Research Article

Wearable-Based Virtual Display Information Processing and Data Fusion Research

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Abstract
This paper is combined with the existing acquisition module design to achieve the upper computer online information monitoring system. Real-time mapping technology is adopted to change the trend of data collection potential for real-time tracking and monitoring. The monitoring data can be predicted and analyzed by changing trend, at the same time combined with SQL2008 database technology, user login system, registration system, monitoring system, data query, and data storage system. The integration and other functions are improved, so that the system not only has the advantages of information management platform but also realizes the remote client base matching layer wireless information real-time monitoring function. Data fusion technology refers to the information processing technology that uses computer to automatically analyze and synthesize some observation information obtained in time and sequence under certain criteria, so as to complete the required decision-making and evaluation tasks. The intelligent wearable online information monitoring system designed in this paper realizes wireless sensor network, to some extent feedback and monitoring of underlying real information. Through the corresponding information processing and data fusion, the user can easily and clearly get product information. Based on the existing 80 sets of data, the experiment trains and extracts 320 feature vectors, which verify the effectiveness of the method.

1. Introduction

Nowadays, with the development of mobile Internet technology, the traditional labor force and resources can no longer meet the needs of technological innovation. With the gradual narrowing of innovation space such as smartphones and the near saturation of the market, smartphones can be worn. Technology as a branch of the Internet of Things has been widely recognized in various fields [1]. The development of mobile Internet to wearable devices provided a good experience platform; with the continuous improvement of technology, consumers are more able to accept such new products and things. The difference between networking is that garment factories and jewelers are joining the ranks of smart wearables. Adidas has also developed a fitness chase sneakers. In this way, wearable equipment is gradually opening up the market to the garment and other industries. Today’s development is mainly in the following areas. The results of the continuous technological innovation are as follows: (1) rapid development of microelectronics technology, (2) development of multimedia technology, (3) development of embedded software and hardware technology, (4) continuous improvement of wireless communication technology, and (5) development of new generation structure design technology and human-computer interaction technology. The development of wearable equipment cannot be separated from the increasing demand of society. The research and development of monitoring equipment such as product are very meaningful [2–4]. With the rapid development of technology in various industries, the combination of development, wireless sensor networks, information fusion technology, and wearable computing makes wearable smart clothes.

From the development of wearable devices in the field shown above, we can see that wearable smart clothing will be a long time in the future. In the meantime, its main task
is to change and improve the traditional clothing function by using high and new technology and information technology, so that clothing can become the carrier of modern scientific and technological progress, which will be mainly reflected in the research and development of intelligent wearable clothing. Now, a broad definition of wearable smart clothing can be simply understood as information-based clothing; that is, through all kinds of microchips, sensors, power supply, and other devices are embedded in clothing, making clothing a man-machine with specific functions. Intelligent clothing is the traditional textile and garment technology, information sensor technology, and communication technology; artificial Intelligence is an organic collection of many fields. It uses advanced electronic information technology to process, perceive, input, and transfer information. At the same time, the electronic hardware equipment is miniaturized and flexible and then embedded into traditional clothing. Without affecting the overall comfort of clothing, wireless information acquisition, transmission, analysis, and other functions are realized. A set of wearable electronic equipment can be used to real time carry out the physical and sensing equipment. It is a challenging cross-cutting field. Virtual display technology is a real-time representation of a computer-generated world that simulates human perception, sometimes referred to as a virtual environment. The "world" here refers to a realistic three-dimensional figure, which can be either a real reproduction of a particular real world or a world of ideas. Operators can interact with them through visual, auditory, tactile, and force sensations, thus creating an “immersive” scenario, so virtual reality technology provides new interactive media for human interaction. Virtual display technology mainly includes simulation environment, perception, natural skills, and sensing equipment. It is a challenging cross-cutting discipline and research field. Virtual display technology is a combination of various technologies, including real-time 3D computer graphics technology, wide angle, stereoscopic display technology, tracking technology of the body parts of the observer, as well as tactile and force feedback, stereo, network transmission, voice input and output technology. At present, the development of virtual display technology is becoming more and more mature and has made great progress in many fields, such as medicine, aerospace, urban planning, architecture, virtual studio, art, entertainment games, and education. With the development of the times, in virtual reality, the application of virtual display technology in the future will become an indispensable technical means in the future.

2. Related Work

2.1. Development Background of Wireless Communication Technology. With the development of microelectronics, computer technology, and wireless communication technology, intelligent wearable devices are becoming more and more popular. Wireless sensor technology can provide people with a comprehensive and efficient method to monitor the economic layout and acquisition parameters of nodes [5–7]. Zigbee wireless communication technology is an intelligent wearable device. One of advantages of this technology is that its low cost enables more consumers to enjoy the high-quality services brought by science and technology while at the same time bringing people to life. They are freed from the complex and restricted wired equipment, so that the wearer has a higher degree of flexibility and mobility. At present, Zigbee technology is widely used in wireless communication technology. It has its unique application characteristics [8]. It is mainly used in wireless communication technology and control system with short distance transmission and small amount of information. It is suitable for monitoring physiological and environmental parameters of human body. At present, Zigbee is mainly used in the following fields: smart home: commercial buildings can use Zigbee to complete automatic control, reducing the efficiency of manpower management and management costs. With this intelligent system at home, we can easily monitor the usage of tap water, electricity, gas, etc., and we can also use it. It has the function of safety monitoring. Industrial field: use wireless sensor technology to collect data in each workshop of the factory, and automatically process and analyze. Thus, work personnel can monitor the operation in real time to prevent accidents [9]. At the same time, it can communicate with the host computer to realize assistant decision-making, thereby improving production efficiency and increasing benefits. Master’s Degree Thesis of Beijing Institute of Fashion Three Medical field: using sensors, we can real time monitor human heart rate, body temperature, and other signs. It has greatly reduced the number of doctors and nurses. The workload of the staff and nurses cannot regularly inspect the patient’s physical parameters, only on the terminal equipment regularly [10].

2.2. Background of Information Fusion Technology. As early as the 1970s, the concept of information integration was gradually proposed, and the concept of “data fusion” introduced by JDL laboratory experts in the United States put forward that the concept of information fusion was widely used in the 1990s. From the initial military field to today’s, various industries have applications [11–13]. The core of data fusion is coordination, optimization, and comprehensive processing. Information fusion uses specific mathematical methods and techniques. The tool processes, correlates, and synthesizes multisource information to obtain high-quality useful information [14]. So choose one. An optimal intelligent data fusion algorithm monitors the collected data and trains and analyses the data, so as to establish a certain data fusion system. It is of great significance in real life that some evaluation systems can be used to predict unknown
risks and minimize risks and losses. Establishing a remote terminal through the algorithm of information fusion technology can transparently reflect the tester’s own condition or field environment. Real-time monitoring and prediction, as well as inquiry and analysis of past information, are convenient, fast, and easy to operate [15–17].

2.3. Virtual Display Technology. Virtual display technology can create and experience a virtual world generated by computers and experience the realities and things in this environment. Virtual display technology has significant features such as presence and interactivity. This technology simulates human sensory functions such as vision, hearing, and touch by combining computer graphics and image technology, multimedia timely, and real-time simulation. It can let people in the virtual world created by virtual display use real-time communication methods such as language and action. This technology has developmental help in many fields.

Virtual display has four characteristics: immersion, interactivity, multiperception, and conception. The user wears a sensor device such as a helmet display and gloves to keep himself in a virtual environment and achieves close to natural human-computer interaction, so the user has visual, tactile, taste, and other perceptions in the virtual reality environment. Users can build a tailor-made virtual reality environment through their own imagination.

2.4. Contribution. This topic combines the product itself with the electronic intelligent equipment, takes the wireless sensor network as the carrier, and at the same time uses the wireless sensor network as the carrier, integrating the advantages of the monitoring system, perfecting the user monitoring management system, and facilitating the user to manage the data of the remote acquisition module and queries and intelligent analysis of data. Using wireless communication technology to achieve ultralow power consumption is the current software design. In the future, the monitoring of product parameters will be an automated mode of operation. The terminal software can automatically analyze the parameters of the acquisition point. When the environmental parameters are not within the normal range, the host computer software will automatically analyze the parameters of the acquisition point, so as to judge, analyze and timely process and issue an alarm signal. It can effectively avoid artificial misjudgment and facilitate management data. Inquiry improves the work efficiency of field personnel, and wireless communication also improves the safety of staff and the availability of equipment. Reliability management, remote control, and remote operation are realized at the same time. Because this new type of intelligent wearable device can be increased or decreased, wireless acquisition module can be used for different needs. Necessary modifications are made to make wearable smart products more widely used. For example, it has been extended in the fields of combat, field rescue, human posture, and emotion recognition. In a word, intelligence with information processing function product has broad application prospects. The research of these key technologies can be extended to aerospace and other fields. Applied research lays a very strong foundation for the engineering and practicality of intelligent wearable product.

3. Design of Wearable Intelligent Product Architecture

3.1. Intelligent Product Architecture Design. In the design of the system, we need to consider the architecture of the system and design it according to the specific environment and actual needs. Intelligence wearable system embeds various sensor modules, signal transmission units, information processing units, and microcontrollers in garments. At the same time, it must satisfy different application requirements so that it has the functions of perception, transmission, calculation, and display [18]. All wearable systems have general computing power. Using hardware and software platforms, sensor models with different functions are designed according to demand analysis and block to collect some physiological signals and environmental parameters of human body. Figure 1 shows a schematic diagram of the wearable network structure.

The design architecture of each functional module of the whole system is shown in Figure 2.

3.1.1. Design Characteristics of Intelligent Wearable System

1. Modularization of architecture design. Each module includes sensor module, storage module, and communication module for sensing environmental parameters. Block, power supply module, etc. Table 1 shows the wearable data fusion model

2. Multiapplication oriented. Modules can be configurable to be added or subtracted to suit different application areas, such as for medical health, rescue, and fighting

3. Low energy consumption and real time. The system uses Zigbee wireless communication technology, which saves energy consumption and has good reliability. Sex meets design requirements

4. It has the function of information fusion. Sensors can collect product signals and environmental parameters of human body, requiring complex information, information processing, and fusion decision-making in order to improve the accuracy of discrimination

5. The material of product is suitable for harsh environment. The material used in smart product should be wear-resistant, moisture-proof, and fire-proof. The characteristics meet the requirements of field operation

3.2. Network Structure Design Based on Intelligent Wearable System. The whole system involved in this paper includes the existing modules of the research group: temperature and
humidity module, methane gas module, and acceleration module. In this paper, besides increasing the number and optimizing the accuracy of the existing modules, we also design a new model based on it. The photoelectric pulse acquisition module based on Zigbee technology carries out serial communication and on-line information remote monitoring for all modules, and uses database technology for data processing.

3.3. Hierarchical Structure Design of Intelligent Wearable System. Wearable system can be divided into four layers: application layer, service layer, driver layer, and hardware layer.

3.3.1. Hardware Layer. The hardware layer is mainly composed of wireless sensor module based on Zigbee protocol embedded in smart clothing. And these module can realize the functions of acquisition, calculation, display, input, output, and storage. The design of these hardware modules is the first requirement. To meet the needs of intelligent design, we can collect product parameters, environmental parameter information, and so on. Secondly, in order to ensure these work, energy module can judge information better and realize human-computer interaction. Processors are needed to filter the collected signals digitally: wave, decision-making, feature extraction, and other information processing. Finally, the hardware design of the system needs to be comfortable and accessible. It is mobile and convenient for normal human activities. Figure 3 shows the 4 levels of the wearable system.

3.3.2. Driver Layer. Driver layer can provide a unified signal interface to service layer according to the characteristics of each functional sensor module.

3.3.3. Service Layer. As the core level of the system, the service layer realizes the preliminary acquisition of information through signal allocation, scheduling, and decision-making. Fusion and wisdom can ultimately achieve high-level fusion of information to meet the requirements of different applications.

3.3.4. Application Layer. The system can be used for different users to meet the relevant application needs. Different scenarios are implemented according to different design requirements.

4. Information Processing Analysis Based on Wearable Devices

Photoelectric pulse sensor has high integration and is easy to use; noncontact measurement can be realized; output signal stability is fixed, and there are no signal amplification processing or filtering processing and other advantages. Pulse sensor has high sensitivity, low complexity, and low adjustment circuit. The characteristics of good output effect fully meet the design requirements of the hardware circuit of the system. IAR is the main working environment of software system design and compilation in this paper. IAR embedded workbench is a type stable, complete, and easy to apply professional embedded application development tools; its C cross compiler function is powerful, compatibility to be strong. IAR embedded workbench can provide a unified user interface for different microprocessors. At present, it supports at least 35 8-bit, 16-bit, and 32-bit ARM microprocessor architectures. Fully compatible with standard C language, the program speed of the built-in corresponding chip is fast, which supports efficient floating point operation, memory mode selection, and so on. Figure 4 shows the sensor pulse measurement graph.

According to the data in Figure 4, it can be seen that our measurements are divided into five groups, and each group uses this system measurement and professional system measurement to form a data comparison. After the experimental data, it is found that the difference between the two systems measurement is small, which shows that the measurement system designed in this thesis has practicality.

Although the above method can achieve pulse frequency acquisition, the pulse signal sampling cycle is too long, the user waiting time. In response to this problem, it immediately occurred to reduce the timing time to 10 seconds to calculate the pulse signal in this period of time to estimate the number of pulse signals per minute with the obtained value. Arithmetic mean filtering is one of the software filtering methods; it is suitable for random interference signal filtering and simple implementation. The specific implementation method is as follows: set the timing time to 5 seconds and calculate the pulse within 5 seconds. The number of beat signals and the sampling values within 3 timing times is obtained continuously, the arithmetic mean value is taken, and the arithmetic mean filtering is carried out. Finally, the number of pulse signals per minute is obtained.
5. Attitude Discrimination Based on Data Fusion Algorithm

In this paper, MMA7455L sensor is used to collect the triaxial acceleration of human body, and the information is summarized. Combined with the treatment, the body posture of field rescue personnel was determined. The following uses different algorithms for analysis and discrimination. The method is from easy to difficult, and the accuracy is from low to high. Data fusion technology utilizes computer technology and embedded technology to multiplex. The information obtained by sensors, under certain rules, can be intelligently analyzed, optimized, and synthesized to complete the decisions and estimates we need. The optimal data fusion algorithm is selected to train and analyze the collected triaxial acceleration values so as to realize the difference.

Table 2 shows the comparison of fatigue detection methods. According to the data in Table 2, it can be seen that each of the three methods has its own advantages. The physiological parameters are measured with better reliability but must be in physical contact with the user, the vehicle operation measurement is greatly influenced by the measurement model, and the driver behavior measurement is simple to operate.

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<tr>
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5.1. Empirical Value Fall Algorithm Based on a Single Acceleration Sensor. The acceleration sensor module designed in this paper can make corresponding signal acquisition and judgment according to the product. In this paper, an empirical value fall detection and analysis algorithm based on statistical theory is designed, which can collect three squares of triaxial acceleration.

5.1.1. Establishment of Spatial Coordinate System. Point O through space as three perpendicular number line, they all start with O and have the same unit length. These three number axes are x-axis, y-axis, and z-axis, respectively, which are collectively referred to as coordinate axes. As shown in Figures 2 and 3, it works on an upright product. Firstly, a three-dimensional coordinate system is established to facilitate the judgment of triaxial acceleration. MMA7455L sensor is adopted in this paper. It is a three-axis acceleration sensor, it can detect the movement and direction of objects, and it is based on the movement and direction of objects. Change the voltage value of the output signal. The placement of sensors must also be strictly controlled; otherwise, it cannot accurately obtain the three axes of information.

5.1.2. Establish Human Motion Model. The coordinate system has three vectors perpendicular to each other, and any vector change through any point in space will have one. The sum of three vectors in space is better to have a vector with both magnitude and direction than acceleration in all three directions. The space vector and calculation are shown in

\[ a = xi + yj + zk. \]  

Changes in parameters collected by the acceleration sensor are caused by the product. Now, the accelerations in the three directions are set as \( ax, Ay, \) and \( az \) with three values. In this paper, the support vector machine is used to reduce the computational complexity and the amplitude of the...
This system measures

Professional system

Figure 3: Wearable system hierarchy.

Figure 4: Sensor pulse measurement graph.
acceleration. Vector changes can reflect the intensity of product movement. Then, the resultant acceleration is shown in

$$a = \sqrt{a_x^2 + a_y^2 + a_z^2}. \tag{2}$$

When the acceleration in three directions is known, the change angle of product posture can be obtained, which can be used to calculate the angle alpha between the fall and the vertical direction of the ground, as shown

$$\sin \alpha = \frac{\sqrt{a_x^2 + a_y^2 + a_z^2}}{|a|}. \tag{3}$$

Similarly, the angle values in the other two directions can be obtained. In this paper, the angle difference between the two postures is calculated. The value, according to the trend of change, can judge whether the state of the product changes dramatically. Table 3 shows the acceleration action data characteristics.

5.1.3. Specific Implementation of the Empirical Value Algorithm for a Single Acceleration Sensor. Judge whether to fall forward: the forward fall is mainly caused by the acceleration change of $z$-axis and $x$-axis and the acceleration of $y$-axis. The degree basically does not fluctuate much, and the angle between the $x$-axis and the $z$-axis also changes a lot. For a single acceleration sensor, it has been verified by a large number of experiments that the change of $a$ caused by product vibration will not exceed $1/2 g$, because the $y$-axis acceleration is essentially unchanged, except that the acceleration in the other two directions is not exceeding the acceleration due to gravity. The sample can preliminarily set a boundary with the acceleration, as shown in

$$\frac{1}{2} g < a < \sqrt{2}g. \tag{4}$$

But this restriction alone does not preclude a change in attitude angle caused by a product squatting down sharply, even though it is X. The acceleration in the $y$-axis direction is basically unchanged, but the $z$-axis direction changes a lot, so it is not possible to accurately judge whether a fall occurs. It can be concluded from experience that when the acceleration change in the $x$-axis excludes vibration interference, the acceleration change in its direction exceeds $1/5$ gravity. Acceleration can be used to determine whether the product falls by adding the limited conditions of formula (5). The angle between the two will increase, and when the angle value changes more than 55 degrees, it can be judged that the product is in a forward leaning state.

$$a > \frac{1}{5} g. \tag{5}$$

5.2. Fall Detection Algorithm Based on Secondary Judgment
5.2.1. Algorithm Flow of Secondary Judgment and Fall Detection. The fall detection method of secondary judgment designed in this paper is to add the fall time on the basis of the empirical value fall algorithm. The change of speed is judged by the over threshold. When the critical threshold is reached, a timer is used to start the timing for 30 seconds, if within 30 seconds. If the acceleration remains the same, that means the fall. Otherwise, if you go back to the upright position in 30 seconds, the acceleration will be the same change, so that it can be judged as a miscarriage of justice, cancel the alarm, so as to effectively improve the accuracy of the judgment. Table 4 indicates the brain wave states at this moment.

According to the data in Table 4, it can be seen that after the measurement of the physical state by professional instruments, the mental state at different time periods can be accurately predicted, and then, the experiment can be conducted according to different states. Table 5 shows the telecast special rate setting.

According to the data obtained needed to be described, the data is judged and parsed, and the individual results are judged in real time, with specific reference to Table 6.

According to the Table 6 data system, TÜV sets specific markers for each data in advance in order to pack and unpack the data, so that misordering can be avoided during data sending and receiving.

5.3. Figure Recognition Based on SVM. SVM is based on statistical theory, according to the complexity and learning ability of finite sample information model. Seek the best compromise between, in order to obtain the best generalization ability. SVM is mainly used to solve a small number of samples in the pattern. There are great advantages in recognition, which can be extended to learning problems of function fitting and other machines [19, 20]. In this paper, SVM is proposed. The realization of the classification algorithm for human gesture recognition requires two stages: training stage and recognition stage. In the training stage, section mainly establishes different classification models for acceleration values of several different dimensions of acceleration sensor and in the identification phase online identification of different test samples.

5.3.1. SVM Human Posture Recognition Steps. The training of the original data samples mainly consists of the following three steps, which correspond to the SVM human posture recognition in the figure above. Other system block diagram is as follows: (1) for the known attitude \( I \) \((I = 1, 2, 3 \cdots, n)\)
collect data as training samples; (2) to extract the same eigenvalue (triaxial direction and parameter size of different attitude) from the data to form the eigenvector; and (3) establish a multiclassification model for existing data samples. After the completion of the training, the real-time data are diagnosed and identified.

5.3.2. SVM Human Posture Feature Extraction. In the process of product posture discrimination as shown in Figure 5, different features can be extracted from the values on each axis of the acceleration sensor. To obtain the signal characteristics of time series, in the description of relevant literature, four features are usually selected as the posture characteristics of human body. The characteristic data are mean value, variance, correlation coefficient, and data value of each dimension. In this paper, by placing sensors in different places, the state is used for data collection and the characteristic parameter values of $X$, $Y$, and $Z$ in three different directions. Based on the existing 80 sets of data, 320 feature vectors were trained and extracted, among which 160 stood up, 40 fell forward, forty left, forty right, and forty down. These original eigenvectors are associated, every four vectors as one. The discrimination group, in the process of training, uses the self-detection classification algorithm to evaluate, uses the training data set to train the classification model, and uses the classification model to classify the test data. SVM self-detection classification algorithm is adopted, and SVM branch is used. The vector machine is used to judge the test data.

5.4. Decision Layer Data Fusion Is Used to Judge the Fall State of Human Body. Data fusion at the decision-making level belongs to the highest level of information fusion, through the calculation of the original data, feature recognition and the corresponding logical operation, and the final output decision results. The comparison of data fusion algorithm is shown in Figures 5 and 6, which is the general classification of information analysis and processing, in a more humane and accurate way to identify the product, and when the data processing is associated with the upper computer algorithm, remote real-time monitoring and alarm can be issued to facilitate display.

6. Conclusion

This paper is combined with the existing acquisition module design to achieve the upper computer online information monitoring system, using VS2010Platform, serial port communication, IAR, and other platforms adopting C# programming language to display the data of each acquisition module in real time. Monitor, analyze, and alarm abnormal data and information. Real-time mapping technology is adopted to change the trend of data collection, potential for real-time tracking and monitoring. The monitoring data can be predicted and analyzed by changing trend, at the same time combined with SQL2008 database technology, user login system, registration system, monitoring system, data query, and data storage system The integration and other functions are improved, so that the system not only has the advantages of information management platform but also realizes the remote client base matching layer wireless information real-time monitoring function. In this paper, the three-axis acceleration of the acceleration module is analyzed. With calculation, different algorithms are adopted to track and distinguish the product. Smart wearable devices can to some extent to prevent serious consequences caused by the occurrence of hazards, reduce the hazard index, and facilitate timely rescue, in real life is very necessary. The intelligent wearable online information monitoring system designed in this paper realizes wireless sensor network to some extent feedback and monitoring of underlying real information. Through the corresponding information processing and data fusion, the user can easily and clearly get the product parameter information reflected by human physiological parameters and does not have to tangle with the underlying network structure and data calculation. Although wearable devices designed in this paper can achieve the purpose of prediction and monitoring, the collection accuracy and algorithm are divided into two parts.
The optimization degree of analysis needs to be further improved and deepened.

Although this paper has carried out in-depth research on virtual display information processing and data fusion using wearable devices, there are still many deficiencies. The depth and breadth of this research is not enough, and my academic level research is also limited. According to the existing technology and level, we will study suitable ways and means from more angles and continuously improve the quality and performance of the technology.

Data Availability

This article does not cover data research. No data were used to support this study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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