Track and Field Competition Track and Field Monitoring System Based on TEB Algorithm

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Abstract. With the increasing innovation of information technology, motion trajectory monitoring technology has been developed rapidly, and is widely used in track and field competitions for athletes' motion trajectory monitoring system, and TEB trajectory planning algorithm is a necessary guarantee for system implementation, so based on TEB The research of algorithmic track and field competition trajectory monitoring system has very important significance in theory and practical application. The main research content of this article is based on the TEB algorithm to study the track and field competition trajectory monitoring system. Starting from the TEB algorithm, this paper analyzes the system-related functional requirements of the system, and describes the overall functional process design in detail. In this paper, the main functional modules of the system are divided into real-time motion trajectory monitoring module, online map browsing module, motion trajectory statistics module, and exercise plan formulation module, and the sub-function modules are designed according to the actual functional requirements of each module. Finally, this article tests the system, testing the response time and packet loss rate. Among all the test functions, the maximum response time of the system is 1.67 s, the minimum average response time is 0.62 s, and the response time of the main functions of the system is within 2 s. It can be seen that the system has fast data response speed and good operating efficiency.

Keywords: Trajectory planning · TEB algorithm · Trajectory monitoring · Track and field competition

1 Introduction

With the development of computer technology and GPS global positioning system, by combining GPS positioning technology with an electronic map system, real-time dynamic positioning services and motion track monitoring services are provided on the terminal, and relevant positioning points and The trajectory information is displayed, and the visualization application of GPS positioning is realized [1, 2]. Track and field competitions have a high degree of attention, and the research on motion trajectory monitoring technology has important practical significance and good application prospects [3, 4]. In particular, the TEB algorithm has been widely used in the field of track and field competition trajectory monitoring in recent years because of its excellent feature extraction and trajectory tracking and planning capabilities [5, 6].

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Regarding the research of motion trajectory monitoring, many scholars at home and abroad have conducted in-depth discussions on it. For example, Hai L extracts the athlete's activity area based on the threshold of the area, aspect ratio, color distribution and other characteristics, and uses gray information to compare and eliminate the sports field area [7]; Yue S proposes a set of color spaces containing multiple colors to improve the versatility of the detection algorithm [8]; Cheng G inputs Histogram of Oriented Gradients (HOG) features into the SVM classifier for detection [9]; Qazani M uses the design of the search window, when the object moves in the picture, it can be reflected in the back-projection image of the histogram, because the Meanshift algorithm can move the window to the new position with the maximum density to achieve movement tracking [10].

This article takes the design of track and field motion trajectory monitoring system as the research object, conducts in-depth discussion and analysis on it based on the TEB algorithm, and designs the corresponding motion trajectory monitoring system. This article first analyzes the relevant functional requirements of the system, and explains the design of the overall functional module in detail, and finally tests the system to test the response time and packet loss rate.

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2.1 Analysis of System-Related Functional Requirements

(1) Real-time monitoring of track and field events
The real-time trajectory monitoring module of track and field competition is the most core function of the whole system. By selecting sports categories and items, after turning on the motion track monitoring function, under the condition that the system is connected to the network via Wi-Fi or 3G, 4G, the built-in GPS system in the system combines the map to perform real-time positioning and perform relevant location information. As the 5G and 6G technologies make breakthrough, the system also develops rapidly [13–15]. The user's motion track is displayed on the system in real time, and the distance and time of the user's exercise are counted according to the position information. According to the statistical result, after the track monitoring is over, the speed of the exercise process and calorie consumption information are calculated. The final motion trajectory and corresponding data will be stored in the server in XML format to support the subsequent data processing of the system.

(2) Online map browsing for track and field competitions
The online map browsing module of track and field competition mainly serves the movement track monitoring module. It will also display the map information of the track and field competition venue for users based on the built-in GPS positioning of the system. The displayed map supports 24 levels of zooming out or zooming in on a certain area.

(3) Statistics of track and field competition records
The track and field sports record statistics module mainly relies on the user's historical data records. This module mainly stores and displays the user's sports history

trajectory by date, and supports the user to click to view the history trajectory. And with a certain period of time as a unit (month, week, day) to perform data statistics and chart statistics on the user's exercise situation, through this function module, the user can clearly grasp their exercise situation in the past period of time.

(4) Athlete plan for track and field competitions
Through the track and field athlete plan formulation module, users can make certain training plans according to their actual needs, and develop a training schedule that meets their actual conditions. The system will also promptly push notifications to users according to the schedule.

2.2 System Function Module and Process Design

(1) Design of real-time motion track monitoring module for track and field competitions
For users of the track and field competition track monitoring system, the core functional module of the system is the real-time track monitoring module, and the functional module mainly includes three parts: the classified track monitoring module, the real-time data feedback module and the track uploading module.
Among them, the classified trajectory monitoring module requires the user to select the competition category (long and sprint, high jump, long jump, etc.) each time the user uses the trajectory monitoring function, and then the system will implement the user's movement trajectory through the built-in GPS positioning system and real-time online map. The real-time data feedback module is mainly used to receive related exercise data fed back by the server through statistical calculations during the process of exercise track monitoring, including exercise time, distance, average speed, calorie consumption and other information, and at the same time press the relevant information on the client certain parsing rules are used to analyze data, and then the analyzed data is pushed to the main interface of the client for users' reference.
The motion trajectory upload module is used after the trajectory monitoring is over, the client side pushes the relevant trajectory and data to the server side through the XML format file for storage, and prepares the data foundation for subsequent users to query the historical data of the competition and share the sports status.

(2) Design of online map browsing module for track and field competitions
Under the condition that the user client is connected to the network, the user can browse the online map through the motion track monitoring system. The system supports 24 map zoom levels, and the user can zoom in or zoom out the map as a whole according to their actual needs. At the same time, during the user's map browsing, the system will locate the target through the client's GPS and display the user's current location information through the map. In the process of browsing the map, the user can also mark a certain area and allow the user to give a brief description of the marked location. After the map marking is completed, the system will save and upload these user marks. After going through this process, when the user opens the map browsing function again, the pre-recorded marker will appear on the map. By clicking on the relevant marker, the user will get the feedback information of the relevant information of the marker.

(3) The design of the statistics module of track and field competitions
The statistical function of track and field competitions is mainly based on the historical data uploaded and stored by the user in the system for statistical analysis, so as to give the user's movement in a certain period of time. The main statistical records include user historical track, exercise category statistics, exercise distance statistics, and common exercise area statistics. Among them, the user's historical trajectory is mainly to arrange the historical trajectories according to the order of the upload date of the trajectory, and the user can select the corresponding historical motion trajectory according to the exercise time, and view the trajectory corresponding to this exercise and related exercise information.
Sports category statistics are mainly presented in the form of pie charts. The user can select the time interval preset by the system to check the number of times and the corresponding proportions of various sports recorded by the user during a specific date interval, so as to scientifically formulate the individual training plan. Sports distance statistics are mainly in the form of histograms, with daily or weekly time units, presenting the cumulative distance and time of users participating in various sports in a specific time period, and then more intuitively reflecting the user's track and field sports situation.

(4) Modular design of athletic plan formulation for track and field competitions
The athletic plan formulation module of track and field competition is mainly used to provide users with sports training plan arrangements, which is convenient for users to formulate scientific and effective training arrangements. Its main functional modules include the formulation of training schedules and the setting of track and field events schedule reminders. Through this functional module, users can make a training plan for a period of time in advance, and the established training plan will be based on the schedule in chronological order. The form is presented on the client. While browsing the preset training schedule, the user can also modify the settings of the corresponding plan. At the same time, users can set reminders on related schedules according to their actual needs and usage habits, ensuring that users receive exercise reminders from the system before training, which serves as a training memo.

2.3 TEB Motion Trajectory Monitoring Related Algorithms

TEB motion trajectory data has the following characteristics: the number of sampling points of each motion trajectory is not exactly the same, the length of the motion trajectory is also very different, and the path change of the motion trajectory is more complicated [11, 12]. Taking into account the above characteristics, in order to calculate the similarity of the motion trajectory more accurately, by measuring the distance between the motion trajectories, it is judged whether the two motion trajectories are similar; the common algorithms for monitoring the distance of the motion trajectory are:

(1) Euclidean distance:
Just use the Euclidean distance for the data of the corresponding positions in the two data to be calculated. Usually, some weights are added to measure the different

meanings of different components. The Euclidean distance formula of two two-dimensional coordinate points as shown in formula (1):

$$Euclidean(a, b) = (a_x - b_x)^2 + (a_y - b_y)^2 \quad (1)$$

(2) Manhattan distance:
The original intention of Manhattan distance is to find the distance between two coordinate points. The calculation method is to sum the absolute value of the difference of all components. The specific formula is shown in formula (2):

$$Manhattan(a, b) = |a_x - b_x| + |a_y - b_y| \quad (2)$$

Taking the sampling point of each position of the motion trajectory as a component, the distance between the motion trajectories is the distance between all pairs of sampling points, which is very close to the Euclidean distance.

3 Experimental Research on Track and Field Competition Tracking System Based on TEB Algorithm

3.1 Experimental Design

In order to verify the effectiveness of the performance of the system, the trainers in the track and field are tested separately in the experiment. The pre-training data set in this article is ImageNet, and the training data sets are VOC2007 and VOC2012. The training data set is divided into training set and validation set, with a total of 16000 images. The test data set uses VOC2012test, a total of 5000 sheets.

3.2 Experimental Environment

Operating System (OS): Ubuntu16.06LTS
Processor (CPU): IntelCorei5-6500
Graphics card (GPU): NvidiaGTX1070

3.3 System Function Response Time

During the test, the operation response time of each main module function is tested, including: real-time motion track monitoring function, motion track uploading and saving function, online map browsing function, historical track and statistical data query, training schedule query and setting function.

3.4 Packet Loss Test

In this system, the data transmission between the data forwarding base station and the Alibaba Cloud server is based on the HTTP protocol, which can ensure the stability of data transmission, so the reliability of this system depends on the wireless transmission between the data collection terminal and the data base station the packet loss rate. The

packet loss rate is an important indicator for judging the quality of network data links, and it is mainly affected by factors such as transmission distance and weather. This experiment is tested for different distances and weather.

Test conditions: The wireless transmission power is adjusted to the maximum, and the transmission rate is 2 Kbps.

4 Data Analysis of Track and Field Competition Monitoring System Based on TEB Algorithm

4.1 Response Timetable for Each Main Function

In the test process, the operation response time of each main module function was counted. Each function was tested 10 times. The response time of each function is shown in Table 1: among all the test functions, the maximum response time of the system is 1.67 s; the minimum average response time is 0.62 s.

Table 1. Response time of each main function (s)

	Maximum response time	Average response time
Real-time motion track monitoring	0.87	0.62
Upload and save the motion track	1.16	1.00
Online map browsing	0.78	0.65
Historical trajectory and statistical data query	1.49	1.20
Training schedule query and setting	1.67	1.41

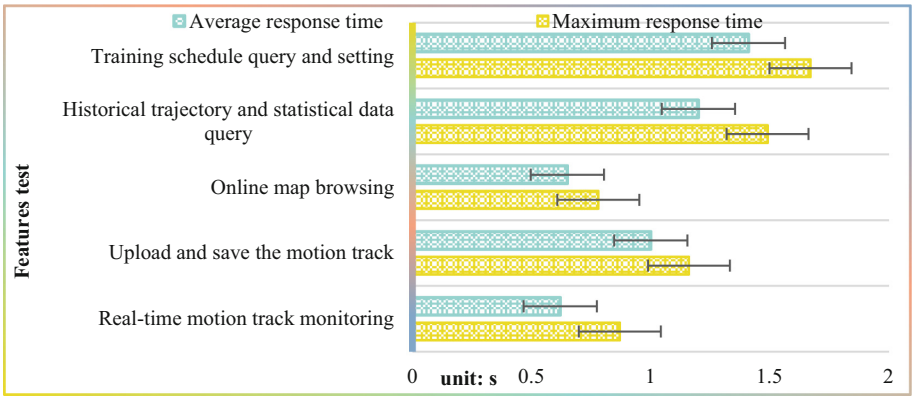

Fig. 1. Response time of each main function (s)

It can be seen from Fig. 1 that on the whole, the various interfaces of the track and field competition trajectory monitoring system switch smoothly, and the data response feedback speed is faster. In an environment where the system network is unblocked and the GPS positioning system is turned on, the response time of the main functions of the system is within 2 s.

4.2 Packet Loss Rate

With packet loss retransmission turned on and packet loss retransmission turned off, the transmission distances of 500 m, 1000 m, and 1500 m were tested under sunny, cloudy, and rainy weather. The test results are shown in Table 2: the packet loss rate of the system is 0 within a distance of 500, sunny, cloudy, and rainy; at a distance of 1000 m, the packet loss rate of the system is 0.004%, 0.00041%, and 0.0043%, respectively.

Table 2. Packet loss rate (%)

Distance	Sunny day	Partly cloudy	Rain
500	0	0	0
800	0.002	0.0021	0.0034
1000	0.004	0.00041	0.0043
1500	0.0046	0.00467	0.0083
2000	0.0061	0.0063	0.0124

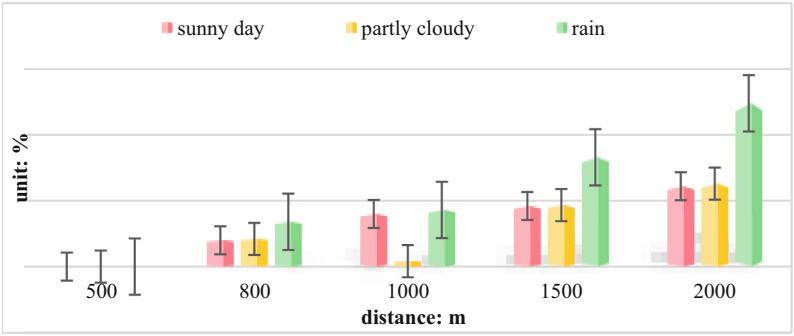

Fig. 2. Packet loss rate (%)

It can be seen from Fig. 2 that within 500 m, the packet loss rate of the system is 0. As the distance increases, the packet loss rate will increase, and rainy weather will cause the packet loss phenomenon to become more serious. In addition, after the loss of packet retransmission is turned on, it can be ensured that no data will be lost within a transmission distance of 1000 m, which meets the requirements of the system design.

5 Conclusion

With the rapid development of information technology, all walks of life in society are trying to apply information technology to traditional business processes, including the monitoring of track and field competition trajectories, and the effective information construction based on the actual business needs of track and field competitions, which has greatly promoted the development of monitoring efficiency of athletes' trajectory during the competition. Based on the TEB algorithm, this paper designs a track and field competition trajectory monitoring system. The system has passed the test, has good practicability and reliability, and can provide relevant references and references for the development of the industry.

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