Evaluation of Sports Visualization Based on Wearable Devices

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Abstract—In order to visualize the physical education classroom in school, we create a visualized movement management system, which records the student's exercise data efficiently and stores data in the database that enables virtual reality client to call. Each individual's exercise data are gathered as the source material to study the law of group movement, playing a strategic role in managing physical education. Through the combination of wearable devices, virtual reality and network technology, the student movement data (time, space, rate, etc.) are collected in real time to drive the role model in virtual scenes, which visualizes the movement data. Moreover, the Markov chain based algorithm is used to predict the movement state. The test results show that this method can quantize the student movement data. Therefore, the application of this system in PE classes can help teacher to observe the students' real-time movement amount and state, so as to improve the teaching quality.

Keywords—wearable, school sports, sports simulation, visualization management, Markov process

1 Introduction

In the past 30 years, some achievements have been made in the reform of school physical education in our country [1]. However, the issue of juvenile health remains a major issue of concern to schools and the society. Five years after the release of the Opinion on Strengthening Juvenile Sports and Enhancing Juvenile Physical Fitness in 2007, the State Council posed 17 new demands to raise the juvenile health levels in the Opinions on Further Strengthening Physical Education Work in School, which expatiated on the underlying cause to juvenile health problems. In the Third Plenary Session of the 18th CPC Central Committee in 2013, it was demanded to promote the adolescents' physical and mental health through intensified PE class teaching and extracurricular exercise. This shows that the country has, from a strategic perspective, paid high attention to the healthy development of PE education course and teenagers in China. School sports are expected to maintain the healthy growth of young people. To innovate and spice up the contents, forms, and methods of sports is the necessary measure to promote the development of physical education and juvenile health as well. With the rapid development of mobile Internet, the application of the network

technology with 4G mobile communication technology and big data technology as the core has brought more and more advanced technologies in schools. At present, wearable devices [2] and virtual reality technology have been mature to serve for sports competition and mass fitness. As sensors have finer and finer functions, they develop towards movement capture. American Zepp's products include three sensor wearing devices for baseball, golf and tennis. The athlete can capture his movements by wearing a lightweight motion sensor and wirelessly transmit the motion data to the data server (or mobile Client). Athletes and coaches can replay the captured movements to improve their performance.

2 Literature review

In the researches on sports training, Spelmezan et al. [3] proposed a wearable system for skiing that can identify the common mistakes made by beginners, such as uneven force distribution on boots, wrong postures, incorrect upper torsion angle, and the curvature of the knees. Once the wrong gesture or movement is detected, it will automatically send feedback to the mobile device host, and the coach can remotely guide learners through postures and movements. A. U. Alahakone et al. [4] put forward the method of gait research and rehabilitation, and achieved the effect of scientific gait training by using inertial sensor technology to identify toe-off and landing on the heel when exercising on a treadmill. In the research of virtual reality technology in physical education [5-7], Lin Zhang et al. [8] and Xu Lanjun [9] discussed the application of sports simulation technology and tactics in basketball teaching practice and volleyball teaching, respectively; In the field of campus sports simulation, Liu Heng et al. [10] focused on how to stimulate students' independent learning. In the research of Markov process on sport competitive prediction and teaching prediction, Yonggan Wang [11] predicted and analyzed the basketball competition results, while Liu Yaxin studied the application of Markov process on teaching evaluation. In summary, the extensive application of wearable sports devices and virtual reality provides a reliable technical basis for the simulation study of visualized management of school sports under the information background. However, as it has yet to be applied as to the bulk tracing and visualized management of daily movement states based on wearable sports devices. We conducted related studies to contribute to this research field. The prototype system sends the motion data to the virtual reality client in real time through Bluetooth technology, which instantly drives the virtual character model in virtual scenes. The Markov process based algorithm is used to analyze the daily movement rhythms and types of students, so as to provide a theoretical basis for the development of a more scientific exercise program to achieve the simulation studies of school sports visualization management.

3 Methods

3.1 Campus sports simulation visualization management system design

The system has the following functions: (1) Real-time collection of student movement data through wearable devices and synchronization of the collected data into the data server database; (2) Movement visualization management system reads data from the data server to drive the virtual character to "move" in real time, so as to visualize the data (3) The algorithm based on Markov process is used to predict the future state of movements according to the previous student exercise data; (4) The human-computer interaction and multi Virtual role management. The system framework of 3D motion management system is shown in Fig.1.

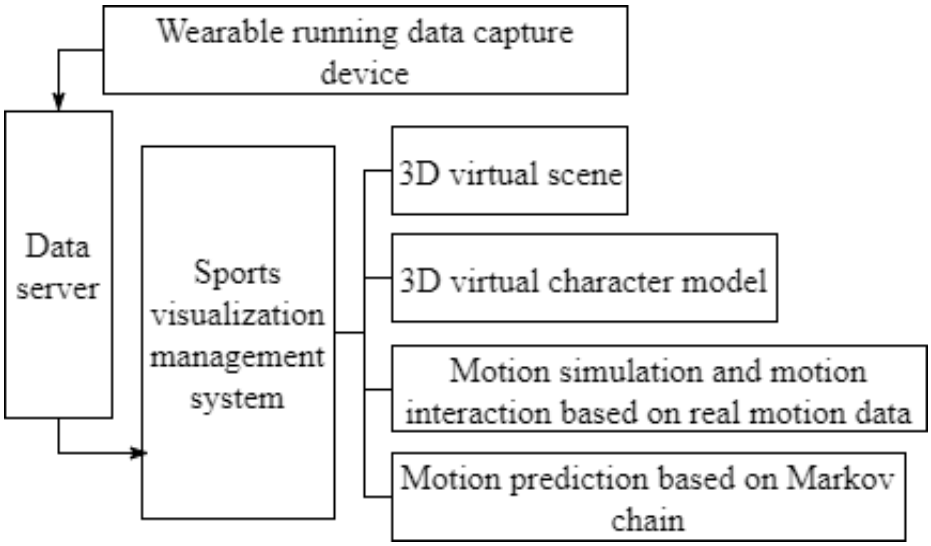

Fig. 1. System framework of 3D sports management system

3.2 Exercise Management Visualization

At certain time intervals, the wearable device sends the acquired movement data to the virtual reality system client through Bluetooth signals. These data are employed to drive the virtual character to move, so that the student movement parameters are visualized for analysis. The current movement states are shown in Figure 2. After collecting a certain amount of data, we can demonstrate in Figure 3 the amount of exercise and average movement speed in any time period.

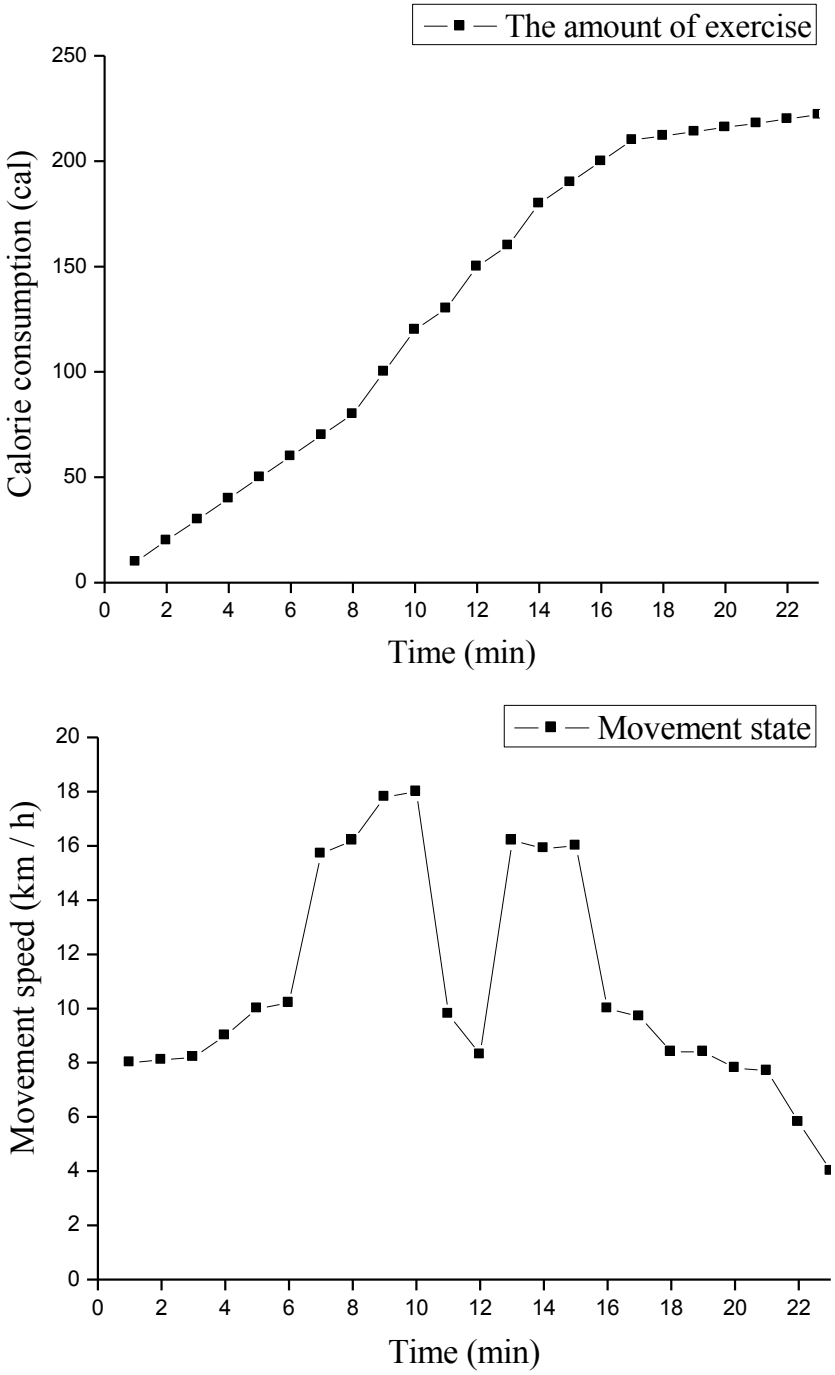

Fig. 2. The movement of a student in a movement

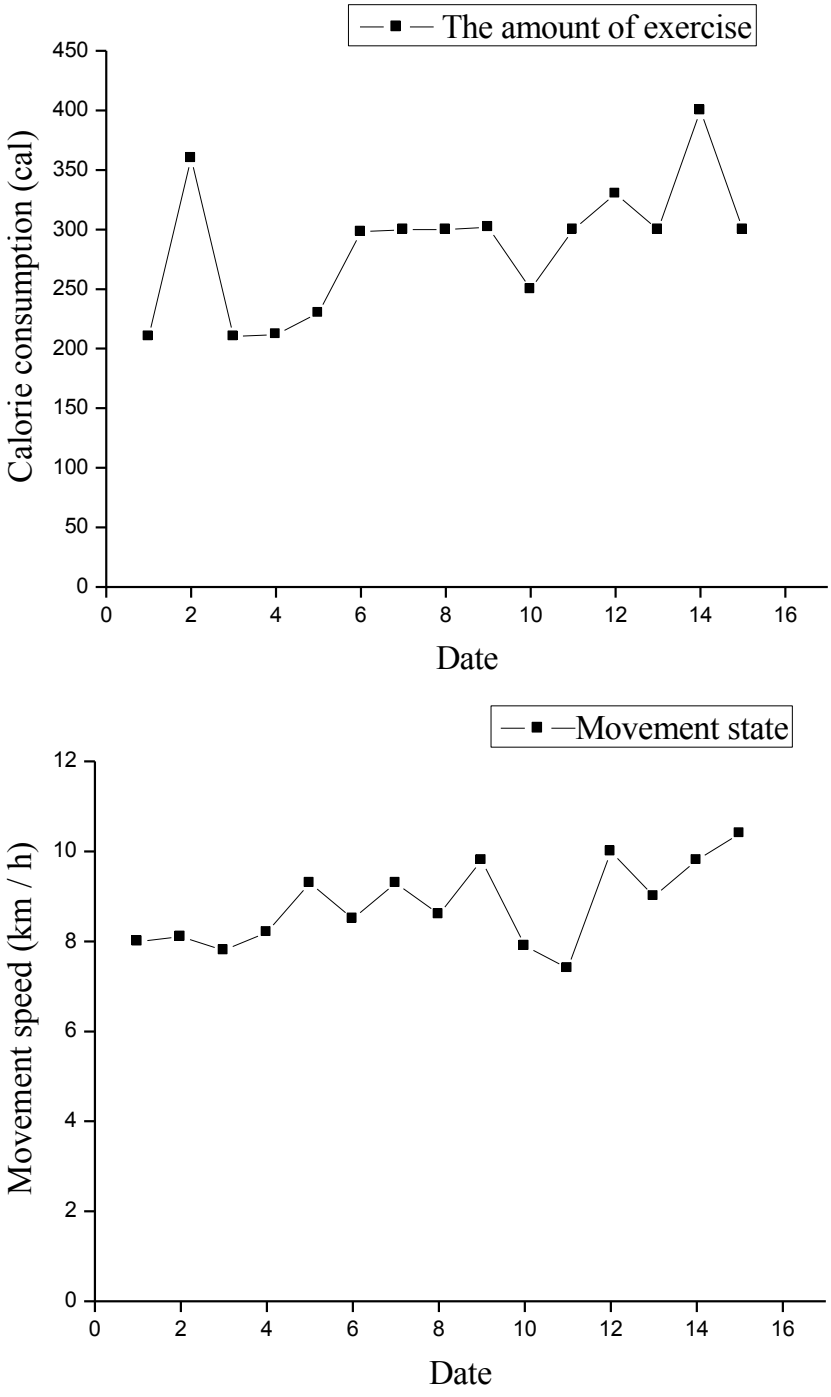

Fig. 3. The movement of a student in half a month

3.3 Exercise forecast

The data server opens network interfaces to the client to meet a variety of functional requirements of movement data acquisition. The client visits different interfaces to call the movement data as needed, and shows the statistical result of data change. Through the data analysis, the system provides scientific and effective suggestions on student exercise. Table 2 is the min/cal correspondence data of a student in a normal exercise.

According to the above state division, state transfer can be counted as shown in Table 2.

The movement data of a student captured by a wearable device is listed in Table 3.

Table 1. A student's min / cal correspondence table

Minute	Calories	Minute	Calories	Minute	Calories	Minute	Calories
1	7.499	7	13.132	13	15.405	19	6.877
2	7.502	8	13.216	14	14.265	20	4.793
3	6.712	9	13.492	15	14.513	21	2.33
4	11.621	10	14.877	16	11.109	22	1.405
5	10.755	11	10.793	17	9.216	23	0.858
6	12.307	12	8.33	18	7.492		

Table 2. Calorie consumption state transfer statistics

	A	B	C	D
A	2	2	0	0
B	1	2	1	1
C	0	1	3	2
D	0	0	2	6

Table 3. Movement data captured by wearable devices

Date	Time	Distance (m)	Duration (s)	Average speed (km/h)	Pace (min/km)	Calorie
12	14:17	3012.96	1379	7.9	7.6	218.4
13	13:34	5060.69	2275	8	7.5	367.0
14	21:04	3002.11	1449	7.6	7.9	217.7
15	12:10	2996.88	1334	8.1	7.4	217.3
16	17:15	3076.24	1195	9.3	6.5	223.0
17	13:36	4045.73	1829	8.5	7.1	293.3
18	14:33	4116.35	1600	9.3	6.5	298.5
19	14:21	4063.18	1701	8.6	7	294.7
20	16:17	4039.14	1536	9.5	6.3	300.2
21	21:04	3402.22	1579	7.8	7.7	242.1
22	15:12	4094.11	1995	7.4	8.1	296.9
23	16:11	4339.71	1556	10	6	320.2
24	16:57	4090.51	1646	8.9	6.7	296.6
25	17:17	5094.29	1915	9.6	6.3	396.9
26	16:47	3012.96	1381	7.9	7.6	302.4

4 Conclusion

By applying the system to the physical education classroom in school, teachers can observe the amount of exercise and movement states of students in real time; they can also check the figures and tables of daily total amount of exercise and movement states during any time periods. Through the segmented analysis of student movement data in a normal exercise, the system can predict the possible movement rhythms in future. The previous movement data in a period can be employed to conduct an Markov process analysis on the movement tendencies in the future. By comprehensively analyzing motion data records and student health information (age, health state, etc.), the system provides scientific and targeted suggestions to every student, which is quite meaningful in guiding them through scientific exercise. Despite the high credibility of exercise amount prediction, it should be noted that the Markov chain is heavily subject to factors like holidays and festivals, seasons, and weathers. For example, the Markov steady state will change with seasonal change. In this case, one must re-construct the state transfer probability matrix according to the aforementioned method until it conforms to the new law, so as to improve the credibility of prediction.

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