into the nodes to be configured, and the nodes are placed in the field;
- Connect the wireless gateway with the computer safely and start system software;
- System software detects the nodes in the network itself first, and then the connected nodes are shown in the software interface;
- Choose work patterns and training programs, and then the start button on the software interface lights up, which indicates the system is in a standby state and can be used;
- Press the start button and the system starts to work, and then athletes begin to move when the first node sends out the pilot single, and move to the node continuously along with the single;
- Athletes move to the node that sends out the signal and touch the node with hand, and the sensor inside the node records the touch, which indicates that the movement is completed.

Meanwhile, this node notices the next node through system software sending the pilot single, and the system continue to guide athletes to move.

Moving distance and consumption time between two consecutive nodes are recorded by nodes and system software, and are used to calculate the moving speed. Moving parameters between all of two adjacent nodes are recorded throughout the training period.

4. Debugging and Testing of the Footwork Training and Testing System

The technical researchers have debugged this system hardware and software performance indicators, and then national table tennis players have carried out footwork testing by using this system as shown in Figure 4. The results indicate that the hardware has the characteristics of high stability and reliability, wide measurement range, simple and portable, and satisfying long-time testing requirements and so on; meanwhile the software has the advantages of friendly interface (as shown in Figure 5), simple operation, visual, clear function, real-time and reliable data display and good fault-tolerant technology and so on. In a word this system has good application and popularization value.



Figure 4. National table tennis players are carrying out footwork testing.



Figure 5. The interface of system software.

5. Conclusions

- The footwork training and testing system has been developed by adopting the advanced technology of Wireless Sensor Network (WSN). The system is comprised of some wireless sensor nodes and gateways, system control software and so on. By means of the system, the daily footwork training methods and modes will be simulated to automatically guide the training of the athletes, at the same time the training data concerned will be automatically recorded,

including moving velocity, moving frequency and success average, moving exercise duration and so on, and it is facilitate to evaluate digitally the training and testing effects for coaches and athletes. The system hardware has the characteristics of high stability and reliability, wide measurement range, simple and portable and so on, and may satisfy long-time testing requirements; meanwhile the system software has the advantages of friendly interface, simple operation, visual, clear function, real-time and reliable data display and good fault-tolerant technology and so on.

- This system is economical and practical, has good market prospects, and is ideally suited for footwork ability training of various ball games. Furthermore this system is of great significance to enrich and strengthen the training methods of moving ability, to strengthen the strength of lower limbs and waist, and to reduce the sports injuries.
- This system is easy to realize synchronization test with many systems, such as video recording and acceleration data acquisition and so on. The system will bring about an auxiliary means in sport science training and research, make coaches and researchers have more options for the technical and information forms, and provide the technology foundation for synchronizing and intermingling the training and testing smoothly.

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