Human Health Monitoring System

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Abstract: *Smart sensing devices and the Internet have brought practical solutions to many networking sectors, public and private sector enterprises, and government organisations throughout the world. Health is money. A healthy mind and body are the keys to wealth and pleasure. People nowadays, however, do not have much spare time to monitor their health. As a result, a health monitoring system is required that tracks and alerts individuals about their health state. The health monitoring system may be enhanced thanks to rapid advancements in the internet and technology, such as the Internet of Things. The internet of things enables automated communication between devices and the execution of pre-programmed tasks, making the system more efficient. Patients must see doctors on a regular basis to verify their health condition under the traditional health monitoring system. However, by incorporating the internet of things into the health monitoring system, the procedures of health monitoring may be automated, saving the patient valuable time. Furthermore, the cloud, which revolutionised data storage, contributes in the development of a better and more dependable health monitoring system. This research aims to link Internet of Things (IoT) technology with health monitoring to make it more customised and timely by allowing devices to communicate with one another. This research will look into a variety of wearable health monitoring modules that people may use to track their heart rate, blood pressure, pulse, body temperature, and other physiological data. The wireless sensor is used to collect data in order to develop a health monitoring system. To enable real-time monitoring, the data is integrated utilising the Internet of Things for processing, linking, and computing. The average temperature collected by the monitoring system of three people is 36.5, 36.4, and 36.5 (°C), indicating that the technology displayed relatively accurate and reliable testability. The ECG acquisition system displays the user's ECG in a straightforward and simple manner. The three participants examined by the system have pulse rates of 78, 78, and 79 (times/min), which are similar to medical pulse metre values. The physiological data obtained through semantic recognition, matching, and character matching is relatively accurate. It concludes that a human health monitoring system based on the Internet of Things can provide people with daily health management, which is important for improving the quality and level of health services..*

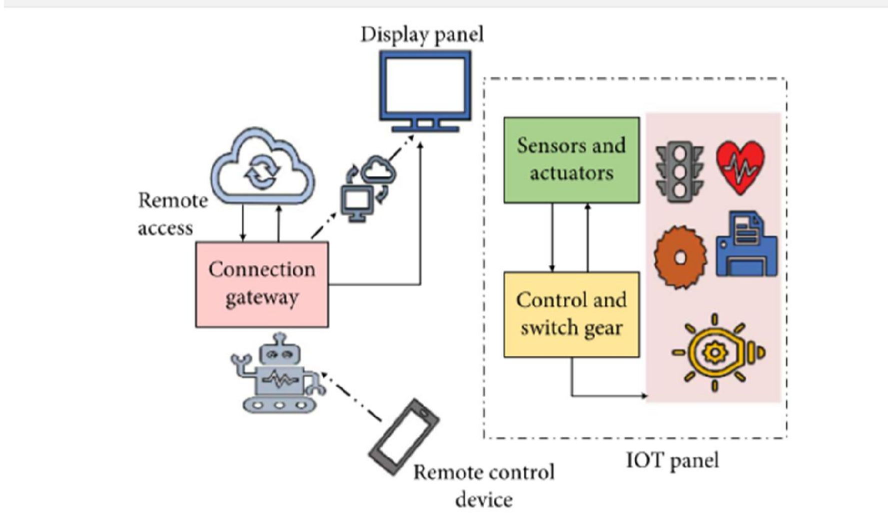
Keywords: Internet of Things, Ontology, E-Health, Context Awareness , Internet of Things, IoT in Healthcare, Patient Monitoring, Raspberry Pi, Smart Health Monitoring.

I. INTRODUCTION

The internet has undergone a revolution, and technology such as the Internet of Things has arisen and is rapidly growing. With cloud computing and edge computing, the Internet of Things enables a new and more efficient method of data exchange and transmission. The Internet of Things will transform the healthcare industry and improve humanity's health and well-being (Rahmani et al., 2018). Patients must attend a clinic or hospital for medical exams under the traditional healthcare system, which is time consuming and inefficient. The Internet of Things can create a real-time health monitoring system with sensors that record patients' heart rate and body temperature and display the data in real-time. People can better regulate their health as a result of this. People may access their health data through the internet and start tracking their health status rather than depending on rare trips to clinics or hospitals for various testing. Using open source services like Google Assistance and IFTTT, the Internet of Things (Tao et al., 2014) allows actions like sending an alert email and texts during an emergency to be feasible. Furthermore, geolocation may be used to track the user's whereabouts.

According to the Ministry of Health's 2017 Report on the Status of Chinese Residents' Nutrition and Chronic Diseases, the annual mortality rate of chronic diseases, which includes cardiovascular diseases and diabetes, is around 85.5 percent, and chronic diseases account for about 75 percent of all diseases in China . Because of the large number of subhealthy groups, as well as the long course, complex aetiology, and high treatment costs of chronic diseases, Internet healthcare focuses on chronic high-risk diseases and subhealthy groups. As a result, Internet of Things (IoT)-based human health monitoring is becoming more common. Because of China's fast growing elderly population and rising living standards, the number of people suffering from chronic illnesses is rising. The Chinese people have a basic demand for efficient, convenient, safe, and dependable healthcare conditions and services. It is critical to build a health monitoring system that allows for remote real-time monitoring.

Smart sensing devices and the Internet are used in IoT technology to give an effective solution to the difficulties that networks, public and private sector enterprises, and government organisations confront throughout the world [5]. IoT developments have ushered in a new era of data analysis employing smart systems and intelligent gadgets for a variety of applications. Figure 1 shows a simple IoT framework with a generalised design.



A number of research on human health monitoring systems based on the Internet of Things are now being conducted throughout the world. Foreign countries were ahead of China in developing human health monitoring systems based on the Internet of Things. Remote consultation and monitoring of blood pressure, blood glucose levels, and some medical data have made significant advances (long-distance transmission). Rezaeibagha and Mu created an Agent system that uses wireless sensors to monitor vital parameters including blood pressure, pulse, breathing rate, and body temperature. Agnisarman et al. created a remote video medical diagnostic system that uses Internet of Things technology to help doctors diagnose patients more quickly, including multipurpose modes like online consultation and video dialogue. Mugica et al. created a remote monitoring ECG monitor that works with the Android system's intelligent terminal. Using the IoT platform, Tamilselvi et al. created a health monitoring system that can measure patients' key symptoms such as oxygen level, body temperature, and eye movement. With the use of different intelligent sensors, Acharya et al. built a kit for healthcare monitoring utilising the IoT platform to measure characteristics such as pulse, ECG, temperature, and breathing. The absence of an interface is the system's biggest flaw, making data visualisation worthless. Banerjee et al. used a noninvasive way to propose a pulse rate detection device. For interactive IoT applications, this strategy employs a real-time monitoring platform. Gregoski et al. demonstrated a smartphone-based heart rate monitoring approach that combined mobile and camera engagement. Oresko et al. created a smartphone interactive tool for detecting cardiovascular disorders and tracking the amount of heart rate over time. Trivedi and colleagues created a mobile-based approach for monitoring analogue data in surveillance applications. The Arduino platform is utilised for digital conversion, and physical amounts must be transmitted to the device through Bluetooth. Kumar et al. proposed a safety device that uses the IoT platform at three different layers: control, device, and transport. Wi-Fi and Ethernet are used to upload the data to the cloud platform. Using the Spartan3 and FPGA interface, Desai et al. suggested a wireless sensor network-based technique to track smart homes and cardiac monitoring. With smart gadgets' incredible capacity to communicate information among themselves, IoT's progress has accelerated. The relevance of IoT in the healthcare industry for remote monitoring of patients' criticality levels has grown as a result of its use in numerous applications. This technical advancement has impacted several aspects of human safety, health, and well-being. Using cloud-based solutions, IoT is beneficial in compute, processing, and storage. It may also be used to analyse and store geographical data on a cloud platform, which can then be shared among devices for various purposes.

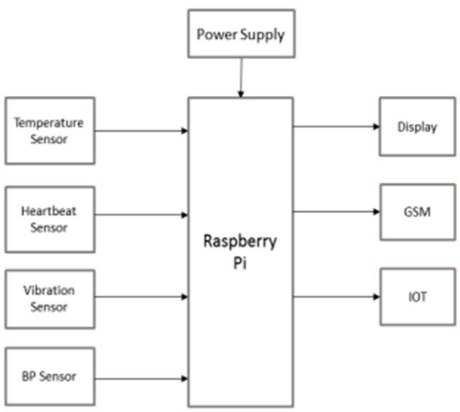
The paper's main goal may be summarised as follows:

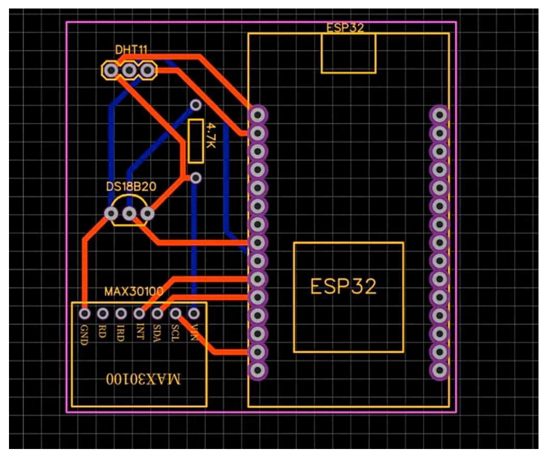
- To use IoT to collect real-time medical information about a patient.
- Information obtained about the patient is processed and classified.
- To understand and anticipate any disease or ailment in its early stages utilising data mining tools, which will also give an optimal decision-making strategy.
- To deliver healthcare solutions based on the Internet of Things at any time and from any location.

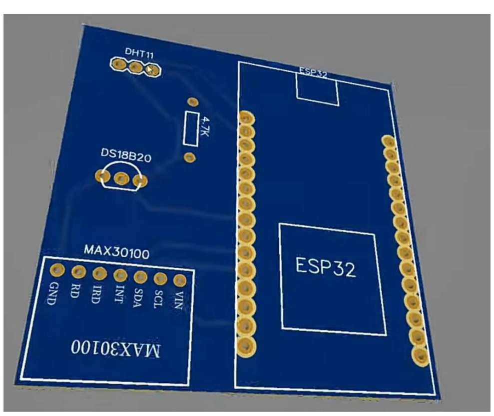
Limitations and Scope

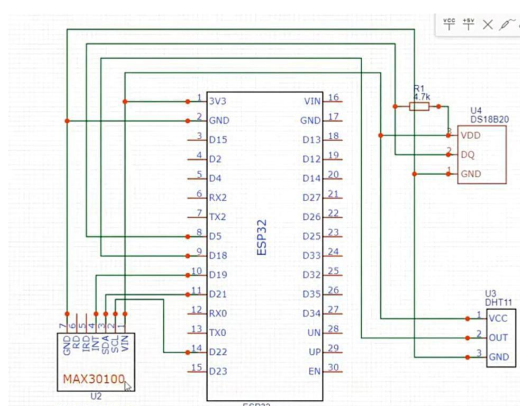
The project focuses on the creation of a hardware and software-based IoT-based health monitoring system. Sensors and a data processing broker make up the prototype system. Authorized people can use the prototype to monitor health data and the location of a health system user through the internet. Furthermore, by accessing the database that keeps all of the user's health data, the authorised user may simply track back to earlier health data. The accuracy of the sensors used in this system will not be taken into consideration because the focus of this project is on the implementation and involvement of IoT in the health monitoring system, and due to budget constraints, the accuracy of the sensors used in this system will not be taken into consideration because the sensors used in this system are not medically verified and are not suitable for any serious medical analysis by any means.

II. SYSTEM ARCHITECTURE

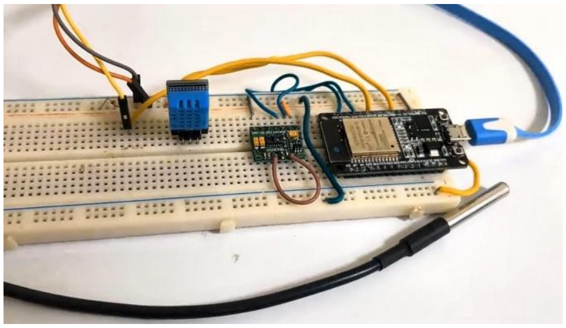


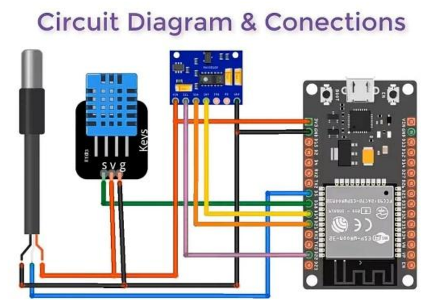






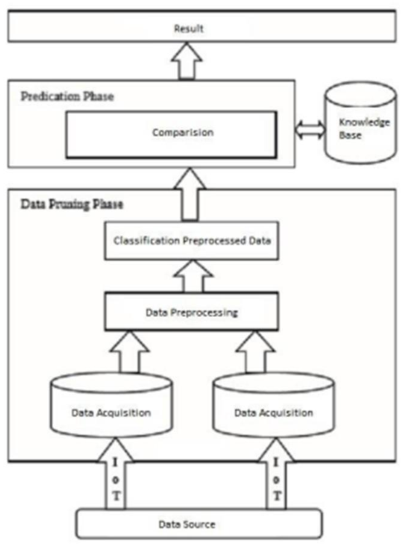
IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Impact Factor: 6.252
Volume 2, Issue 5, May 2022





III. METHODOLOGY PROPOSED

We suggest an automated method to track a patient's body temperature, heart rate, mobility, and blood pressure in this study. Using the numerous health parameters and several additional symptoms gathered by the system, we expand the existing method to forecast if the patient is suffering from any chronic ailment or disease.



The diagram above shows how to extract information about a patient's health state by monitoring several metrics and then using that information to determine whether the patient has a chronic problem or another disease.

Unprocessed data from various IoT devices is collected and stored on the server at level 1. Temperature, vibration, blood pressure, and pulse sensors are among the sensors included in these devices. Because certain sensors produce analogue output that the Raspberry Pi cannot read, we transform the analogue numbers to digital using a convertor IC.We then build python code to read the values from the sensors and update them into the database at regular intervals using the Raspberry Pi with Linux OS loaded.

In level 2, the important information is collected by filtering, classifying, and categorising the data recorded. This information consists of the patient's current health data and symptoms. This information will be utilised in the following level to determine whether or not the patient is suffering from any ailment. This contributes to the system's intelligence and efficiency.

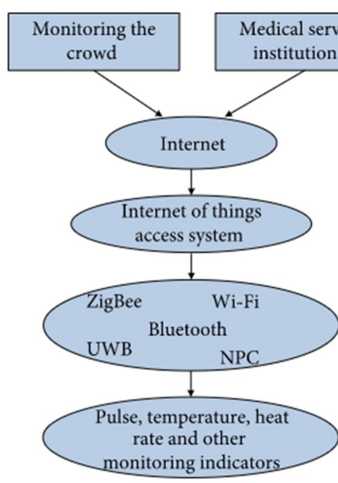
We employ data mining techniques to forecast the kind and nature of the sickness or diseases for which the system was created in the level-3 analysis/prediction phase. Artificial intelligence can improve the system even further by making it smarter. Using the current information base, we may infer the sickness or ailment and categorise the outcome into multiple categories such as Ideal, Normal, and With Symptoms.

IV. MATERIALS AND PROCEDURES

The IoT-based health monitoring system comprises of many modules, including pulse acquisition, body temperature acquisition, heart rate acquisition, and blood pressure acquisition. This section delves into all of these frameworks. Materials and Procedures. The IoT-based health monitoring system comprises of many modules, including pulse acquisition, body temperature acquisition, heart rate acquisition, and blood pressure acquisition. This section delves into all of these frameworks.

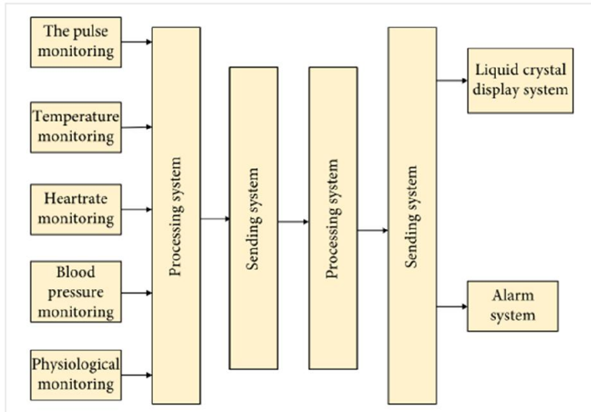
The Framework of the Health Monitoring System based on the Internet of Things

This module contains the physical components of the system that enable it to be IoT enabled, and it is used to track the patient's health parameters via various sensors. Because Raspberry Pi only interacts with digital signals, it serves as a central server to which all of the sensors are attached through GPIO pins or MCP3008 analog-to-digital converter if their output is analogue. The pi reads the real-time information and writes them to a mySQL database, which is then shown on the web interface. The Internet of Things-based health monitoring and medical information system combines technologies such as wireless networks and mobile computing to provide patients with remotely accessible sensing, sound, image, and video multimedia information, improving medical diagnosis accuracy and clinical service quality. Wearing associated equipment allows for precise collection of the patient's blood pressure, heart rate, body temperature, pulse, and other data. Sensor network technologies such as Zigbee, Wi-Fi, Bluetooth, ultrawideband, and short-range wireless transmission are used to convey data.



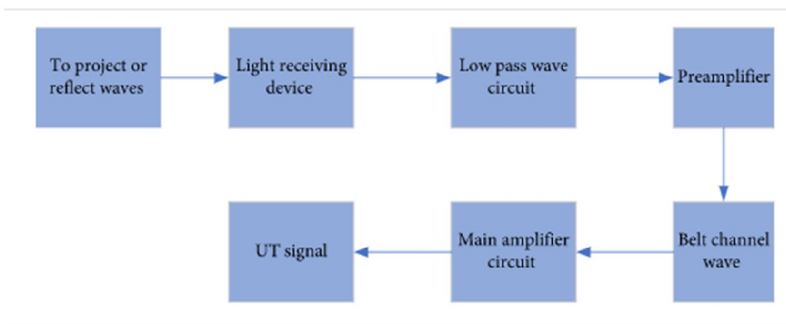
The Human Internet of Things Framework for a Health Monitoring Terminal System

The terminal system is primarily responsible for gathering and monitoring typical human health data in a human health monitoring system based on the Internet of Things. When aberrant data is detected, the terminal's alarm system will sound. It is vital to undertake research and analysis on aberrant data at this time, as well as rapid data processing. For example, the precise situation of the monitor is first established, and then emergency rescue steps are taken. As a result, keeping track of multiple subject indices is crucial. To summarise, the terminal system's hardware architecture is intended for human health monitoring based on the Internet of Things, based on the current research state quo and findings, as well as market need. A health monitoring project module, a data collecting module, a data receiving module, a data transmission module, a data processing module, and a display and alarm module make up the majority of the terminal.



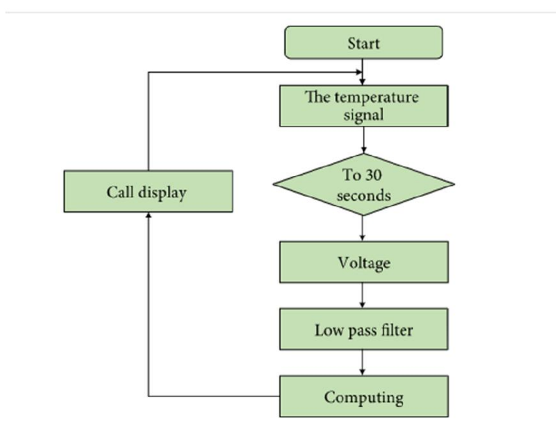
Module for collecting pulses

According to how light is detected, photoelectric pulse sensors are split into two types: transmitted wave monitoring and reflected wave monitoring . Their essential elements are the same (i.e., stable light source and light-receiving sensor). The investigation chose the Rohm Semiconductor Group's impulse data sensor.



Body Temperature Measurement Module

The voltage output integrated temperature sensor for the health monitoring system terminal is chosen in this study, and the hardware circuit is built. The displayer performs the digital conversion of the output analogue signal.

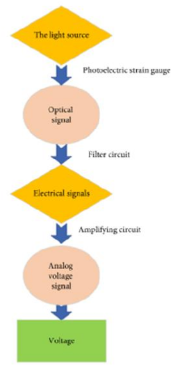


The temperature sensor translates the temperature signal into a voltage output, low-pass filters the output signal to reduce noise, and then the amplifier circuit amplifies the temperature sensor output voltage to a voltage level.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
IJARSCT
Impact Factor: 6.252
Volume 2, Issue 5, May 2022

Module for measuring heart rate

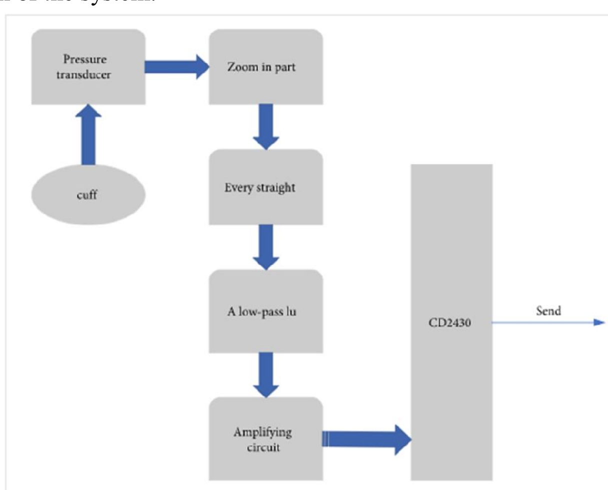
The light volume technique measures heart rate by measuring the change in light transmittance generated by the pulse's pounding in a blood artery. A photoelectric sensor converts the light source into an optical signal, which is subsequently translated into an electrical signal using a filter circuit. The chosen wavelength ranges from 650 to 750 nanometers. The heart rate sensor's signal flow. The volume shift generated by pulse congestion impacts the light source's light transmittance when it travels through human peripheral blood vessels.



The amplifier circuit converts and outputs the light signal reflected by the photoelectric converter through the human body's peripheral blood vessels. Analog voltage is used to display the heart rate. The heart rate acquisition module was used to obtain this value.

Module for measuring blood pressure

There are two types of blood pressure monitoring methods: direct and indirect (Oscillometric method). The indirect technique overcomes the drawbacks of the direct method, such as its complexity and traumatic nature . It uses the link between the vessel's pressure and the FM flow change to monitor the pressure value on the body surface. It is simple to use, clean, and succinct, with no special medical constraints, and it poses no health risks. As a result, the indirect technique is becoming popular. Blood pressure is measured without causing any harm to the human body, and the measured readings are also more precise . Diagram of the system.



The op-amp LM324 is used for signal capture and processing. A BP300 sensor is used, which is sensitive, precise, and accurate. Additionally, air pumps, resistors, and capacitors are required components. By turning the blood flow pressure signal in the inflated bandage into a voltage signal near to the microcontroller's voltage amplitude, the pressure sensor transforms the pressure signal. The signal is collected and processed by the one-chip computer, which also controls the complete circuit.

IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

Impact Factor: 6.252

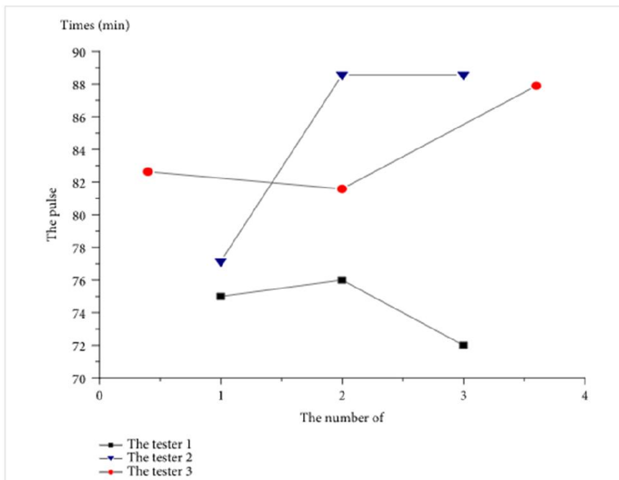
Volume 2, Issue 5, May 2022

V. RESULTS AND DISCUSSION

This part examines the results of the experiments, describing various compliances and evaluating the effects of their application. The next subsections cover several modules such as pulse capture, body temperature monitoring, ECG, and physiological data collecting.

Pulse Acquisition Module Compliance Test

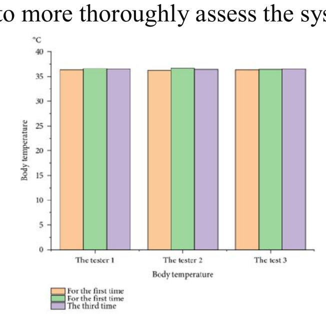
The pulse test findings show that the three participants' pulse rates are all within the normal range (an average adult's pulse rate is 70-90 beats per minute). Each subject undergoes the pulse signal acquisition test three times, with an average pulse value of 78, 78, and 79 (beats/min) obtained each time. The comparable numbers for the thermometer are 77, 79, and 78, showing that the system's test findings are quite reliable.



Although there is some variation, it is always within acceptable limits. This is because the pulse acquisition module's sensor is linked to the circuit design. It can be developed more in the future to provide more precise results.

Body Temperature Acquisition Module Compliance Test

Three persons were chosen as test subjects to take temperature readings and make fair judgements about the temperature monitoring module's performance in order to more thoroughly assess the system's accuracy.



The temperatures of three people using a thermometer are 36.4°C, 36.7°C, and 36.5°C, respectively, as illustrated in Figure 9. The temperature test was repeated three times for each participant, yielding an average of 36.5°C, 36.4°C, and 36.5°C, respectively, for each person. The readings of this device are clearly similar to those of a thermometer, and it can monitor body temperature. It also means that the system's temperature test is generally steady.

ECG Information Acquisition Module Compliance Test

The initial step in monitoring the ECG data collecting module is to update or load the user's most recent ECG measurement record data. Simultaneously, the relevant detailed operation page will appear, allowing for the acquisition of a real-time ECG picture. Given the complexity of ECG data points, minor tweaks to the picture's functional region can be made to produce the best results for viewing a certain segment's image curve. The ECG's user interface is

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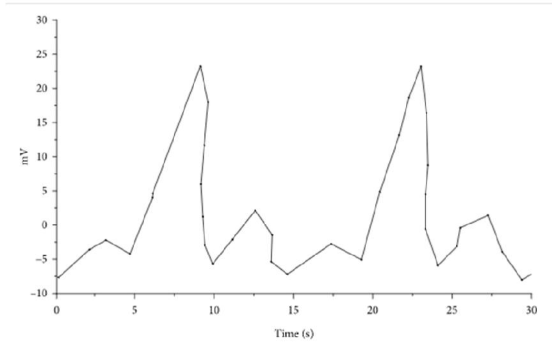
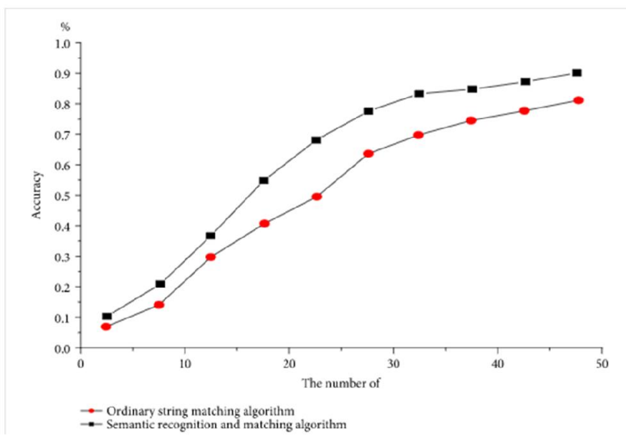


The Physiological Information Acquisition Module's Compliance Test

Through simulation experiments, it was discovered that as the number of keywords input by users increases, the accuracy of obtaining information increases, whether it is a traditional character matching system or not , to verify the rationality of the semantic recognition and matching system and improve the traditional character matching system.

Users should be given more physiological-related information in addition to pulse and temperature measurements to better understand their physical status.



VI. CONCLUSION

To examine health-related indicators, wireless sensor technology is integrated with a human health monitoring terminal based on the Internet of Things in this study. The outcomes of the tests are examined. The Internet of Things' human health monitoring system appears to be quite reliable, with capabilities such as accurate human health data gathering, real-time monitoring and alarms, and subject evaluation. The thermometer was used to measure the individuals' temperature, which produced temperature values of 36.4, 36.7, and 36.5 (°C), exhibiting relatively accurate and steady testability. Similarly, the ECG-based pulse rate monitoring module records test findings of 78, 78, and 79 (times/min), which are identical to the results of a medical pulse metre.

The Internet of Things-based human health monitoring system developed in this study has finished collecting the user's blood pressure, pulse, body temperature, heart rate, physiological information, and other vital sign data, as recommended in practise. Factors associated to a possible risk prediction should be further researched in the future to widen the use of human health monitoring systems based on the Internet of Things after long-term data collecting. In the near future, this will provide a scientific and effective foundation for preventing and treating chronic high-risk illnesses.

The system may be improved even more by including artificial intelligence components to assist physicians and patients. Data mining may be used to look for consistent patterns and systematic correlations in the disease, which includes the medical history of many patients' parameters and their related outcomes. For example, if a patient's health metrics change in the same way as a prior patient in the database, the repercussions can be predicted. It will be easier for doctors and medical researchers to develop a solution if similar patterns are discovered again.

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