Research Article

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Nonlinear analysis and processing of software development data under Internet of things monitoring system

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Abstract: The most important and core technology of the Internet of things (IoT) is still the internet, and it also includes many other technical fields and is applied to many fields. The various processes of IoT data are the guarantee that the IoT can meet the management and management requirements in a certain application field, so that each application field can better meet the requirements of people's lives. In order to study the nonlinear analysis and processing of software development data under the IoT monitoring system, this work uses QT software and socket programming to build the detection, control, and transmission module of the system, and uses multiple processes to classify and process the data. The user interface technology is used to display the data in real time. The system can control the type of transmitted data through interface operation. The classified transmission of data is realized, and the transmission speed is guaranteed to be about 50 MB/s. The experimental results show that after the functional design of each module is completed, the whole system is finally tested to determine whether the system can meet the requirements of data transmission, control, and processing. Since these data are simulated data, video playback is used to simulate the occurrence of a real accident. When an abnormal situation occurs, the whole system starts to work. If an accident occurs, a signal is sent after the accident. The system not only ensures the intellectualization of control, but also ensures the rapidity of data transmission.

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1 Introduction

The development of the internet has brought earth shaking changes to our way of life. Internet is closely connected with people's life and production because of its openness and information interaction. Earlier, people only sent e-mail and performed website download through the Internet. Later, by integrating the development of other technical fields, internet technology has played a great role in e-commerce, communication, medical assistance, course learning, online finance, and other fields, and people's life has become more convenient [1]. With the development of the internet, traditional industries have gradually integrated into internet technology, so there have been new development achievements, such as the common UnionPay system. These technical achievements continue to go deep into people's lives. Since the Internet of things (IoT) was proposed, various fields have been given high attention, and have made great progress in more than 10 years of development. IoT technology is used in many fields. For example, in warehouse management, there are many quantities and types of goods in the warehouse, and the goods also have certain environmental requirements for the warehouse. Managers hope to have a set of management system to help them monitor all aspects for management. In this way, we can design a monitoring and management system to collect the data of the warehouse environment through sensors, cameras, and other hardware equipment. The goods are counted and classified by bar code technology, so that the management personnel only needs to monitor the warehouse environment in real time through the computer screen, and can count the incoming and outgoing goods by scanning the code [2,3]. In this way, the system can easily manage the warehouse and greatly reduce the working time and difficulty of staff. If some image processing technologies are added to the system, such as face recognition technology, it can also intelligently manage the incoming and outgoing personnel [4]. The application and development of the IoT in various application fields makes our lives more and more intelligent. For example, online shopping, which is commonly used by everyone, allows consumers to easily search for the items they want, and then consumers can comprehensively compare the same items in different stores, both the seller and the buyer save a lot of time, and at the same time bring more benefits to the seller. Another example is "telemedicine." When monitoring a patient, sensors can be used to collect and detect the basic characteristic data of the human body. When the data is abnormal, the doctor will be intimated, so that the doctor can know the patient's disease in time. Since each patient's condition is different, the doctor needs to obtain the required data through his control, so the types of data collected are different. These data include one-dimensional data such as human feature data, and data such as human medical pictures. These data are classified, transmitted, and processed before being displayed to the doctor, which can help the doctor to have a deep understanding of the patient's condition and be of great help in finding the most suitable treatment method in time. When the IoT system is in use, various data will be obtained through hardware devices such as sensors and cameras, so the processing of these data is extremely important.

The most important and core technology of the IoT is still the Internet, and it also includes many other technical fields and is applied to many fields. In order to promote the stable development of IoT technology and explain its architecture, key technologies, and application characteristics, it is necessary to establish a scientific IoT architecture. The most commonly used architecture is a three-layer architecture, namely, the perception layer, the network layer, and the application layer. The perception layer is mainly responsible for collecting data; the transport layer is mainly responsible for transmitting data; and the application layer is mainly for customer needs. The system model is shown in Figure 1.

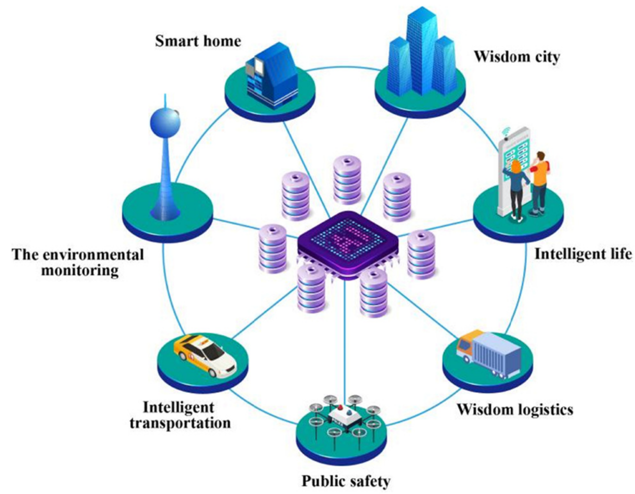

Figure 1: IoT system model.

The main job of the network layer is to process and transmit the data collected by various hardware devices, which realizes the data interaction between the perception layer and the application layer. The perception layer collects data. Without the support of a huge network system, the data cannot be transmitted to the application layer, and the role of the IoT cannot be reflected in the application field. As shown in Figure 1, the transport layer generally uses wireless networks, the Internet, and wired networks for data transfer. When the IoT system transmits the collected data, the network layer needs to transmit the data safely, completely, and quickly, which mainly solves the problem of long-distance transmission of data at the perception layer; and the network layer needs to be able to withstand the huge amount of data to achieve high-quality data interaction. Tmall is a large online shopping platform in China. Therefore, a good network layer in the system is needed to meet the data needs of consumers. There are many key technologies used in the network layer, such as Wi-Fi technology, TCP/IP protocol technology, *etc*. These technologies mainly meet the requirements for data transmission, to achieve the purpose of fast, safe, and no data loss. Due to the above characteristics of IoT data, the processing of IoT data is very necessary, and the processed data can reflect the functions of IoT in the application field. Because the data collected by hardware devices such as sensors and cameras may not directly meet the requirements of managers, it is necessary to process the data so that the data can intuitively reflect the role of the data.

On the basis of the current research, in order to study the nonlinear analysis and processing of software development data under the IoT monitoring system, this work uses QT software and socket programming to construct the detection, control, and transmission modules of the system, and classify the data through multiple processes, and processing using user interface technology to display data in real time. The system controls the transmission data type through interface operation, realizes data classification transmission, and ensures the transmission speed is about 50 MB/s.

2 Literature review

The most important and core technology of the IoT is still the Internet, which also includes many other technical fields and is applied to many fields. In order to promote the stable development of IoT technology and explain its architecture, key technologies, and application characteristics, it is necessary to establish a scientific IoT architecture [5,6].

Muñoz *et al.* decomposed the IoT application system into equipment, gateway, communication link, protocol, and terminal system, and analyzed the reliability evaluation of the system [7]. Lindsjorn *et al.* creatively put forward the definition of the reliability of the IoT system from the perspective of the system, developed the reliability evaluation system of the IoT, and simulated and evaluated the reliability of the IoT system of a bureau in Beijing [8]. Sarker *et al.* pointed out that the reliability research related to the IoT system mainly focuses on RFID and wireless sensor networks. With the development of the Internet of Things from theory to reality, Muñoz and others decomposed the IoT application system into equipment, gateway, communication link, protocol, and terminal system, and analyzed the reliability evaluation of the system. Sarker and others pointed out that the reliability research related to the IoT system mainly focuses on RFID and wireless sensor networks. With the realization of the IoT from theory to practical application, ensuring the high reliability of the IoT system has become the key of system design. Combined with the service congestion probability, the communication reliability under interference is studied. From the aspect of node mobility in the IoT, the reliability of the network is studied [9]. Aizaz *et al.* pointed out that at present, most studies are isolated, and gave the meaning of the reliability of the IoT system from the system level. Based on the packet loss in link layer, retransmission in transmission layer, problems in application layer, and observability of use, this work puts forward the mechanism and strategy to improve the reliability of IoT. The literature points out that the reliability of the IoT system is considered from the aspects of system architecture, deployment, transport layer, sensor gateway, and mobile network support [10]. Shi and Zhao proposed an IoT architecture based on service computing. Each device in the system acts as a router and can calculate, communicate, and forward data to other devices. The reliability of the program and the reliability of heterogeneous subsystems are instantiated and verified by the fire alarm system [11]. Hiranrat proposed to evaluate the cold backup and active redundancy mechanism of a single component and system based on Markov model. The switching device switches with a certain probability to evaluate the reliability of components and systems under failure events, which laid a foundation for the evaluation of the IoT. He proposed to solve the problem of building a spanning tree in the reliable data collection of the IoT based on ant colony algorithm, which can not only improve the reliability but also reduce the energy consumption [12]. Silveira *et al.* proposed to build the reliability and availability indicators of the IoT based on the gamma probability density function model [13]. Scotti and Dunand proposed a comprehensive evaluation model of the reliability of the IoT by using the reliability system theory and AHP method. The main idea is to assign corresponding values to various indicators and evaluate the importance of indicators in the reliability evaluation process of the IoT according to certain standards, calculate the final system reliability value according to the selected quantitative analysis method, and realize the quantification of the whole process and results [14]. Valerio *et al.* proposed a mobile ad hoc network reliability evaluator based on node mobility for the reliability of the sensing layer responsible for data acquisition and device control in IoT applications [15,16].

3 Research methods

The data analysis and processing system described in this article is applied in the telemedicine of smart city. It mainly processes the data generated in telemedicine, such as data transmission, control, curve display, and three-dimensional reconstruction. The description of the system and the complete construction of each module of the system are provided in the following subsections.

3.1 Main composition and structure of the system

The data analysis and processing system described in this article are applied in the telemedicine of smart city. It mainly processes the data generated in telemedicine, such as data transmission, control, curve display, and three-dimensional reconstruction. In a smart city, people are the main service objects, and people's health and safety are very critical. The telemedicine system can monitor people's physical condition all the time, so that patients can get the most timely and effective treatment when they get sick. Usually, the human body is constantly moving, the position of the human body is uncertain, and the situation of each patient is not fixed. Therefore, when monitoring the human body, it often only monitors the most basic life characteristic data of the human body, while for different conditions, it will collect different data according to the suggestions of the doctors. Therefore, this system needs to meet the requirements of this intelligent control. At the same time, when monitoring the human body, the collected data are diverse, including characteristic data monitored at any time and other data collected according to the requirements of the doctors. Therefore, these data need to be classified and transmitted in both directions [17,18]. After obtaining the data, in order to let the doctors directly understand the condition, the processing of these data is also very important. The system is composed of detection module, control module, transmission module, processing module, and front-end display module.

3.2 Framework design of detection module

The main function of the detection module is to check the collected human body characteristic data and give an alarm when the data are abnormal. For example, if the observed and detected data are human blood pressure data, the cause of the abnormality can be displayed when the blood pressure data are abnormal. In the design, first, a label part is placed on the interface to display the alarm text, and the LCD part is placed to display the value. The value displayed by the LCD part is the value of blood pressure, and the following label part displays the prompt of hypertension or hypotension.

Hypotension: label_7-> setText("Warning:Hypopiesis!"),
Hypertension: label_7-> setText("Warning:Hypertension!"),

The label part will display the prompt in parentheses, respectively, and set the displayed font to red by using set color(Q Palette:Window Text,Qt:red). The purpose of the main interface is to define an exception, and a warning light will appear on the main interface at the same time. Use the signal and slot to connect the accident signal and the accident function to complete the warning light function. The signal and slot are connected as follows: connect (&vide, SIGNAL (accident()),this,SLOT(accident Hapend())); Where accident () is the signal sent by the exception.

3.3 Design of data processing and display module

There are two kinds of data in the system. One is one-dimensional data, which include ECG data, blood pressure data, and body temperature data, while the other is image data, mainly medical data. For one-dimensional data, they need to be displayed in real time at the front end. For medical image data, they need to be displayed on the interface after processing.

3.3.1 Nonlinear processing of one-dimensional data

For the real-time display of one-dimensional data, a coordinate system should be established first. The ordinate is the displayed data and the abscissa is the time value. In addition, in order to better observe the value of blood pressure and body temperature, when the curve displays these two data, the value is also displayed in the interface in the form of LCD [19,20]. Use the CustomPlot method library for coordinate design. The color of the horizontal and vertical coordinate label text is black, as follows:

ui-> CustomPlot-> *y* Axis-> set Label Color("black");
ui-> CustomPlot-> *x* Axis-> set Tick Label Color("black");
ui-> CustomPlot-> *y* Axis-> set Tick Label Color("black");

Set the ordinate range and ordinate name of the three coordinate systems as follows:

ECG range: CustomPlot-> *y* Axis-> set Range(-2,2) , CustomPlot-> *y* Axis-> set Label("ECG")

Blood pressure range: CustomPlot2-> *y* Axis-> set Range(50,260), CustomPlot2-> *y* Axis->
Set Label("Blood Presure")

Temperature range: CustomPlot3-> *y* Axis-> set Range (32,45), CustomPlot3-> *y* Axis->
Set Label("Body Temperature")

Set the value of abscissa as time and determine the time display format as follows:

CustomPlot-> *x* Axis-> set Tick Label Type(QCP Axis:It's Data Time);
CustomPlot-> *x* Axis-> set Date Time Format("hh:mm:ss");

3.3.2 Medical data processing

Real time display of 3D data can directly call the method function (MC function) in VTK. Therefore, you need to define a new object before using it, and then read data through the object.

VtkSmartPointer < vtk Marching Cubes > mcubes = vtkSmartPointer < vtk Marching Cubes >:New();//

Call MC class in VTK, create a new instance and use MC method.

mcubes-> Set Input Connection(readin-> Get Output Port());

mcubes-> Set Value(0,140);

Because the data are of DICOM type, a new pointer that can read DICOM image format needs to be created through VTK before reading the data.

VtkSmartPointer < vtkDICOM Image Reader > readin = vtkSmartPointer

< vtkDICOM Image Reader >:New();

Then, use the set directory name() function in the vtkDICOM Image Reader class to obtain the address of the file where the medical image is located. Create new drawing Windows, drawing objects and characters, and new cameras.

VtkSmartPointer < vtk Renderer > renobj = vtkSmartPointer < vtk Renderer >:New();

//Create a new drawing object.

VtkSmartPointer < vtk Render Window > renobj Win = vtkSmartPointer

< vtk Render Window >:New();//Create a new drawing window.

Renobj Win-> Add Renderer(renobj); //Add drawing objects in the drawing window.

VtkSmartPointer < vtk Actor > act = vtkSmartPointer < vtk Actor >:New();//Create a new drawing character.

renobj-> Add Actor(act);

renobj-> Add Actor(Outline Actor);

VtkSmartPointer < vtk Camera > camera = vtkSmartPointer < vtk Camera >:New();//

Create a new camera.

The established character represents the skin of the geometric element, and the attributes of the geometric element, such as color, reflectivity, and light transmission intensity, are set through the skin. After establishing a new camera, its coordinates and direction are set through the world coordinate system.

3.4 Curve drawing

When the system is monitoring, it is generally necessary to directly display the directly collected one-dimensional data on the front-end interface, so that managers can intuitively understand the real-time dynamic changes in the monitored data. When drawing the real-time curve, you can use the timer to set the frequency interval of the display data. Use qpen to set the form of connection curve. Qpen can be used to draw line types and graphic outlines. The curve style is designed by setting parameters, width is the line width, which is 0 by default; style refers to the style of line brush, which is generally divided into solid line and dotted line. In addition, you can also design the style of curve endpoints and the connection mode of curves. Coordinates are the basis of curve drawing. The numerical range of ordinates is required to display the maximum and minimum values, and the abscissa is time, which can well reflect the real-time performance of data. QT uses the set range method to set the maximum and minimum values of coordinates. For example, Y axis -> set range (–1.5,1.5) sets the display range of ordinates to –1.5 to 1.5. An example of real-time curve is shown in Figure 2.

In the example figure, use Q pen to set the colors of the two curves as blue and red, respectively, and Q Brush to set the color between the two lines as Q color (240255200); Set the value range of the ordinate to (–1,1), and the abscissa changes with time.

4 Results analysis

4.1 Realization of detection function

The detection module is mainly used to respond at any time and intimate the managers. Therefore, in case of abnormal data, an accident signal will be sent to trigger the interface alarm.

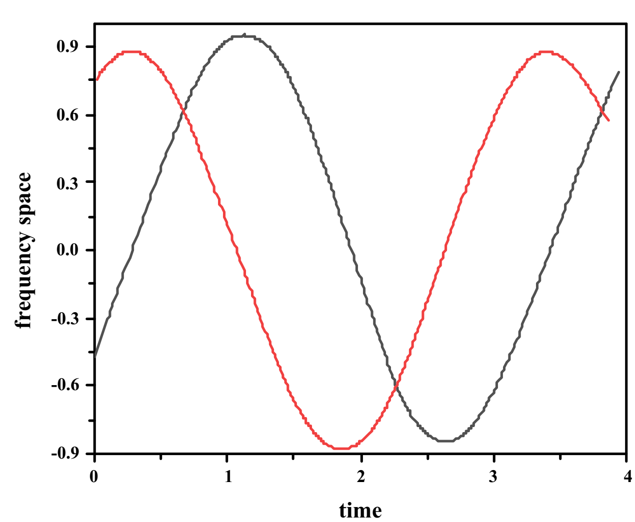

Figure 2: Example of real-time curve.

Connect(&vide,SIGNAL(accident()),this,SLOT (accidentHapend()));

QcwIndicatorLamp*lamp;

lamp = newQcwIndicatorLamp(this);//Establish interface warning lights.

lamp-> move(this-> width()-200,50);//Set the position of the warning light to the upper right corner.

lamp-> setAlarm(false);//Set the initial state of the warning light to false and display green.

voidMainWindow:accidentHapend()

{

lamp-> setAlarm(true);//Change the status of the warning light.

}

The accident () signal is the signal sent after the accident. The signal is connected with the slot function of the warning light. The main function of the slot function is to change the alarm state of the interface to the true state, so that the warning light of the interface will turn red to intimate the management personnel regarding the accident.

4.2 Realization of data receiving function

In response to the difference between the sending end and the receiving end, the sending end sends in different ways, and the receiving end receives in different ways.

4.2.1 Design of one-dimensional data receiving function

While receiving one-dimensional vital characteristics data, at the time of the receiving end listening to the transmission port, when there is a data source, first establish a connection with the host, and then establish a UDPsocket to receive the file for data reception.

QHostAddress*mhost = newQHostAddress();//Get the address of the host and establish a connection with the host.

QUdpSocket*recv;//Create a new socket object to receive.

QByteArraybuf;//Create a datagram to store data

QDataStreamin(&buf,QIODevice:ReadOnly);//Define the data stream for reading datagrams.

in.setVersion(QDataStream:Qt_4_7);

buf.resize(recv-> pendingDatagramSize());//Set the size of the byte array to the size of each packet sent.

recv-> readDatagram(buf.data(),buf.size(),mhost,mport);//Receive data and store the data in buf Datagram.

in > > recvFileName;//Get file name

recvFile = newQFile(recvFileName);//Store the data in the file. The data access the datagram storing the received data in the form of data stream through *in*, and then writes the data to the file.

4.2.2 Design of medical image receiving function

Like data sending, data receiving is also realized by multithreading. Each kind of medical data is stored at different addresses when receiving data, and the external application that starts processing data after receiving data is also different.

The data receiving function is similar to the data sending function. First, the socket at the receiving end needs to be established, and then the data structure required to receive the data needs to be established to obtain the port number and IP address of the received data.

SOCKETsock;

sock = socket(AF_INET,SOCK_DGRAM,0);

sockaddr_inLocalAddr;//Create a new socketaddr data structure.

LocalAddrsin_family = AF_INET;//Generation protocol family for data transmission

LocalAddr.sin_port = htons(dest_port);//Get the data transmission port number.

LocalAddr.sin_addr.s_addr = inet_addr(INADDR_ANY);// To obtain the IP address of the sending end, we use INADDR_ANY, because the IP addresses of the sending end may be different, so we cannot fix the IP address of the sending end. INADDR_ANY indicates the IP address that can listen to all requests for connection. After establishing the data structure required for receiving data, the receiving end needs to monitor the network port at all times, and can receive data immediately when there is data transmission. When receiving data, use the recvfrom method in the sockaddr_in structure.

bind(sock,(sockaddr*)&LocalAddr,sizeof (LocalAddr));

recvfrom(sock,(char*)&file_size,sizeof(int),0,(sockaddr*)&LocalAddr,&

LocalAddr); //Receive data.

4.3 Realization of vital characteristics data display function

When one-dimensional data is received, they need to be displayed on the front-end interface. When the vital sign data are received, the data are identified and classified by the characteristics of different data. The received data are passed to the slot function of data processing in the form of parameters, and the data are in string format when they are passed. The ECG data are taken as an example for description.

After the data are transferred to the processing function, the data need to be transformed and then assigned to the curve for display.

```
connect(&wgd,SIGNAL(bufdata(QString)),this,SLOT
(realtimeDataSlot
(QString)));//When ECG is received, it transmits the data to the processing function.
voidMainWindow:realtimeDataSlot(QStringa)//
Processing function, a is the received data of.
{
doublekey = QDateTime:currentDateTime().toMSecsSinceEpoch()/1000.0;
staticdoublelastPointKey = 0;
if(key-lastPointKey > 0.1)
{
floatvalue;
value = a.toFloat();
ui-> CustomPlot-> graph(1)-> addData(key,value);
ui-> CustomPlot-> graph(3)-> clearData();
ui-> CustomPlot-> graph(3)-> addData(key,value);
ui-> CustomPlot-> graph(1)-> removeDataBefore(key-16);
ui-> CustomPlot-> graph(1)-> rescaleValueAxis(true);
lastPointKey = key;
}
}
```

First, define the current time as the key, and then define another time as the last point key of the previous point. When the time interval is 0.1 s, data will be displayed, and the data within 16 s will be displayed in the coordinate map each time.

4.4 System function test

The system has five modules with different functions. After the functions of each module are designed, finally test the whole system to see whether the system can meet the requirements of data transmission, control, and processing [21,22]. Since the data are analog data, video playback is used to simulate the occurrence of accidents in reality. When the abnormality occurs, the whole system starts to work. If there is an accident, a signal will be sent after the accident. At this time, the warning light on the management interface changes from green to red to remind the management personnel, as shown in Figure 3.

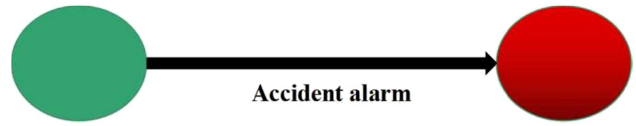

Figure 3: Accident warning light turns red.

After the accident, the sender sends the vital characteristics data directly to the receiver. After corresponding processing, the receiver displays the data in real time at the front end. The curves of ECG, blood pressure, and body temperature are shown in Figures 4–6, respectively.

5 Discussion

There are many influencing factors that need to be considered in the client program design of the smart home security monitoring system of the IoT. In order to ensure the accuracy of the data information sent by the control command, it is necessary to do a good job in data communication and video collection in time, and gradually optimize the client program design. In the design of the data communication system, the communication of different modules is effectively connected with the server side. At this time, the advantages of wireless network technology should be exerted, and the information transmitted from the server side should be transmitted wirelessly. The video data acquisition system is optimized according to the actual situation of the system operation, so as to ensure the integrity of the video data acquisition

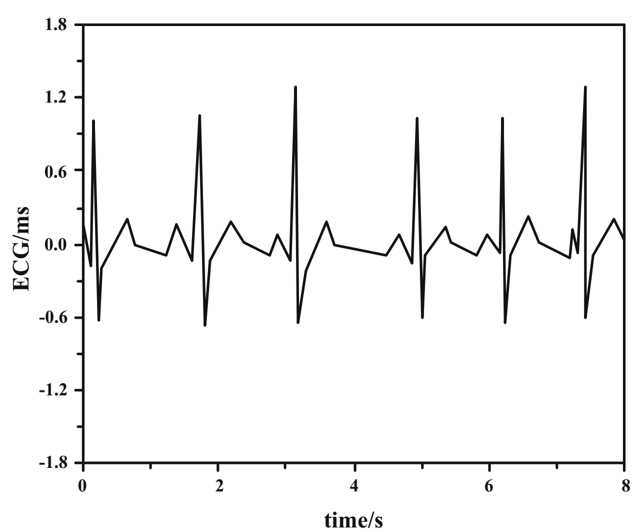

Figure 4: ECG data display.

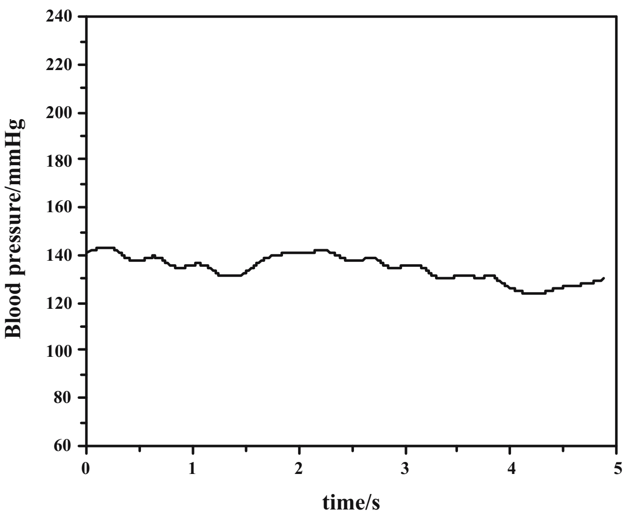

Figure 5: Blood pressure value display.

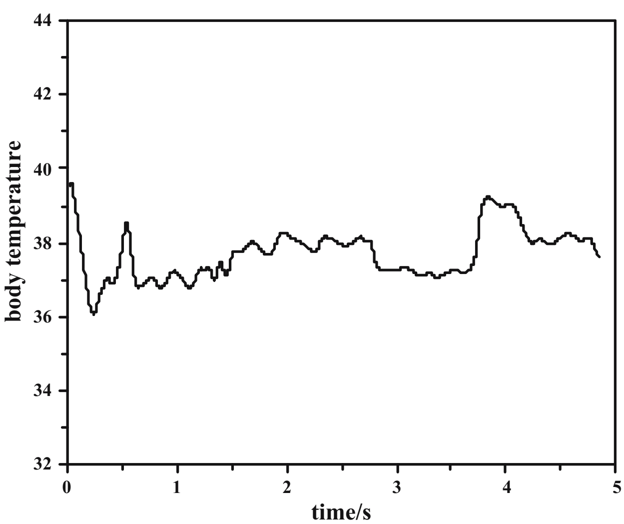

Figure 6: Temperature curve display.

data transmission and lay the foundation for the transmission of control information. When the function test of the smart home security monitoring system of the IoT is carried out, in order to ensure the effective realization of the design function, the testing of the communication quality is done well. When using the communication distance test, it is necessary to ensure that the positions of the coordinator node and the terminal node are in the optimal range. In the actual test link, the coordinator node should be fixed and processed. It moves in a straight line and keeps a constant speed, records the running distance between the terminal node and the coordinator, and sends data information to the coordinator in real time according to the distance between the terminal node and the coordinator. In the functional test of the home security monitoring system, the node of the coordinator should be installed in the best position in the home, so as to improve the accuracy of the data transmission of the intelligent home security monitoring system.

6 Conclusion

With the rapid development of advanced technologies such as big data and cloud computing, more and more fields apply IoT technology to all aspects of management, such as telemedicine and public security. When the IoT is used for monitoring and other applications in various fields, a lot of characteristic data will be generated, and these characteristic data represent the functions of the IoT in this field. Therefore, it is necessary to process IoT data, including the transmission and control of various data, the real-time display of data, and the three-dimensional reconstruction of medical data. This work introduces the architecture of the IoT, then describes the principle, function, and key technology of each layer structure, describes the key technology used in the design of this control transmission system, and introduces the principle of VTK technology used in data processing. The experimental results show that, first, the current time is defined as the key, and then another time is defined as the last point key of the previous point. When the time interval is 0.1 s, data will be displayed, and the data within 16 s will be displayed in the coordinate graph each time. After the medical data transmission is completed, the control module uses multiple processes to call an external application program to reconstruct the head medical data in three dimensions, and displays the three-dimensional results after the reconstruction is completed. In the future, in the actual development and design link, we will increase the research on the server and client program design of the smart home security monitoring system of the IoT, give full play to the advantages of modern scientific information technology, and focus on the functional testing of the smart home security monitoring system and ensure the safety of the home environment.

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