



Construction of Monitoring System and Data platform for Students' Physical Fitness

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Abstract—Monitoring System and big data cloud platform was to be developed to monitor students' physical activity and exercise by smart bracelet in real time. The main parts of the system include: (1)PA subsystem for measuring physical activity; (2) HR subsystem for measuring heart rate and sleeping; (3) HF subsystem for measuring physical fitness and instruction feedback. Conclusions: the high accuracy of the measuring system for physical activity and heart rate can measure and evaluate exercise heart rate and physical activity. Therefore, it can guarantee exercise safety for students and provide supervision and instruction for school physical education and students' physical health.

Keywords—physical activity; Heart Rate; monitoring system; smart bracelet

I INTRODUCTION

Teenagers' physical health has been paid more attention by educators all over the world. To know the present situation and changes of teenagers' physical health can help educators especially teachers make specific instruction and practice method. Physical activity refers to any bodily movement produced by skeletal muscle that results in energy consumption^[1]. Student's physical activity refers to the general activities of the students during the school and out-of-school period, including study, exercise, entertainment, sleep and so on. WHO

suggests that teenagers need to do MVPA (moderate and vigorous physical activity) for at least 60 minutes per day to maintain a good and healthy state^[2]. However, there are 80% teenagers (including primary and secondary school students) worldwide whose physical activities do not meet this standard at present^[3]. MVPA of Chinese students mainly comes from physical education courses. There is less physical activity in spare time for students. Female students do less physical activity than male students. Students is sitting for a longer time every day^[4].

In order to monitor students' physical activity information and sleeping quality in real time in daily life of school by objective index of physiology and biomechanics, the monitoring system for students various physical activity is invented and developed. The system can not only evaluate the level of students' physical activity quantitatively, but also guarantee the effectiveness and safety of exercise for individual students. It can provide scientific, individual and quantitative supervision and instruction for school physical education content and students' physical health. To schools and teachers, a timely monitoring and evaluation for course content of physical education, can not only ensure enough physical activity and exercise intensity, but also guarantee the exercise safety and prevent exercise from danger. Parents can monitor children' physical health, physical activity and

sleeping quality in order to find out problem and get feedback. It is of a great significance to improve physical health and physical education.

II METHODS

A. Design of the Monitor Device

Bracelet was made to finish two kinds of measurement as follows:

(1) Measurement of physical activity: The three-axis accelerometer in the bracelet can measure and capture acceleration in the direction of three axes of motion. Physical activity measurements are presented in the form of CPM "counts per minute" data.

(2) Measurement of heart rate: Photoelectricity sensors are to be used. Two green wavelengths of light-emitting LED and a photosensitive sensor are used to sense changes in the light transmittance of the blood in the arm as it pulsates, and the change of the intensity of the light field is tested to converted into pulses. PPG signal can be compensated better by increasing the brightness and sampling rate of LED.

B. Platform Construction For Data Management

Three different data receiving and processing software are designed in one platform, including: ① students version client ② teachers version client ③ parents version client. The compatibility and cooperation of the different testing system should be done well. Monitoring and processing the information transmission and output of three different versions of clients, and timely publishing and feedback of data statistics results.

III RESULTS

A. Constitution of Measuring System

Measuring system include 3 subsystems : PA subsystem, HR subsystem, HF subsystem.

(1) PA (physical activity) Subsystem for testing physical activity, exercise intensity and Energy consumption

The three-axis accelerometer in the bracelet can measure and capture acceleration in the direction of three axes of motion. Physical activity measurements are presented in the form of CPM "counts per minute" data. The three motion axes are VT (Axis1), AP (Axis2) and ML (Axis3), which are the vertical moving axis, the fore-and-aft direction moving axis and the horizontal-direction

moving axis. According to the original data of CPM, combined with different models, the amount of individual physical activity, physical activity intensity and the energy consumption can be calculated. The physical activity intensity (exercise intensity) is divided into different categories by the model which adopts the CPM of VT (Axis1) as the original data index. There are five categories referenced: Sit-in, low-intensity physical activity, moderate-intensity physical activity, high-intensity physical activity, ultra-high-intensity physical activity. MVPV refers to the sum of all time of moderate and high intensity physical activity. The energy consumption are calculated by the energy consumption equation, which took the synthesis vector activity count VM as the independent variable, $VM = \sqrt{VT^2 + AP^2 + ML^2}$.

(2) HR (heart rate) subsystem for testing real-time heart rate, exercise hazard warning and sleep monitoring

Equipped with photoelectric sensor, the bracelet can monitor static heart rate, morning heart rate, real-time heart rate before and after exercise, recovery heart rate after exercise, average heart rate in each period, heart beat reserve, optimal heart rate threshold (target heart rate) and heart rate variability HRV. Static heart rate can be used to evaluate the effect of exercise; Morning heart rate can be used to evaluate body fatigue and recovery; The bracelet can provide an early warning signal to the individual whose heart rate is higher than 90%HRmax more than 1 minute during exercise, and warn that there is a risk of exercise; In the period of sleep, quality and efficiency of sleep are systematically read and calculated by capturing the HRV frequency domain index. Sleep quality can be evaluated trough the ratio of LF/HF. The frequency range of LF(low frequency) : 0.04-0.15Hz, the frequency range of HF (high frequency) : 0.15-0.4Hz. During the deep sleep period, the sleep quality was good when the ratio was lower than 1. If the ratio was more than 1.5, the vagus nerve activity does not increase significantly, and the sleep quality was poor.

(3) HF (health fitness) Subsystem for testing physical Health and instruction feedback

The physical fitness and health fitness data are transmitted to the APP account file belonged to each bracelet through bluetooth transmission. This system can

track and record the testing data of physical activity and health fitness. The students' fitness are recorded by way of body weight, vital capacity, endurance, strength and other physiological functions and physical fitness testing equipment. Body composition, waist circumference, hip circumference and other testing content also can be added to conduct morphological and nutritional assessments. The individual's physical health can be judged according to the physical health data of the students, so as to guide them to carry out balanced nutrition and reasonable

exercise prescription.

B. Management System and Big Data Platform

Equipped with APP, different display panel are provided on the phone. In the process of monitoring and feedback, pay attention to handling the information transmission, information output and publishment of data statistical results of the client. A big data management platform of students' physical activity is built to receive and statistical analysis of the massive data from the smart bracelet (see Fig. 1).

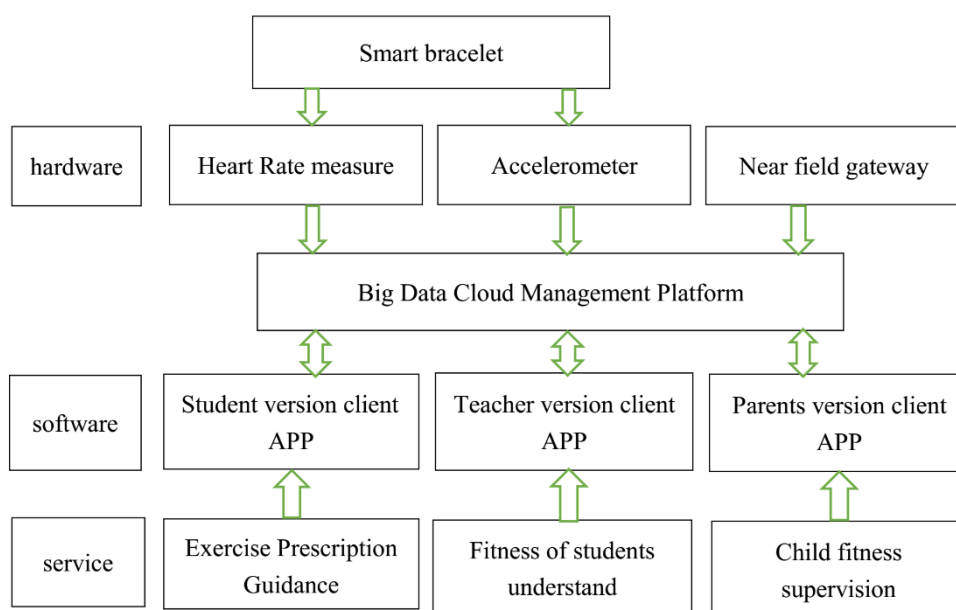


Fig. 1 Construction of monitoring system for students' physical fitness

IV CONCLUSIONS

- A. Students' physical activity and heart rate can be quantitatively monitored by smart bracelet in which there are three-axis accelerometer motion sensor and photoelectric sensor, to guarantee the safety of physical activity and exercise intensity, and warn the hazard during exercise.
- B. Monitoring physical activity and physical health index at the same time, the level of physical activity can be traced through the results of physical health tests, to monitor and control the influencing factors of students' physical health together.
- C. By measuring physical activity during the day and sleep quality at night, the 24-hour continuous physical activity and heart rate risk monitoring and measuring can be done, to monitor students in and out of class or campus and in their daily life.
- D. Physical education teachers can not only monitor the efficiency of students' physical education content in real time by this system, but also provide real-time feedback according to individual exercise heart rate to ensure teaching safety. Teachers can evaluate the effect of physical education by regularly comparing the physical changes of the students.
- E. Equipped with different management software (APP) output channels for schools, teachers, students, parents, achieve the goal of multi-role monitoring and management.

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