2021 International Conference on Computer Technology and Media Convergence Design (CTMCD) | 978-1-6654-4856-7/20/$31.00 ©2021 IEEE | DOI: 10.1109/CTMCD53128.2021.00058

A smart health data acquisition mobile application based on heart rate *and* blood oxygen module

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***Abstract*—In the fast-paced social environment, the public work stress, fast pace of life, increased mental and physical burden. Most people often neglect their mental and physical health while focusing on their physical condition. The purpose of this project is to promote and cultivate public awareness of health management. This project is mainly divided into three parts. Health data synchronization application is used to obtain the physical conditions that cannot be perceived by sensors and provide psychological test questionnaires. The data measurement application is mainly used to receive the user's health data, step number,and location information sent by the hardware, and then carry out step number screening and send the information to the health data synchronization application. The hardware part takes STM32 MCU as the core and drives various sensors(like heart rate and blood oxygen module) to realize the collection of various physiological information. By increasing the frequency of data collection, this project improves the accuracy of information collection and achieves the purpose of rapid detection of user status changes. This project records the user's physical condition and monitors the user's mental health condition, thus realizing the user's health's multi-directional monitoring.**

Keywords-*Android APP; Health data collection; SQLite database;*

I. INTRODUCTION

In recent years, people's attention to their health conditions has given rise to many health-related softwares. At present, this software's mainstream applications include health care, chronic disease prevention, exercise and fitness, online consultation, and peer-to-peer services for people suffering from certain conditions. Early foreign Rollo"] et al. developed a mobile phone application for diabetic patients, which realized helping diabetic patients have a good diet by designating nutritionists to analyze their food pictures. Apple Inc. proposed the Apple Fitness+ program at its 2020 launch event. This software, paired with Apple Watch, realizes the function of synchronizing users' exercise status to display various Apple devices and selecting Fitness programs online.

In recent years, the more mature domestic health applications include Weiyi, Ali Health, Chunyu Doctor (2) , etc. These applications' primary function is online consultation, among which Ali Health also provides expanded services, including medical e-commerce and product traceability. In some academic research, early domestic scholars' research fields are primarily sports and fitness, health management, and disease prevention. They mainly use big data to make further analysis and physical condition prediction based on users' health information. For example, Chen Zhuo's team (3) uses big data to carry out comprehensive monitoring on the intelligent platform. In recent years, the purpose of most research on health applications is to record and display users' basic health information, realize information sharing among devices and provide accurate and intuitive health check-up information to promote further the intelligence and intelligentization of public medical care in China 同.The health data analysis cloud platform designed by Chen Jiaohua [习 is an Android application software for monitoring and analyzing the ECG health of the elderly. This application will take the initiative to contact the elderly's family members after finding abnormal data, which has occupied precious time for the treatment of diseases. Yang Hongmin 's team[6] is dedicated to designing portable medical testing instruments and the data acquisition and collation system shared with them. By analogy, most current health applications are supported by big data and cloud storage and collect health information through smart wearable devices. Besides, applications take the Android operating system as the carrier for the software's flexibility and portability.

For most health application failed to provide the psychological status of monitoring and steps in the recording function failed to screen out commuter steps, produced by the team hope that the development of a from two aspects of physical and mental conditions for health monitoring system, and the systems that can perform more efficient steps motion detection recording function. It is hoped that the system will encourage people to exercise consciously to reduce the effects of negative emotions and to pay more attention to their own psychological conditions.

II. SOFT WARE DESIGN

A. System O^vervie^w

This project is mainly composed of three parts: the hardware part, the mobile terminal data receiving software, and the user client software used to record and synchronize data. The hardware part's main control chip is STM32 single-chip microcomputer, which drives various sensors by using a singlechip microcomputer to obtain and collect the user's current state information, such as step number, position, heart rate, blood oxygen, blood sugar, and blood pressure. In this project, the user's position information and step number information are used to effectively eliminate the step number problem under the condition of non-active movement through the wave peak detection algorithm, and the actual walking step number of the user can be well detected. Also, the system combines the

This work was supported jointly by the National Natural Science Foundation of China (61862018); Guangxi Natural Science Foundation Project(2018GXNSFAA138084); Innovative Training Program for College Students (201910595088).

978-1-6654-4856-7/21/$31.00 ©2021 IEEE
DOI 10.1109/CTMCD53128.2021.00058

collected sports information, health information, and the user's basic health status and psychological evaluation results stored in the server for deep learning analysis, generating analysis reports to help users better grasp their own sports status, basic physical and mental state and trend.

B. The Implementation of Motio~n Screening in Measurement Software

First of all, active movement is defined as the number of moving steps generated in the normal walking state, while passive movement refers to when the positioning information is not consistent with the change of step number in the vehicle or indoors.

Exercise screening first requires calculating the number of steps taken in a certain period. The fluctuation range measured by the acceleration sensor during the movement can be used to judge whether the current movement occurs or not. When a fluctuation is measured, it isjudged that a step has been moved. The core of the step counting algorithm is the wave peak detection method. The realization process is divided into two parts: wave peak detection and step number detection.

The wave crest detection algorithm's principle is to determine whether the movement distance is generated under active movement by comparing the total step size with the total motion displacement distance measured in different periods. The formula for calculating the total step size is a model trained by the least square recursive algorithm. The actual displacement distance is calculated by recording the longitude and latitude values of the user's starting position and terminal position within a certain period. If the absolute difference between the total step length and the actual displacement distance is within the specified range, the distance can be determined to be the distance generated by normal walking or running exercise.

Indoor positioning uses sensors combined with GPS position information to achieve accurate positioning of indoor position.

Combined with the above points, if all the motion states meet the requirements of the possibility of active motion, then the final program can determine that the current state is the state of active motion, and if one of them does not meet the requirements, it is the state of passive motion. Finally, the statistical data are processed according to the state mode determined at this time. Passive mode data are excluded from the final movement data.

C. Design of Mobile Client

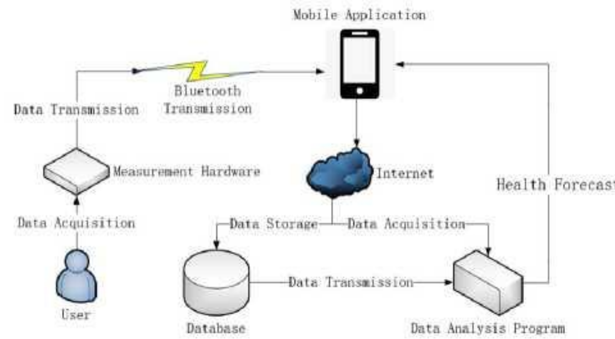
The mobile phone client is developed using Android Studio, which is mainly divided into six modules: registration module, login module, health self-test module, trend analysis module, news and information module, and setting module.

The registration and login module encrypts the user's password using MD5 algorithm to consider the account's security. After the client's startup, it needs to input an e-mail or mobile phone number, enter the password, and click the login button to log in. If it is the first time to use it, click the registration button and then click the login button to return to the login interface for login. To improve the system's friendliness, if the account or password entered is empty or the password is wrong, the corresponding program is written to prompt the error message.

The upper part of the software's main interface is the inner display area, and the lower part is the function navigation headline. ViewPager and Fragment components are used to realize the function of switching between pages by clicking the corresponding ICONS.

After the user logs in for the first time, the setting module will automatically jump to the page of setting basic personal information. After recording the user's specific information, it will jump to the health self-testing module's daily self-testing interface. If there is any need to change the basic information interface after the first set, click Settings to switch to the setting interface and click Personal Information to enter the modification interface. When the user clicks the exit button, the current account information will be logged off, and the login interface will be reopened.

The health self-test module is mainly used to fill in relevant data and collect some data that hardware sensors cannot collect. This module is divided into daily self-test and weekly self-test. Users can switch according to their own needs. The daily module includes the Mood Self-assessment Form (mandatory) and the Body Data Change Form (optional). The weekly module content is PHQ-2 screening scale〔刃.



Figurel. System architecture diagram

The health self-test module is used to monitor the user's mental health status. At present, it only carries out selfdetection and prevention for depression.

The trend analysis module uses the WebView component as the container and displays the strip-like statistics HTML page with the number of steps to the specified location through the loadURL 0 method. The page uses the open-source visualization library Echarts to render the charts. Considering the time it takes to load HTML and JS files from the server, package these files with the client to speed up the chart load.

Information pages also use WebView components as page containers. The link page is the home page of the mobile terminal of the People's Health Network.The setJavascriptenabled 0 method is called and set to true to enable the system to call JavaScript correctly to ensure that the page loads correctly.

III. STYLING HARDWARE DESIGN

In this study, STM32 microcontroller was used as the central processing chip, and a variety of sensors were used to measure and calculate human blood glucose, blood pressure, heart rate, blood oxygen, walking steps, and other data, and the measured data were transmitted to the mobile APP through Bluetooth module.

The module used for detecting heart rate and blood oxygen is the MAX30201 module. When detecting heart rate and blood oxygen value, the pulse oxygen saturation and pulse can be estimated only by pressing a finger on the sensor. It is found that red blood cells carrying oxygen can absorb more infrared light (850-1000nm), while red blood cells without oxygen can absorb more red light (600-750nm). Therefore, this module uses the principle of an absorption spectrum of different red blood cells to detect the human body's blood oxygen saturation.

In order to ensure the measurement and processing speed of data, two STM32F103 microcontrollers were used in this study for task allocation and processing, and the two chips were connected through serial ports. Figure 2 and Figure 3 are schematic circuit diagrams.

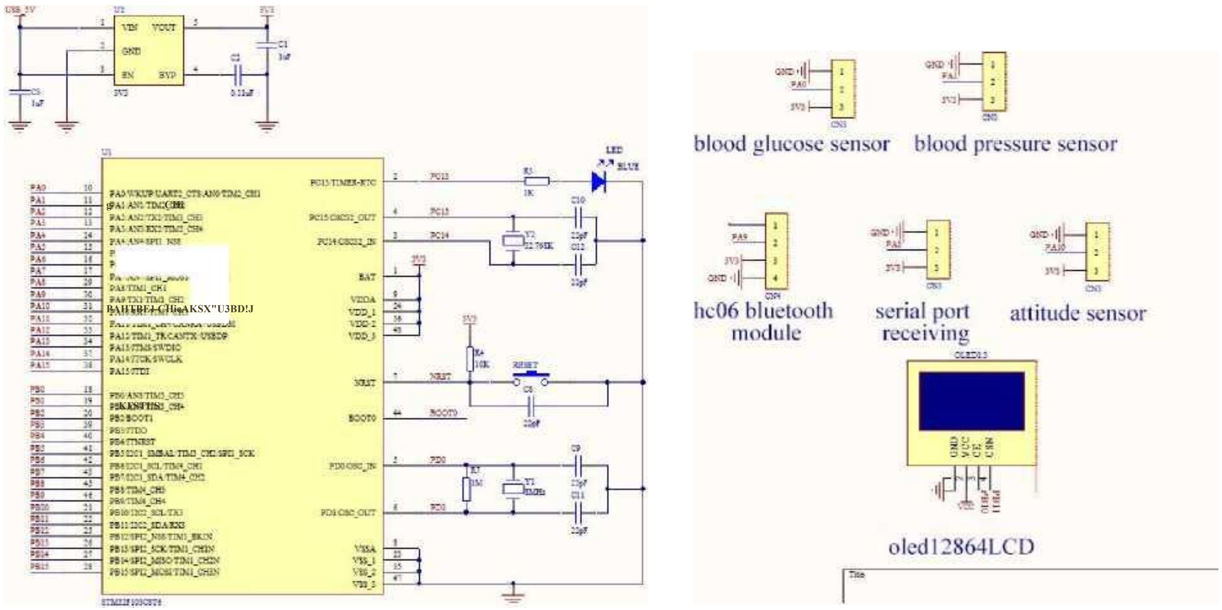


Figure2. Circuit diagram of the main circuit board

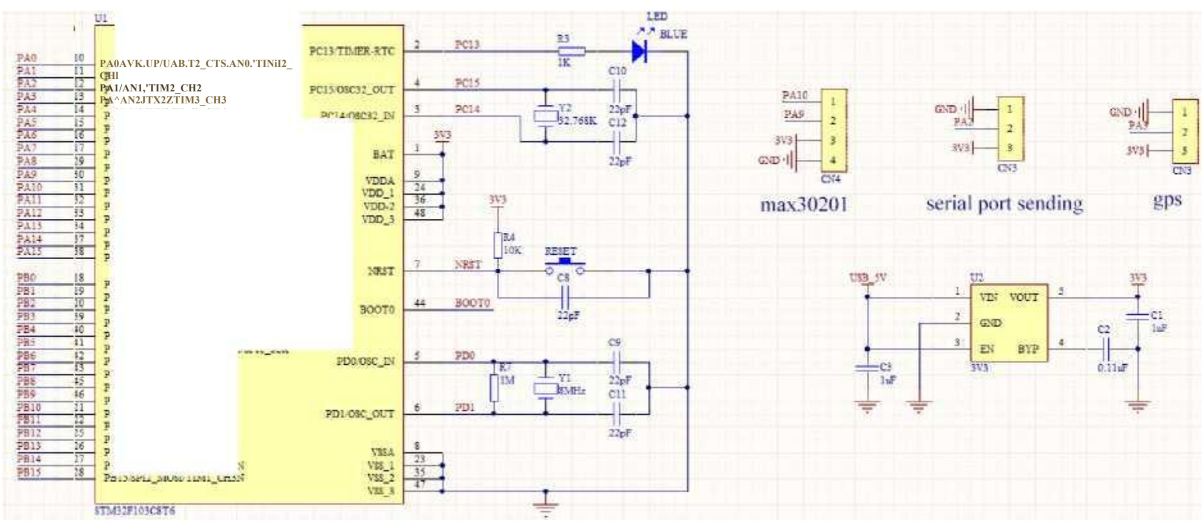


Figure3. Circuit diagram of the auxiliary circuit board

PA5ARiSPn_SCK
PA6ANSSPn3tEOTIM3_CHI
PATA>TSPI1_MC61.T11E_CH1

PA5/AN5/SPU_SCK
PAfrAN6.SPII_NflSOTIM3_CHI
PA7., 'AN7/SPH_MOS: 1/TIM3_CH2
PA8/I1M1_CH1
PA9miiMI_CH2
PA10,RXITD.ir.CH3
PAI irmil_CH4.'CANRX//U®DM
PA12/TIM1_TOCANT5&/USBDP
PA13/JTMS.^VDIO

PAU/JTCK/SWCLK
PA15/TTDI
PB0/AN8,<TIM3_CH3
PBl/AN9.'TDiB_CH4
PBiBOOTl
PB3/JTOO
PB4ZJTNRST
PBj.I2Cl_SMBAL.CnM3_CH2'SPIl_SCK:
PB6,I2Cl_SCLCnM4_CHi
PB7/I2C1_SDA/TIM4_CH2
PBS,TIM4_CH3
PB9/HM4_CH4
PB10J2C2_SCL/rX3
PBU/I2C2_SDA/RX3
PB12, SM2_NSS/nMl_BKIN
PB13,SPI2_SCK/nMl_CmN
PB14.SPI2_MISO.'TIM1_CH2N
PB15.SPI2 MOSITTM1 CH3N

The main circuit board is mainly responsible for measuring blood glucose, blood pressurea, posture data, and data integration and transmission, while the secondary circuit board is mainly responsible for positioning and blood oxygen detection. When the detection data is collected, the main circuit board will send the data to the mobile APP through the Bluetooth module for display and recording. This study's hardware programming language is C language, and the development platform is the Keil platform.

IV. TEST

After the design of each project's system was completed, the mobile terminal's data receiving software was successfully connected with the hardware through Bluetooth. The finished hardware is shown in Figure 4.

The data receiving software interface is divided into two main areas, as shown in Figure 5. The upper part of the interface is used for hardware Bluetooth connection and the display of steps, heart rate, blood sugar, blood pressure, height, longitude, latitude, and other data. Step count and heart rate are updated at one-minute intervals. The lower half of the interface is used to display the data sets received from the hardware every second. After the Bluetooth connection between the data receiving software and the hardware, when the user presses the heart rate sensor on the hardware for a long time, the display light will start flashing to prompt the measurement, indicating that the system is working normally.

Next, test the client. Here, we use the test registration function as an example to test the client's response results by entering all possible scenarios. The results show that when users enter various types of information that do not match, such as an empty account and password, the system will be prompted accordingly. For example, when you try to register an existing account during a test, the software will tell you that the relevant account has been registered and the registration failed. If the user sets a password that is too simple, such as entering 123456, it will be shown that the password is too weak as shown in Figure 6. Indicates that the software registration is functioning properly.

Finally, an attempt is made to submit the user's status data, and the test results are shown in the Figure 7. As shown from the figure, the user's status data was successfully uploaded to the cloud.

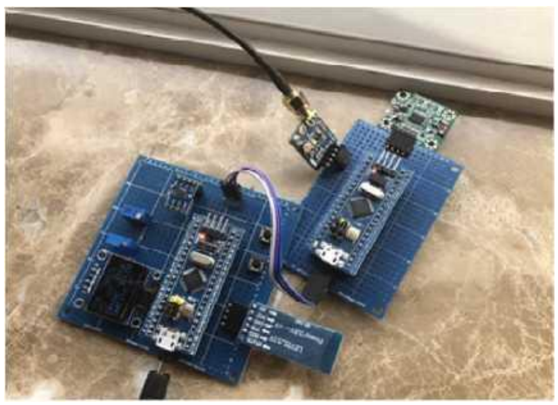


Figure4. The hardware system

successful connection

Steps: 010 per minute

Heart rate: 088 per minute

Blood sugar: 081 mg/dl

Blood pressure' 077 mmHg

Height: 163cm

Longitude: 025.32C

Latitude: 110.41C

Health assessment

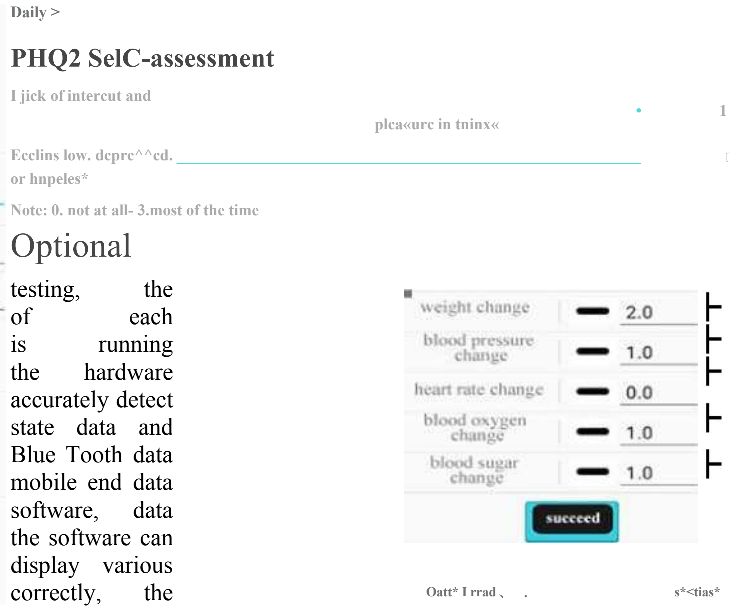
Query records **Delete records**

Steps	Heart rate	Longitude	Latitude
010	088	025.32	110.41
009	073	025.32	110.41
010	077	025,32	110.41
010	076	025.32	110.41
010	082	025.32	110.41
000	086	025.32	110.41
002	083	025.32	110.41
004	071	02532	110.41
005	082	025.32	110.41
009	077	025.32	110.41
012	070	025.32	110.41
002	071	025.32	110.41
007	069	025.32	110.41
010	107	025.32	110.41
010	081	025.32	110.41

Figure5. Data measurement and collection

Figure6. Test of the login interface

After testing, the objective of each subsystem is running normally, the hardware part can accurately detect the various state data and user can via Blue Tooth data transfer to mobile end data receiving software, data receiving the software can receive and display various state data correctly, the client software is running well, upload the state of the user data correctly. This project can accurately screen the number of steps and realize the number of steps excluding non-exercise and record and read the basic physical conditions and psychological evaluation data submitted by users.



Figure?. The test of submitting user data

V. Conclusion

This project realizes the acquisition of user status information in the hardware part, the development of data receiving, and data synchronization analysis software in the mobile terminal part. The program not only records the user's physical signs, but also provides a self-assessment of depression. Besides, this project also has the function of screening the number of exercise steps, which can intelligently exclude the number of exercise steps generated by the ofUce and commuting tools. Only the number of exercise steps generated by the user every day is recorded and displayed in the client in a bar chart. Besides, this project has also realized the integration of sports and fitness with psychological evaluation and physiological signal monitoring so that the public can accurately monitor their physiological and mental health conditions while exercising.

Through the test, each system of this project runs well, the hardware part can accurately detect the user's status information, the data receiving the software can receive the data from the hardware in real-time, and the client software also runs well.

In the future, with further development and research, we can try to make the hardware into the style of sports bracelets to improve the portability of the device. At the same time, we can enrich the self-test table of the health self-test module and enrich the contents of the database to conduct self-test and prevent more mental diseases.

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