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Contents

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Wearable Device Detection based on Physiological Parameters of Human Motion State

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Abstract: In daily life, people inevitably need to perform manual labor or exercise training. Detecting the human body's fatigue status in real time is conducive to the rational arrangement of people's daily work life, and to improve the efficiency of work or training and avoid accidents. At present, most portable physiological parameter monitoring products mostly refer to clips, but finger clip type monitoring instruments are not suitable for real-time detection when people are doing sports. Because the vibration amplitude of the head during movement is relatively small, the signal collected on the head is more accurate than on the finger and does not affect the motion of the human. Therefore, the test instrument is head-mounted in the experiment. In this paper, we study wearable devices based on physiological parameters of human motion. The proposed methodology is based on the smart sensing framework and the simulation is conducted with Python flowchart. The simulation results show the effectiveness of the methodology.

Keywords: Multi-physiological parameters; Data monitoring; Realtime system; Dynamic identification; Smart sensing

1. Introduction

In daily life, people inevitably need physical labor or large-volume exercise training. Knowing in real time the fatigue state of the human body in favor of the reasonable arrangement of people's daily work life, improve the efficiency of work or training, and avoid accidents. Therefore, the detection of human fatigue is very necessary. The sub-health state in which physical activity is reduced due to excessive activity or long duration is called exercise fatigue. It is normal for the body to recover from mild rest and rest. Moderate fatigue can cause feelings of fatigue, leg pain, decreased attention, and slower thinking. Severe fatigue can lead to indifferent expressions, apathy of the eyes, confusion of thoughts, poor coordination of movement, and signs of headache, chest pain, nausea, and even vomiting. It can be seen that with the deepening of the degree of fatigue in human sports, its self-physiological sensation and external physiological manifestations will also change, which provides a basis for judging and also dividing the degree of fatigue.

At present, a large number of studies have confirmed the correlation between human physiological signals and the degree of fatigue, and obtained the relationship between them, such as human fatigue detection based on gait acceleration characteristics, pulse signal monitoring system for human fatigue status detection, and drivers. Modeling of fatigue analysis of each link. Most of the above studies only detect single physiological parameters or perform fatigue detection when the human body is static, and there are disadvantages such as inaccurate fatigue detection and poor real-time performance. Taking into account the non-linear relationship between heart rate, SpO2, energy consumption, and human fatigue during exercise, parameters such as gender, height, weight, and age have a Considerable impact, based on BP neural network modeling techniques to obtain the reasonable and wide applicability model estimation. This kind of model estimation will be a better method for predicting exercise fatigue, and it will facilitate people who are engaged in physical exercise activities to know their own degree of fatigue in a timely manner so as to make reasonable arrangements.

With the development of computer technology, the place, mode of use, and external form of the computer are constantly changing, resulting in a new type of personal mobile computing system "wearable computing." It can be worn on the user, tightly integrated with the user, interacts closely with the outside world, perceives the user's physical activity, provides accurate and inaccurate information activities in the context, and realizes "user-centered" service requirements. Wearable computing has important applications in the fields of industry, medical care, military, disaster relief and daily life. In recent years, with the increase of the aging population and the rapid increase in public health care costs worldwide, wearable computing has been closely integrated with the medical field and a series of the new research areas have been

formed, including personal health monitoring, telemedicine, and community medical care. Helping disabled interactions, etc. These researches provide a new method for the reform of the hospital-centered medical service model and among them as the wearable health monitoring system achieves automatic, continuous and dynamic acquisition of the general human physiological signals under low physiological and psychological loads, and has been further studied in recent years. Therefore, for the training, we should consider listed aspects.

Interval training for aerobic metabolism, in the intermittent training for the purpose of developing the aerobic metabolic endurance, the exercise intensity requirement is between 80% and 85% of maximal oxygen uptake or near the anaerobic intensity, and the duration should be appropriately extended. Interval time is as long as exercise time.

Lactate threshold training is one of the effective training methods to improve aerobic capacity of athletes. The training can be done with an interval of 80% to 85% of the maximum oxygen uptake or close to the intensity of general lactate threshold.

Altitude training, hypoxic condition is the plateau environment one of the most important features. Plateau the purpose of the training in addition to the use of anoxic conditions to improve the athlete body tissue re-synthesis of the ATP the ability, but also can improve the tissue cells obtain and use oxygen ability, so that the body's aerobic capacity has been strengthened.

Therefore, in the general post-genomic era, systematic biology as the research object, system biology represented by genomics, proteomics and metabolomics has also gradually become the trend of life science research. Metabolomics reflects the response of organisms to different stimuli by measuring all the metabolites in the sample," and uses metabolic profiles to study life systems. Metabolomics is more sensitive and overall than genetic studies with stronger and simpler and faster testing and analysis. Many researchers tend to use parametric motion models to deal with this problem. The main idea is to establish a parameter space for a series of motion segments with the same type and structure, and then adjust these parameters directly or indirectly to move in the original space. Exert influence; this not only guarantees the quality of the synthesis, but also effectively reduces the complexity of the control. According to the different selection methods of motion parameters, these models can be roughly divided into the two categories: The first category requires human observation of the data first, and the key indicators depicting this type of exercise are refined into motion parameters such as step size, turning amplitude, and speed, etc., then establish a relationship between the motion parameters and the original motion data, and finally guide the synthesis of the motion by adjusting these parameters.

In this system, the sensing device collects the multiple physiological parameters of the user, providing a basis for real-time processing of the personal terminal and upper-level decision making at the remote server. How to provide real-time and accurate services based on user's movement, position, physiology, and other related information on a limited-mobile device is a core issue for wearable health monitoring systems. This article will proceed from the application requirements and challenges of the wearable health monitoring system. It will mainly describe the research background, research significance, main research contents and innovative work of the topic. Finally, the organization of the paper and the subsequent chapters will be arranged.

2. Research on Wearable Device Detection based on Physiological Parameters of Human Motion State

2.1. Wearable computing and wearable health monitoring

Wearable computing is a new type of personal mobile computing system. Prof. Mann of Canada defines it as a computing system that belongs to the user's personal space, is controlled by the wearer, and has the continuity of operation and interaction. It is non-restrictive, Non-exclusive, observable, controllable, environment-aware, and general communicative. Wearable computing provides people with a new type of human-computer interaction model: using the human body as the background of physical support, wearing a supporter in the form of a vest, a backpack, a belt, etc., and fitting it with various types of sensors and other devices. , And adopt new human-computer interaction methods such as augmented reality, intellisense, and scenario computing so that users experience only services. Under normal circumstances, wearable computing consists of four parts: a micro-host, a human-computer interaction system, a sensing system, and a communication system. Wearable computing has very important applications in the fields of industry, military, medical care, agriculture, disaster rescue and disaster relief, and therefore has great application prospects.

The wearable health monitoring system is based on wearable computing and generally refers to the collection of human body's physiology, activity, location and environment, and other context information through various types of sensors. The information is processed locally or remotely through modern communication technologies. The user's current or the future physical condition makes a diagnosis or prediction. The system can provide patients with low-load, non-contact, long-term continuous physiological monitoring, and is considered to be the most effective and practical monitoring method in the new generation of some medical monitoring modes.As the sports biomechanics study of the important means of

the human body motion for the multi-camera synchronization test, in the body of a single block of muscle length, moment arm, etc. muscles function parameter has missing shake it. The use of the EMG instrument and the measuring station for muscle function models of the study provides analysis of the work of the muscle groups of the basis, and then the muscle function of the model with multi-machine synchronization test combined can make the required quantitative information is more abundant, more convenient for human movement intrinsically linked to the simultaneous analysis.

The lower extremity of each part of the movement reference position of the quantization and describe the lower extremity part of the attitude angle of the generalized coordinates of the selection. In order to properly describe the body part in the movement of the change, the use of international anatomical will the provisions of the related human standard anatomical position terms. And standards of human anatomical posture state of the lower limb reference position, the basic movement of the surface is quantized, so that the description and mathematical analysis. In the description of the lower limb part of the attitude angle of the generalized coordinates of the selected aspects, the present study uses thebrean angle describes the human part of the pointing movement, the human body reference position part coordinate system of the coordinate axes, the human body, basic shaft and brean angle of the shaft of the three corresponding. Existing speed estimation models are questioned in applications due to their lack of accuracy.

Therefore, it is necessary to verify the accuracy of the existing model, and to develop a new acceleration signal acquisition device and establish an accurate speed estimation model.In this way, the performance of different muscles in kinematics, kinetics and electromyography can then be comprehensively analyzed in this system as the muscle function model is based on the main function of muscle contraction in length change and the muscle tension in the process of line and the change of the joint center position to evaluate the working nature of muscle and muscle tension on the torque ratio of the shaft of the relationship, namely muscle tension on the link in the size of the rotation effect. Exist certain muscle function transformation angle, for example, in the joint activities within the scope of muscle will appear to elongation and shorten the length (or the opposite), the effect of the properties of the joints in the before and after the joint angle is opposite.

2.2. Wearable health monitoring system features

The definition of a health monitoring system in a medical research unit should be: safe, effective, and patient-centric, providing real-time, effective, and fair medical and related services. Wearable computing provides sensors and monitoring equipment with a platform to monitor individual physiological conditions. Due to its characteristics of “natural, convenient, and direct interaction”, it is widely used in clinical medicine, home health care, sleep analysis, emergency care, and special care. Crowd monitoring, psychological evaluation and so on.

The development of microelectronics technology provides portable devices with small-sized, low-power sensing devices; the development of multiple wireless communication methods facilitates interconnection between devices. The development of intelligent mobile terminals provides a powerful computing platform for mobile computing. The three powerful combinations provide an advantageous way for the broad development of wearable health monitoring technologies.

Figure 1. Prototype of amon

2.3. Wearable device model

In the 21st century, the people’s living standards have improved, and more attention has been paid to the quality of life and health conditions.

The higher, in this context, with the development of big data, sensors and network technologies, wearable device systems for human body physiological parameter detection based on acquisition, transmission, and analysis have emerged and are applied to all aspects of mobile healthcare.

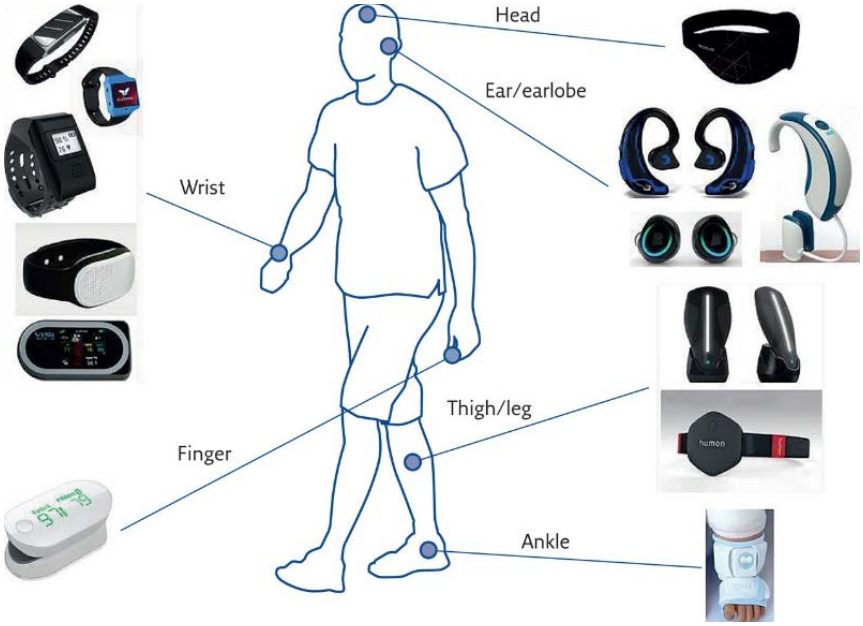

Figure 2. The smart sensing frameworks

Wearable medical devices, by definition, are portable medical devices that are worn directly on the body or integrated into the user's clothes or accessories. It is not only a kind of hardware device, but also realizes powerful functions through software support, data interaction, and cloud interaction. Wearable devices will bring a great change to our life and perception. By consulting the product data of domestic registered cities, equipment is mainly focused on the detection of physiological parameters such as electrocardiogram, blood pressure, body temperature, and blood oxygen. Its main products are dynamic ECG recorders, wireless electronic thermometers, and dynamic electronic blood pressure. Its structural composition is mainly composed of a physiological parameter detection host that can be attached to the body, a power adapter for charging the host computer, and mobile phone application software.

The single-channel ECG recorder is suitable for home and medical institutions to measure ECG waveform and heart rate, store test data, and view historical records, which can provide reference for diagnosis of medical personnel. This product can be used to screen for arrhythmias such as premature beats, atrial fibrillation, supraventricular tachycardia, and ventricular tachycardia. During the measurement process, the device sends the ECG data to the smart terminal software for recording and display through the Bluetooth. At the same time, the terminal software performs real-time analysis of the ECG. When there is a major risk, the ECG data is uploaded to the back-end data center through the wireless network in real time. The back-end physician directly contacts the phone to provide professional emergency guidance.

Wearable is an ECG product that utilizes bioelectric sensing technology. This kind of product can record dynamic ECG data within a certain period of time, transmit it to mobile phone APP through Bluetooth technology, and send it to ECG data analysis center through public wireless communication network. The analysis center can realize the remote real-time monitoring of the user's ECG data, with the characteristics of anytime, anywhere, timely response, and accurate monitoring. It can provide routine cardiac health care services and disease monitoring and warning for high-risk groups of cardiovascular disease and heart disease patients.

2.4. Wearable device functions

Step counting function: use 3-axis gravitational accelerometer to measure the number of steps caused by the jolt caused by the movement, and then eliminate the wrong count according to a certain principle to obtain the final result.

Heart rate monitoring: using a reflective photoelectric sensor, collecting photoelectric signals to monitor and calculate changes in pulse blood volume, and then calculating the basic parameters reflecting the human heart rate based on the relationship between the absorbance of blood substances and the concentration.

Body temperature detection: the use of thermistor to change the temperature changes into resistance changes, and then use the appropriate measurement circuit to convert the resistance into voltage, then the voltage value is converted to a digital signal, and then the digital signal can be processed accordingly Temperature value.

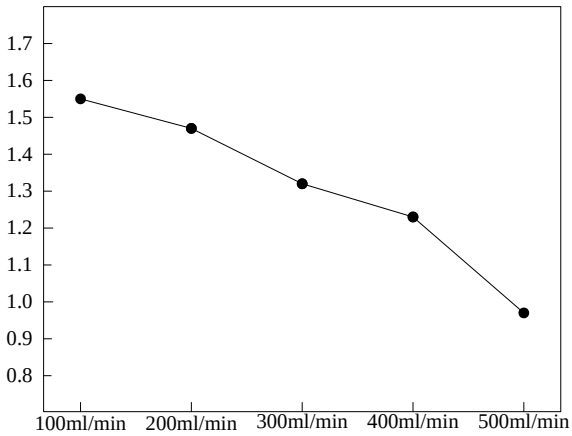

Figure 3. The statistical data collected

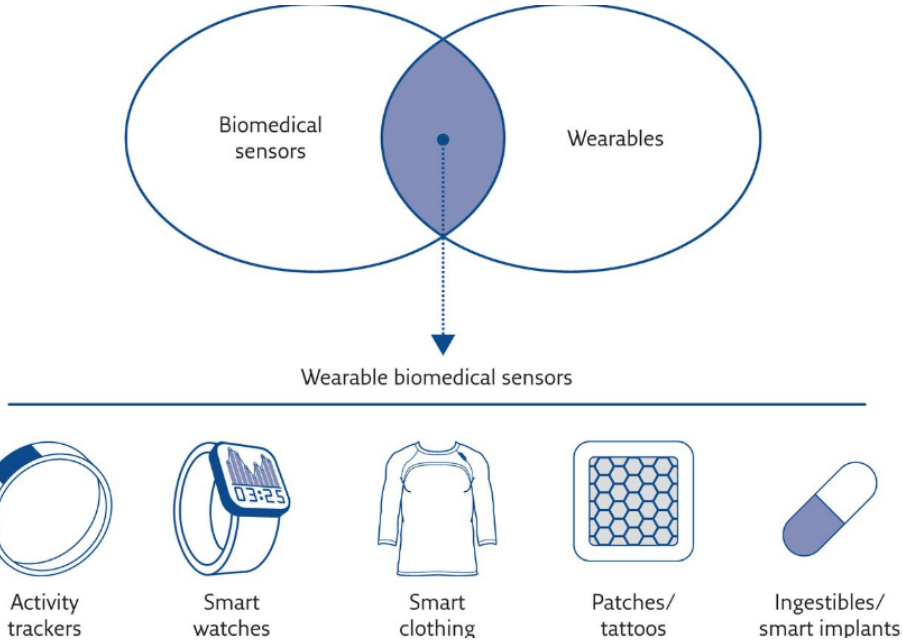

Figure 4. The wearable devices detected for references

Energy consumption and sleep monitoring: The sensor detects the movement, heart rate, and body motion frequency of the person through contact with the wrist and calculates the sleep state and energy consumption of the subject. Different products have different algorithms.

The heart of a wearable device is a sensor. Mainly divided into biosensors, motion sensors and environmental sensors. With the development of sensing technology from embedded technology to MEMS technology, sensing materials gradually transition from semiconductor materials to nano- and nano-silicon materials, and the sensors tend to be miniaturized. Intelligent, which promotes the gradual development of wearable devices to implantable devices.

Biosensors mainly include the heart rate sensors, blood pressure sensors, blood glucose sensors and the body temperature sensors. These sensors are used to collect human physiological signals, mainly to monitor the user's physical condition and condition, and to promptly report alarms to reduce the probability of a patient's illness.

Environmental sensors mainly include air pressure sensors, temperature sensors, humidity sensors, ultraviolet sensors, pH sensors, ambient light sensors, and particle sensors.

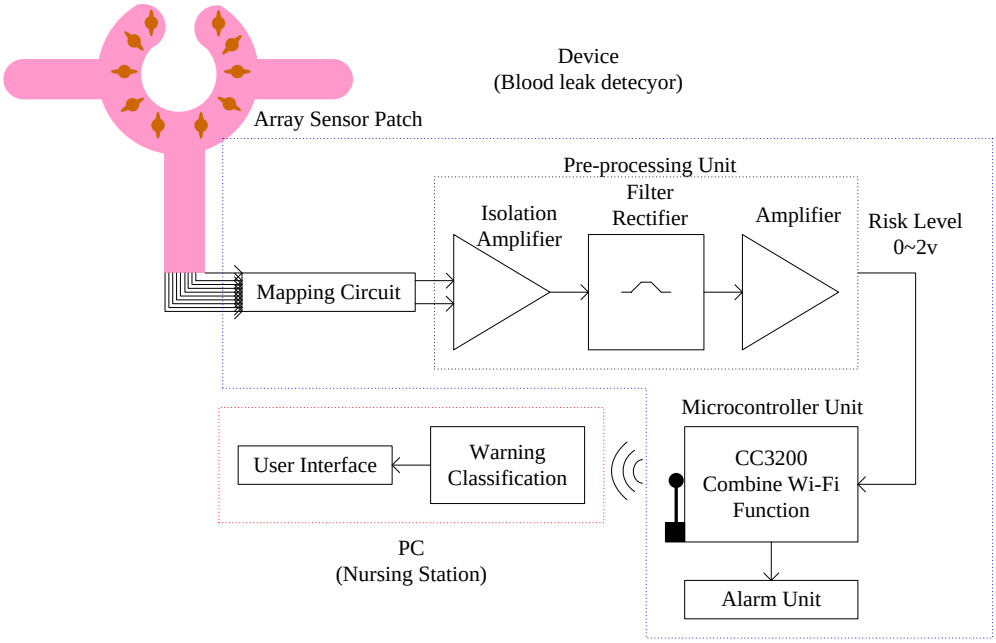

Figure 5. The finalized sensor network topology and organizations

At present, more wireless communication technologies are used in wearable devices: Bluetooth, WIFI, ZigBee, NFC, and the like. At the same time, the wireless communication technologies used by wearable devices need to meet the following requirements: small size, high flexibility, convenient networking, low power consumption, low radiation, strong anti-interference ability, and high security. According to different functions of the wearable device, different wireless communication technologies may be selected, or several wireless communication technologies may be used in combination.

3. Conclusion

The idea and prototype of wearable devices were proposed by the MIT Media Lab in the United States in the 1960s. They refer to products and electronic devices that can be worn by users and manufactured using technologies with advanced features and characteristics. Used to record daily activities or monitor the protection of the user's physical health. Wearable technology mainly explores and creates science and technology that can be worn on the body, worn or embedded into the user's clothes, or integrated into the accessory device. With the rapid development of electronic products, various wearable products have also entered our lives. Among them, wearable products such as smart wristbands and watches have been well-known to many people.

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