A Human Health System Based on Raspberry Pi and Deep Learning Models

Xingyu Zhao[1,a], Wangxin Wu[2,b], Zheng Jian[1,*]

[1] School of Computer and Information Engineering, Institute for Artificial Intelligence,

Shanghai Polytechnic University, Shanghai 202308, China.

[a] 1754232764@qq.com, [b] wwxwwx19990822@163.com, * zhengjian@sspu.edu.cn

Abstract. This design uses Raspberry Pi to control the sensors to measure physiological indicators, avoiding the measurement results to be affected by subjective factors. This system design chooses to use a simple sensor, the overall system in the hardware design and production is simple and easy to implement, with low cost, low power consumption, easy to operate and other advantages. This Raspberry Pi based human health monitoring system can basically realise the human body temperature, heart rate and blood oxygen saturation monitoring, and when the above health data exceeds the human body health standard value, it will carry on the alarm reminder. At the same time, the health information can be transmitted to the computer of relatives and family doctors through the network data, so that when the health data is abnormal, you can get the help of relatives and family doctors. Deep learning algorithms can also be used to predict human health trends and identify potential health problems.

Keywords: Raspberry Pi; deep learning; upscaling; human health.

1. Introduction

As the pace of life continues to accelerate, the pressure of people in their daily lives and work continues to increase, resulting in people being in a state of sub-health. However, along with the continuous improvement of the level of science and technology, more and more intelligent health products have appeared in the current science and technology market. In the situation of increasing health awareness, from the perspective of the children or other relatives of the elderly living alone, the elderly living alone often forget to check their health, and the relatives are not easy to get hold of the physical condition of the elderly living alone, which leads to worry.

Through my background investigation of human health monitoring systems on the current market, I have found that there are two main problems with human health monitoring systems on the current market: firstly, the monitoring technology is not sufficiently centralised, and it is necessary to monitor human health through a variety of different devices, and secondly, the centralised devices are expensive, and they cannot get the effect of widespread popularity and use[1]. These factors more or less affect the human health monitoring products of the times, but also limits the iteration of such technology products.

The human health monitoring system designed in this project enables the elderly to measure their heart rate, blood oxygen and body temperature every day, and their relatives can know the data of heart rate, blood oxygen and body temperature at once, and when the relatives see that the data is normal, they are more at ease, and when they see that the data is abnormal, they will contact the elderly who live alone, or take the elderly who live alone to the doctor directly. If an elderly person forgets to take the measurement, the relative will not receive the data on the same day, and then the relative can remind the elderly person. Sometimes an elderly person living alone may not be able to take a measurement because he or she is experiencing difficulties, and this prevents the elderly person from being unable to seek help for a long time before he or she is found to be in trouble, thus avoiding family members from worrying about him or her[2]. At the same time, the user's data from recent days can be used to predict upcoming risks before they occur.

2. Hardware Module

2.1 Raspberry Pi Development Board

Figure 1 shows the RaspberryPi 4B used in the design of this project, and its specific functional parameters are as follows: 64-bit/quad-core ARM Cortex-A72, 1.5GHz CPU; VideoCore VI (GPU) 500MHz; 2G LPDDR4 RAM;Gigabit Ethernet, dual-band WIFI 802.11ac, Bluetooth 5.0, low-power Bluetooth; 3.5mm Audio/AV jacks; 2 micro HDMI 2.0; 2 USB 2.0 and 2 USB 3.0 ports, Camera Serial Interface (CSI), Display Serial Interface (DSI); storage microSD, supports up to 512GB; 40-pin GPIO pinout, Power over Ethernet (additional hardware); USB Type-C (5V 3A) power supply[3].

2.2 Sensor Modules

Sensor is a detection device, can feel the prescribed monitored quantity, can be converted into a signal according to a certain protocol or law of the device, the conversion components and sensitive components is an important part of the sensor. Specifically, the sensor is able to sense and detect certain information of the object to be measured, and according to certain rules will be converted to the corresponding output signal components or devices[4].

2.2.1 Infrared Temperature Sensor

The infrared temperature sensor module uses model GY-906, which is inexpensive and easy to integrate, with a supply voltage of 3-5V (internal low-dropout regulator), supports an I2C interface with a 10K pull-up resistor, and has a temperature range of -40 to 125 degrees Celsius for the sensor, and a temperature range of -70 to 380 degrees Celsius for the object, with a measurement error of about 0.5 degrees Celsius[5]. The infrared temperature sensor is shown below.

2.2.2 Heart Rate Oximetry Sensor

The MAX30102 heart rate and blood oxygen sensor module is used in this project to monitor the heart rate and blood oxygen data, which can transmit the collected values to the Raspberry Pi for heart rate and blood oxygen calculations through the standard I2C-compatible communication interface[6].

2.3 Overall System Design

As shown in Figs.1 and 2, the main control platform of the human health monitoring system is Raspberry Pi 4B, which is connected to the infrared temperature sensor module and the heart rate and blood oxygen sensor module through the I2C serial port, and completes the collection, uploading, backing up, and calculation of the human health monitoring data through the wireless LAN communication technology with the software on the PC. First of all, we need to connect each sensor module with Raspberry Pi through the serial port to ensure that the power supply of each module and the serial communication is normal, and then connect the Raspberry Pi to the power supply to make the Raspberry Pi power on and run, the Raspberry Pi power on will automatically establish a wireless LAN connection with the router, then boot the computer to run and make the computer and the Raspberry Pi connect to the same wireless LAN under the router, through the Advanced IP Scanner software searches for the IP address of Raspberry Pi under the current wireless LAN, and then after obtaining the IP address of Raspberry Pi, you can establish a connection with Raspberry Pi and enter the graphical user interface of Raspberry Pi through VNCviewer software of the computer terminal, and then control the Raspberry Pi to turn on the infrared temperature sensor and the heart rate and blood oxygen sensor through the computer terminal, so that the computer terminal can get the body temperature, heart rate and blood oxygen data. In addition, by opening the Navicat 15 for MySQL cloud database software on the computer, the monitoring data can be uploaded to the cloud in real time for backup, and then open the Visual Studio 2013 graphical user interface on the computer, so that the current monitoring data can be displayed in real time through the graphical interface to show the dynamic changes of the fold line, and the graphical user interface can be set up for the normal range of the human body temperature, heart rate and blood oxygen[7]. In the graphical user interface, you can set the normal range of human body temperature, heart rate and blood oxygen, when one of the monitored data exceeds the normal range value, an alarm will appear, and when the data is restored to the normal range value, the alarm will disappear automatically, and you can also view the historical health data by entering the historical data number in the graphical user interface.

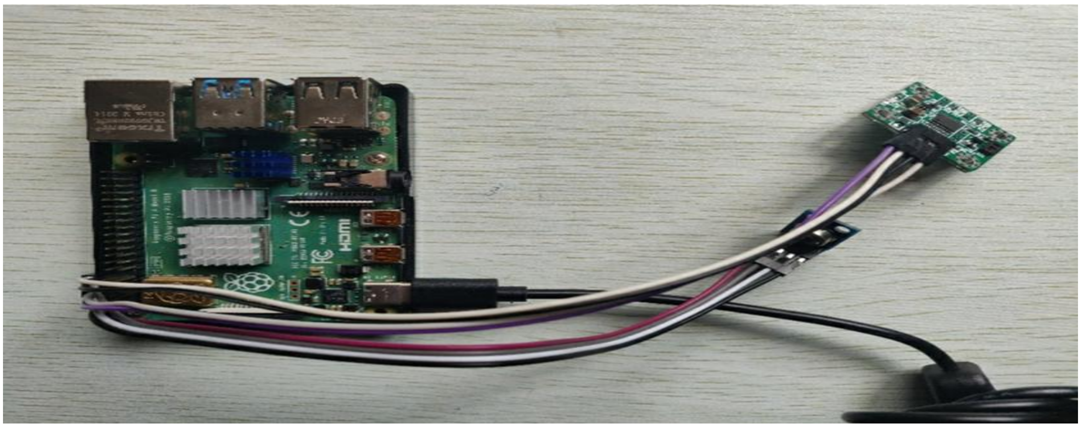

Fig. 1 Overall system design diagram

Fig. 2 Hardware Module Structure Diagram

3. System Software Design

3.1 System graphical interface and cloud database connection

All the detection data from the above mentioned sensors will be transferred to the cloud platform and then uploaded to the mysql database through the cloud platform and connected to the database[8]. The connection interface and database interface are shown below.

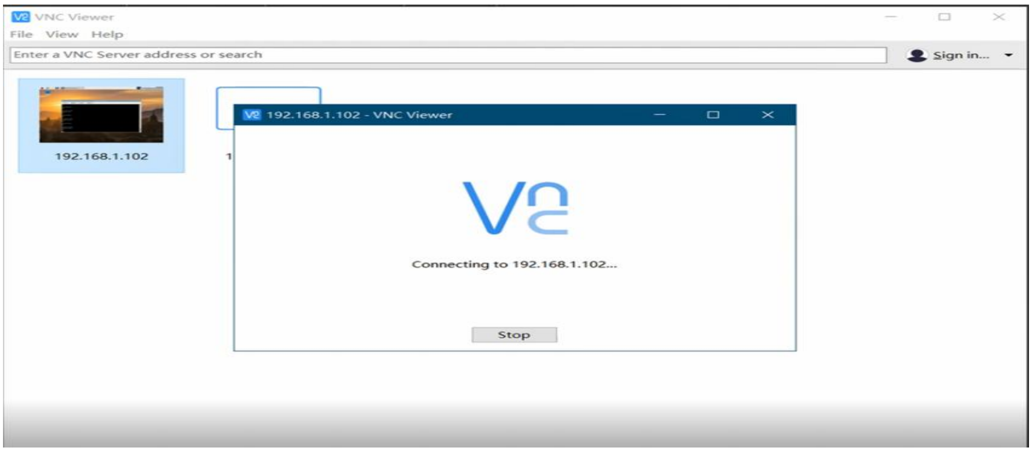

Fig. 3 Raspberry Pi Connection Interface

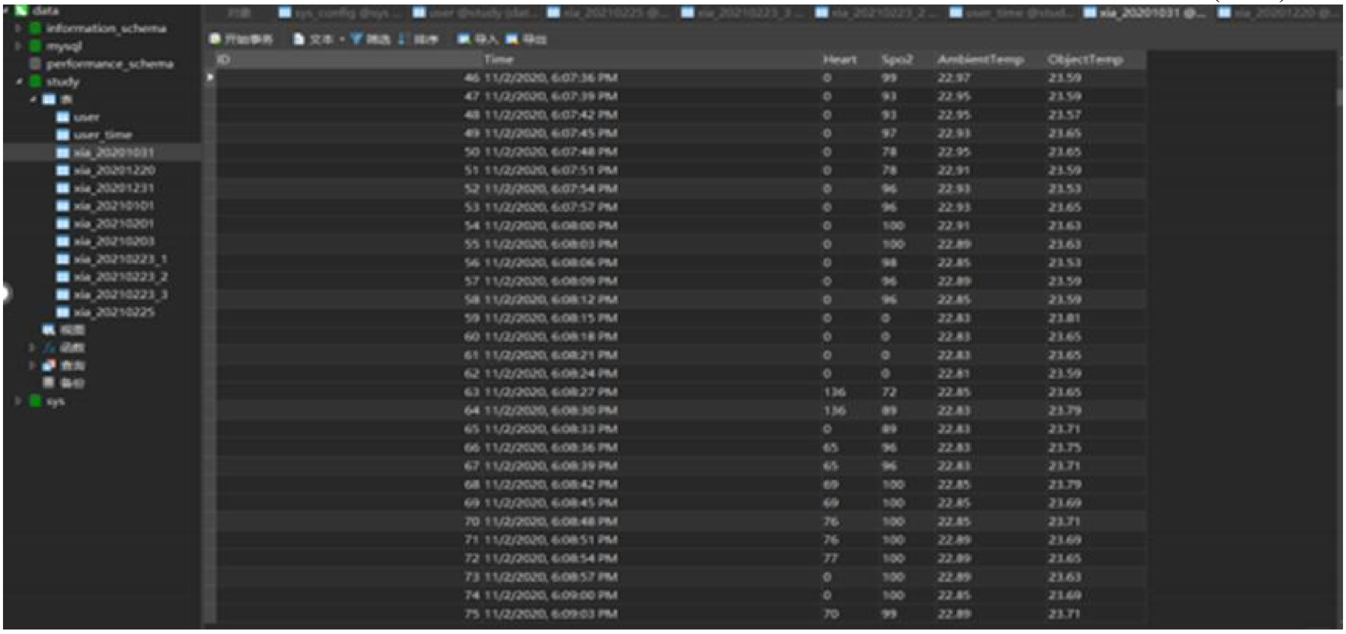

Fig. 4 Database interface

3.2 Upper computer cloud platform

The upper computer is programmed in C#, and the interface is shown below.

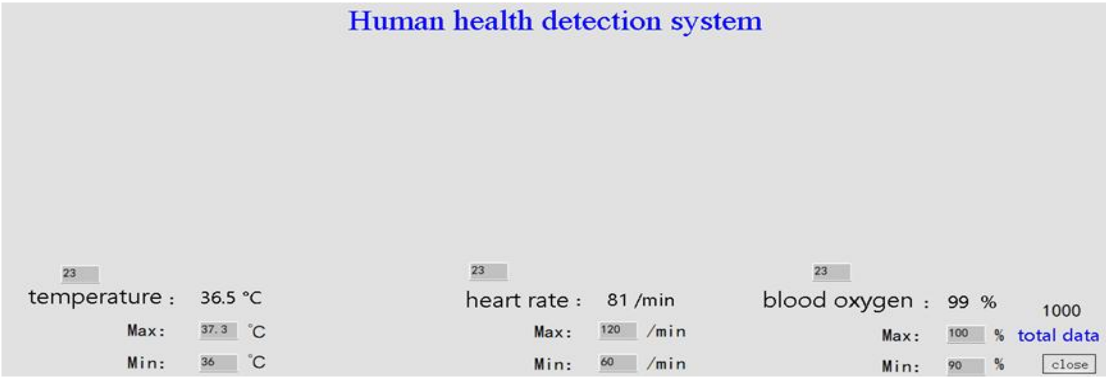

Fig. 5 Host computer interface

4. Model prediction

4.1 CNN and CNNLSTM

The main idea of the CNN-LSTM model is to use CNN to extract the spatial features of the input sequences and use these feature sequences as inputs to the LSTM to model and process the sequence data[9]. This combination is able to take into account both the temporal dependencies and the spatial structure of the sequence data, allowing the model to better capture the long-term dependencies and contextual information in the sequence.

4.2 Transform

The Transformer model is able to model elements in an input sequence without relying on positional information by using a self-attention mechanism. The Transformer model consists of an encoder and a decoder, with each part consisting of multiple layers stacked on top of each other[10].

The advantages of the Transformer model are its ability to handle long dependencies and contextual information, and its ability to parallelise computation to speed up training and inference. It has been widely used in the fields of machine translation, text generation, language understanding and question-answer systems.

4.3 Prediction structure and comparative analysis

The prediction results using the CNNLSTM model are shown in the table1.

Table 1. Data predicted by CNNLSTM

Temp	Bmp	SaO2
36.20436	82.510056	97.73957
35.955082	81.09144	98.6604
36.077908	85.76118	98.61194
36.54536	82.14177	98.5961
36.49496	81.30475	98.00615
36.790554	82.082245	98.56027
36.874622	83.52771	98.48802

The prediction results using the Transform model are shown in the table2.

Table 2. Data predicted by Transform

Temp	Bmp	SaO2
36.67526	76.626	99.8852
36.457726	80.53908	98.0788
36.293125	87.41669	94.20783
34.822704	76.12817	95.6892
35.765396	75.74435	97.11307
35.963604	79.447296	97.07833
36.13933	80.62968	98.10632

We use the loss function to measure the difference or error between the predicted results and the actual results. When training a model, we usually use the loss function to measure the error between the two. Regarding the model prediction and the actual result, we adjust the model parameters to minimise this error. By comparison, we find that the CNNLSTM model predicts significantly better than the transform and CNN models. The comparison graph is shown below.

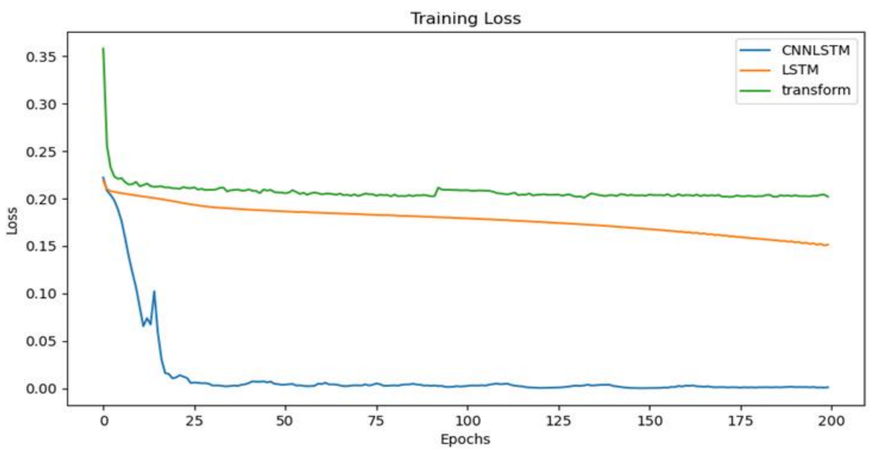

Fig. 6 Comparison Chart

5. Summary

This design uses the Raspberry Pi platform to control the sensor module to monitor the body health indicators, such an operation can replace the traditional health monitoring instrument measurement process needs to be manually operated, and can avoid the health monitoring data by other subjective factors. This Raspberry Pi based human health monitoring system can basically realise the human body temperature, heart rate and blood oxygen saturation monitoring, and when the above health data exceeds the human body health standard value, it will carry on the alarm reminder, in addition, it can also predict the future development trend of the human body health according to the past health data, at the same time, it can transmit the health information through the network data to the loved ones and the family doctor's computer terminal, and when the health data is abnormal, it can be obtained by the loved ones and the family doctor's computer. When the health data is abnormal, you can get help from your relatives and family doctor.

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