Design and Implementation of Android–based Teenager Sports Real-Time Monitoring System

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Abstract. In the paper, some risks of sudden death for teenager during exercise are analyzed. In this system, Android terminals are adopted as data collection nodes according to practical demands, and MINA-frame data transmission is adopted based on Socket. Also, data stream server, scheduled task analysis server and data analysis server are designed, and these three modules can cooperate jointly, thereby facilitating real-time data analysis and processing, and obtaining correct conclusion. In this paper, we propose a system framework, design a set of highly efficient data transfer protocols, and an effective mean and method is provided for rational exercise of teenagers systematically. The actual test results prove that data obtained on the terminal is highly consistent, thereby verifying practical value of the system.

Introduction

National physical fitness, especially physical fitness of teenager, is declining gradually with rapid economic development and improvement of people's living standards. Sudden death phenomenon of teenagers during physical exercise is reported frequently [1][2]. The physical health of teenager is worrying. Only by tracing and obtaining physical energy consumption changes of the teenagers during sports exercise process and mastering physical condition of teenager sports in real time with modern means can sports exercise be effectively measured, and possible risks during sports process be reduced. Therefore, we must put a data collection terminal on bodies of the teenagers to obtain relevant data during sports activities. However, data collection node is not only efficient, but also inconvenient. If Android mobile terminals, which are popular at present, can be adopted as data display node, related tiny sensors can be adopted for collecting data, and sports data during exercise can be easily obtained [3][4]. In the paper, Socket-based C/S structure is adopted as a basis; MINA framework is adopted with TCP protocol as basis for realizing efficient data transmission. In this paper, a set of complete real-time monitoring system is designed and implemented. Sports teachers can observe exercise energy consumption in real time through Android mobile terminal during exercise [5]. The exercisers can be guided and adjusted in real time according to the observed results, thereby making rational plans for PE class and reducing the risk of sudden death during exercise. Meanwhile, corresponding data processing module is also designed on the server, thereby facilitating data analysis and mastering various indexes during teenager sports.

System Overall Framework

Problems in the following aspects are mainly considered in designing sports real-time monitoring system in order to be truly and effectively realize accurate measurement and rational intervention of teenager sports exercise: (1) Teenager sports monitoring system should primarily solve the problem of acquiring time, acceleration, step quantity and other sports data of exercisers during physical exercise in real time, energy consumption condition of exercisers can be obtained accordingly, therefore sports teachers can observe exercise condition of exercisers in real time, thereby timely adjusting the exercise plan in real time, thereby ensuring effectiveness of exercise and ensuring exercise safety. Therefore, we need to design appropriate data collector for collecting

exercise data of exercisers and cooperating with Android mobile terminal to display sports dynamic trends for teachers in real time. (2) Since the data collected by data collector belongs to triaxial acceleration data during real-time exercise, indexes of students' sports energy consumption cannot be directly reflected, the data should undergo certain filtering and computing process, which can be displayed on Android mobile terminal. However, Android mobile terminal has limit on data processing ability, thereby server with strong data processing ability should be adopted for computing data, thereby improving accuracy of calculating result, greatly shortening delay of data processing to guarantee real-time data communication performance [6][7].

This system is constructed with B/S structure (Website) and C/S structure (Android mobile terminal and data collector). During exercise, system has high requirements on real-time and concurrent data collection. Therefore, the system can be realized based on C/S architecture. After sports data is collected by data collector, the data can be sent to server for treatment by WiFi wireless communication. Then server and Android mobile terminal can be connected by WiFi wireless communication, thereby receiving real-time exercise data from server. Data can be converted into visible graphs through Android mobile terminal, which can be shown to sports teachers, thereby realizing real-time sports monitoring on Android mobile terminal. System architecture is shown in Fig.1.

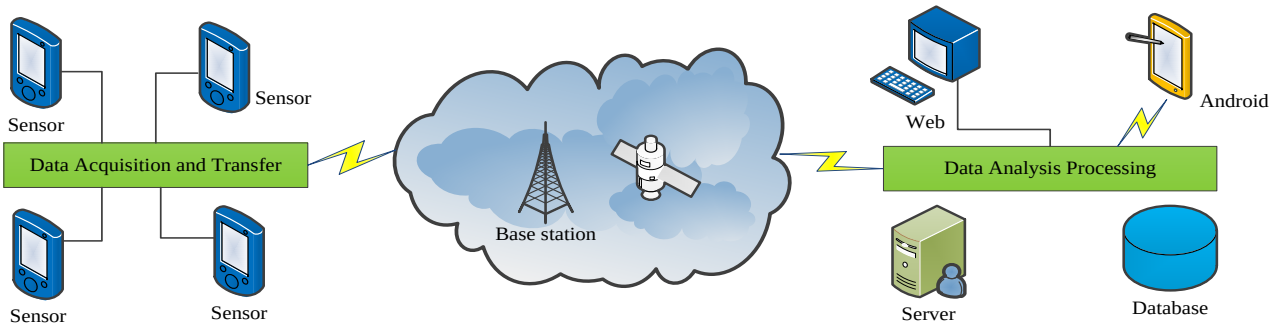

Fig.1 System Architecture Diagram

Server Structure Design

The system server mainly consists of four parts: Android communication server, scheduled task server, data flow server and data analysis processing server. Server structure diagram of sports real-time monitoring system is shown in Fig.2, wherein hardware base station is responsible for data transmission collected by sensor. Data flow server also can package and send data to Android data processing module through Android request, thereby displaying related indexes in real time. Here is an important link. After data flow server receives data, it not only can save data into database, but also can submit data to data analysis processing server. In addition, scheduled task server also can indirectly control workflow of data stream server through related processes, such as real-time data return to Android terminal, implementation of new data processing schedule, etc.

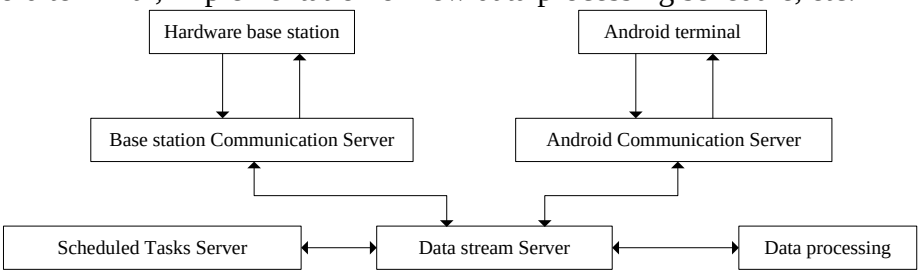

Fig.2 Server Architecture of Sports Monitoring System

MINA Frame Analysis

Basic Principles of MINA Framework. Network application based on MINA framework has three levels, I/O server, I/O filter and I/O processor. (1) I/O server: It is used for performing actual I/O

operations, including I/O services of different protocols, such as TCP/IP, serial port, pipelines in virtual machine, etc. (2) I/O Filter: I / O filter is used for completing conversion between particular object and data structure demanded for upper level application, input and output data can be processed, and many I/O filters should be connected in series for forming I/O filter chain.

Analysis of Event-driven Interface. Event-driven API simplifies MINA-based network development network application. Concrete details related with bottom level transmission are not considered in the application. Only abstracted I/O events should be processed. Session is composed of address and ports, which acts as specific connection between server and client. The connection can be decided by server address, port thereof, client address and port thereof. When request is issued from the client, server address and port can be appointed, the client terminal also can appoint or automatically appoint one address according to network routing information, and one port can be automatically distributed. Session is an abstracted form of server aiming at the connection. It is packaged by MINA; IoSession interface is defined and used for representing connection between client terminal and server. Client terminal is referred in the server, thereby realizing operation of client terminal, and binding information and object related with client terminal, we can conveniently distinguish currently-processed request of client terminal, maintain state information of client terminal and realize mutual communication among client terminals on the server during procedure preparation by utilizing the concept of session.

Improvement of Data Transfer Protocol

TCP has three important issues in traditional MINA: network congestion, disorder and ACK accumulation. The problems are analyzed in turn and improvement programs are proposed.

ACK Accumulation. Asymmetrical factors of many reasons are available in network: including data rate allocation asymmetry, asymmetry caused by multiple paths, TCP unfairness related with position, etc. Asymmetry can be caused by two possibilities: (1) forward the data flow is bottleneck; (2) backward ACK flow is bottleneck. The second condition has more serious influence on TCP since ACK bottleneck can cause accumulation of ACK packets at middle node, thereby producing ACK accumulation effect, leading to data flow burst at the sending end, and increasing network congestion and instability possibilities. The problem can be solved by ACK features due to MINA asymmetry..

Network Congestion. Network resources are very limited. In addition, network effective width becomes very small with increase in nodes and increase in TCP flow sender and the receiver span. In addition, the literature suggests that traditional TCP sender often tends to be larger value. Congestion window control algorithm is too radical in the network, thereby seriously aggravating network congestion. The problem can be solved as follows: congestion in network can be solved according to the method the same as that in wired network. The receiver can adjust beat of sending ACK through ACK Pacing. ACK traffic can be reduced through header compression. Network Delayed-ACK has prominent improvement effect on TCP; the TCP bandwidth can be maximally improved to 40%, thereby greatly easing TCP congestion problems. Optimization of congestion window is also an aspect for TCP layer congestion control

Test results

Description of Experimental Test Conditions. We will deploy WIFI outdoors and carried out several practical tests on 20 teenagers, wherein 20 teenagers can conduct related physical sports for 40 minutes. The collected data can be integrated to server for comprehensive analysis. Then data can be transmitted to Android terminal for data feedback in real time. Finally, the collected data, the terminal displayed data and server terminal data can be actually compared for analysis. Test verification is conducted under WIFI environment in order to describe high transmission efficiency of improved TCP, wherein Fig.3 shows the test result.

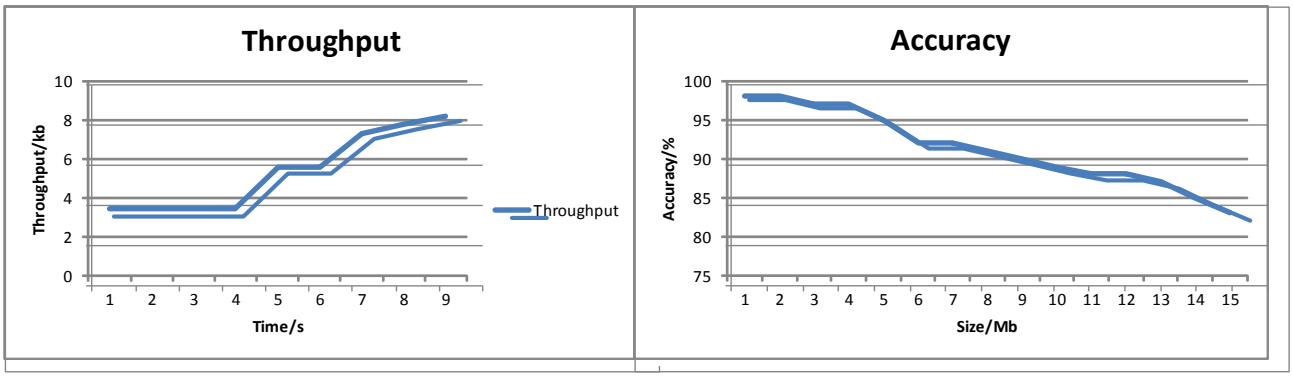

Fig.3 Test result of System throughput and Accuracy

Conclusion

In the paper, some monitoring difficulties during teenager sports are analyzed firstly, a system of monitoring teenager physical state during sports in real time is proposed. Hardware sensor collection node, server data receiving processing module and Android terminal data display software are designed on the basis of proposing real-time monitoring system. Data transmission protocol in MINA frame is mainly improved in three aspects of ACK, packet disorder and network congestion. Finally, relationship between data accuracy, throughout and transmission time is analyzed in details through actual test. The system can be used for monitoring physical condition of teenager during sports with certain practical value. The paper has the following defects that a detailed data monitoring indicator is not proposed, no model is established for processing data more scientifically. Therefore, we will consider establishing data monitoring module and proposing model performance criteria in the future.

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