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Innovative Design of Intelligent Clothing Based on Body Temperature Monitoring

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Abstract: Due to the continuous improvement of the economic level and the changing social environment, people have not only limited to wearing clothes, but also have higher requirements for the beauty of clothes, from the basic need of wearing clothes to the increasingly high requirements for clothes. The emergence of health-monitoring smart clothing reflects the change of people's concept and demand. The application of such health monitoring smart clothing is no longer limited to the military and medical fields, but there are also more and more health monitoring smart clothing for daily life. Therefore, this paper systematically analyzes and researches the theoretical knowledge related to the design of temperature-monitoring smart clothing, summarizes the components of health-monitoring smart clothing for temperature monitoring data and the problems that still exist, and discovers and researches innovative methods for such smart clothing from the research of market demand. In addition, we have found and researched the innovative methods of these smart garments from the market demand research, and carried out the innovative design experiments on the health smart garments for temperature monitoring with the market demand as the starting point.

1. Introduction

The research results of this project will provide ideas for the design method of health monitoring smart clothing, and will also provide some methods for other interdisciplinary research. From a macro perspective, the design of temperature monitoring smart clothing demonstrates that smart clothing is not just a concept or an unrealistic fantasy, but a functional garment that can be used for people in the future. From the beginning, the concept of temperature-monitoring smart clothing has become a reality, from its application in the military field to its expansion in the medical and entertainment fields, proving its value [1]. Nowadays, the development trend of temperature monitoring smart clothing is lighter, thinner and more comfortable, which is updated with the demand of consumers. The design of temperature monitoring smart clothing based on consumer needs is actually centered on the consumer and is closely related to the consumer's psychological activities and wearing experience, which also fully experiences the human-centered principle. From a microscopic perspective, the research in this thesis provides a pathway for the innovative design of smart clothing for temperature monitoring, which is designed to meet the material and psychological needs of people, and to provide an optimal solution to the problems of existing smart

products under the current technological and production conditions. Therefore, this thesis is a theoretical and practical guide to the innovative design of health monitoring smart clothing based on body sign data [2](Figure 1).

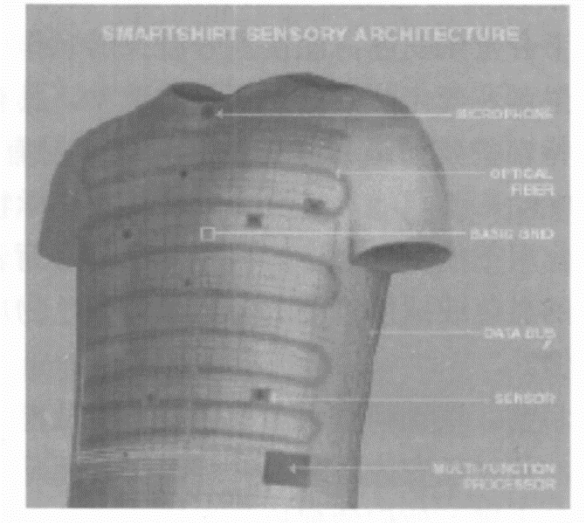

Figure 1: Health monitoring smart clothing

2. Concept and Classification of Smart Clothing

Smart clothing is a branch of wearable devices. We commonly see smart watches and smart bracelets as smart wearable devices. But smart clothing will be the darling of the future because it is the "second skin of the human body" that allows us to digitally analyze devices in an easier and more accurate way [3]. It can use a variety of identification, sensing, connectivity and cloud services and other interactive and storage technologies to replace handheld devices or other devices, to achieve user interaction, life entertainment, human body monitoring and other functions of the new daily wear mobile intelligent terminal. Wearable smart devices were first used in military security and medical fields because of their high functionality, but with the improvement of technology, wearable smart devices are increasingly appearing in the field of fashion and sports and fitness. Smart clothing is also known and worn by the public with the development of smart hardware. Body temperature monitoring smart clothing belongs to the medical health field, which collects body temperature data by implanting temperature modules into clothing, and then analyzes the wearer's health level through data processing [4] (Figure 2).

Figure 2: Neuronaute smart clothing

3. Structural Components of Body Temperature Monitoring Type Smart Clothing

In recent years, monitoring clothing has been used in a wide range of applications, including military security, medical and health care, leisure and entertainment, and so on, penetrating into all aspects of life. Health monitoring smart clothing is mainly used in people's daily life to monitor and remind people of their health status [5]. The body temperature signal is one of the basic physiological signals of human body, and the main physiological signals of human body include blood pressure, ECG, respiratory rate and body temperature signal, which are the most common health data in daily life and are used to detect and remind people of their health conditions. This thesis focuses on the application of human body temperature monitoring to smart clothing innovation. A temperature monitoring garment consists of a sensor, a receiver, a battery and a garment that carries it. The information monitoring part is sampled by the collection module with body temperature sensors, and the information processing will analyze and process the collected body temperature data samples by electricity, storage and wireless receiver, and finally provide physiological feedback through an app application, voice prompts or uploading to a medical center. The main innovation of structural research and development of clothing design is to deal with the relationship between the bearing platform of clothing and these parts[6-7].

3.1 Body Temperature Monitoring Sensor

A sensor is a signal output device or a piece of equipment that converts all physical and chemical information according to certain rules to make it easy to use, and it is crucial for functional clothing. Based on the needs of the garment, sensors are used to test the indicators of the smart garment, so that consumers can use the sensors to detect and collect the internal and external environment. For the human body, blood pressure, heart rate, respiration and temperature are important indicators of vital signs and are significant for the human body(Figure 3).

Figure 3: The sketch map of DHT11 temperature and humidity sensor

3.2 Battery and Wire

The receiving and processing platform on the temperature monitoring garment exists to transmit information between the body and the machine and consists of a battery, a memory, a wire, and an infinite transmission module. The memory and the infinite transmission module are small in size, and the battery and the wire take different forms and shapes depending on the garment[8-9].

(1) Battery

Comprehensive smart clothing with more functions consumes more power, generally has a larger battery capacity and a larger battery size; while smart clothing with fewer functions consumes less power, and generally has a smaller battery capacity and a larger battery size. However, with the continuous innovation of science and technology, the battery required for intelligent modules has been developing towards light weight and long battery life[10-11].

(2) Wires

In the flexible sensor is still in the research stage, the placement of the wire is a big problem in smart clothing, metal wire and clothing fabric material mismatch for the development of smart clothing brings a lot of obstacles, and in recent years, many companies have made a lot of efforts to break through this limitation, Google and Levi's developed a touchable fabric, this fabric will conductive materials woven into the fabric yarn, so that the fabric This fabric weaves conductive materials into the yarn of the fabric, thus making the fabric have a powerful function similar to a hand touch screen. With the development of conductive fabrics, wires out of the stage of smart clothing.

3.3 Garment Fabrics

Body temperature monitoring smart clothing acts as a carrier of intelligent hardware is, of course, clothing. The fabric of the garment varies depending on the needs. The flexible sensor mentioned in the previous chapter is actually a mixture of smart fibers with sensing and response capabilities and ordinary fibers. Because of their special properties, smart fibers are widely used and popular around the world, and some researchers even consider them to be the gospel and future of the textile industry. In terms of the current situation, the smart nature of smart clothing comes from three main ways: first, mixing some smart fibers or modified fibers with garments to give them intelligence; second, using some smart substances to process the garments by dyeing or coating them in the garment division; third, using weaving or direct embedding to mix electronic components with the garments to eventually become smart clothing. The design of health monitoring garments mentioned in this thesis is mostly done in the third way(Figure 4).

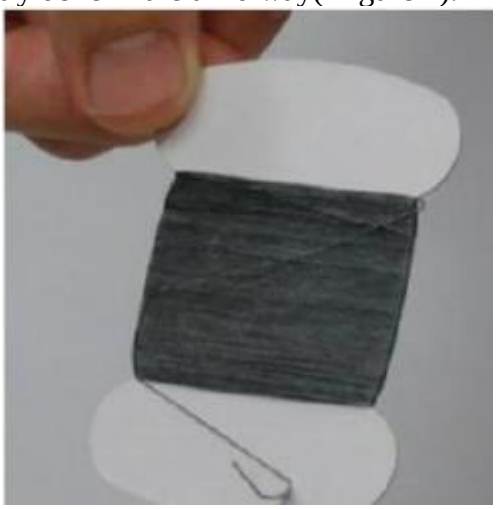

Figure 4: Electrode material coated with conductive polymer “PEDOT-PSS”

For smart clothes, sensors are the main reason for their intelligence and comfort. In today's high-tech society, sensors are a tool for sensing, collecting, transforming and transmitting information, and they are used in every industry. Flexible sensors are developed with the development of technology, it has the function of ordinary sensors at the same time has a good

flexibility, can be folded at will to change the shape, which for complex parts, there is a better determination of its role in contact detection, nondestructive testing, robotics and other applications. In terms of the current situation, both domestic and foreign, wearable flexible sensors are still in the research stage, for commercial purposes, the test accuracy, sensitivity and reproducibility can no longer make it meet, but must be explored more deeply. So far, both domestic and foreign research in the fabric structure sensor is still in the knitting structure, in the conductive needle fabric research has not been involved(Figure 5).

Figure 5: Cool Max under the microscope

4. Innovative Design Elements of Body Temperature Monitoring Apparel Based on Market Demand

Based on the fact that sensing hardware is a special attribute in a different field than conventional clothing, the following elements should be noted in the design process of combining body temperature detection devices with clothing.

(1) the realization of functionality: the emergence of temperature monitoring clothing is not to become a toy, in the design of clothing to focus on the function of technology to the maximum, and hope that through the optimization of clothing design will have its own functionality more comprehensive, with the perfect show, so as to ensure that the functionality and practicality of clothing to be mutually optimized and improved[12-13].

(2) Comfort: pay attention to the size of some intelligent devices, their weight and the reasonableness of the placement, these intelligent devices need to be combined with clothing on the pressure test and wearing practice, so as to ensure that the wearer's wearing experience, so that the temperature monitoring system of temperature monitoring intelligent clothing is no longer a superfluous burden, at the same time, the functionality and practicality of such clothing can also be better solved. At the same time, the functionality and practicality of these garments can also be better solved.

(3) The design elements of security clothing with sensing devices are different from conventional clothing design and the combination of electronic components and clothing is a very important part. However, there is no doubt that it is not enough to simply meet a specific function, but that safety garments with sensing devices also need to include certain fashion elements.

In the design of the combination of clothing and electronics, it is important to look at the safety garment, the electronics and the environment in which they coexist as a system, not just the individual elements. In the design process, the relationship between man and machine should be fully considered, and under the guidance of the theory of ergonomics, the organic connection between different elements should be utilized through scientific means, and the structure of the three elements should be constantly revised and improved to achieve the best parameters of the system, so as to ensure the realization of the optimal combination[14-15].

4.1 Functional design of body temperature monitoring garments

The interpretation and study of body temperature reveals that there are several groups of people who have a greater need for temperature monitoring clothing: children, women, the elderly, and susceptible people. (1) Children's fever monitoring. Children's body temperature is not as stable as that of adults, and they often have fevers, which can lead to other diseases if they are not found in time. (2) Scientific pregnancy preparation for women. Women's body temperature curve can be analyzed by data analysis to obtain physiological period and ovulation reminder, so that women who want to have a baby can plan their pregnancy more. (3) Temperature monitoring for the elderly. Similar to children's temperature monitoring, for elderly people who are less able to take care of themselves, temperature monitoring clothing can help family members better understand the health status of the elderly. (4) Monitoring temperature changes in vulnerable populations. The majority of patients who are recovering from surgery are susceptible people, and their body temperature should be measured daily. For those who have difficulty in measuring their body temperature, they can wear smart clothing to know the temperature situation at every moment more conveniently to understand the recovery of the wound.

Then temperature monitoring clothing needs to be designed according to the needs of different people and wearing occasions. For example, temperature monitoring garments for children need to be designed to meet the accuracy of monitoring data during various activities and to ensure that the structure of the garment is easy to put on and take off and monitor, etc.; garments for pregnant women need to be designed to meet the functional requirements of the garment, taking into account the effective measurement time and occasion. There is a large population of patients in recovery, and each patient's body condition needs to be broken down to better achieve the functionality of temperature monitoring garments. At present, most of the smart clothing commonly used in the market is a combination of clothing and sensor hardware, and the ultimate purpose of designing temperature monitoring clothing is to monitor body temperature more conveniently, so designers need to design functional clothing from the perspective of giving priority to meeting the functionality of the clothing, and optimize other aspects of the clothing while meeting its main functionality.

4.2 Aesthetic Design of Body Temperature Monitoring Garments

Temperature monitoring clothing will eventually appear in the form of clothing, so temperature monitoring clothing also needs to have the qualities of clothing to attract consumers' desire to buy. Currently, some of the smart clothes in the market only have the participation of industrial designers but not clothing designers, which may lead to problems such as unwearable clothes and small consumer groups. Body temperature monitoring clothing also needs to solve the important problems of shape contour, structure, material and color selection. Compared with conventional clothing, body temperature monitoring clothing needs to be more simple and practical style design, because it is used and worn on the human body more time, need to be able to match a variety of daily use occasions to extend the wearing and use of clothing time. The structure of the garment should also be based on the characteristics of temperature monitoring clothing to add the necessary structural line, which is generally a horizontal line around the upper chest circumference. In terms of clothing materials, a variety of materials will be considered for aesthetic purposes to add a rich sense of layers to the clothing, and different styles of fabrics will be selected according to the needs of different people, so that intelligent clothing and conventional clothing as much as possible with a sense of quality rather than a technological toy. The color of the clothing needs to be set in a variety of ways, clothing design can not be separated from the "people-oriented", everyone's preference for color are different, then the temperature monitoring clothing also need to set a variety of colors for

consumers to choose, so as to better meet the consumer's desire to buy, but also to increase the richness of temperature monitoring clothing. Body temperature monitoring clothing as a kind of health monitoring intelligent clothing is for human services, this kind of clothing in the appearance of the design needs to listen to the consumer's mind, respect the consumer's heart demand, clothing designers need to better analysis and interpretation and will be converted into a beautiful clothing.

4.3 Convenience Design of Body Temperature Monitoring Garments

From international to domestic we can learn that smart clothing has become a new trend in the design and technology world. From the most famous international crowdfunding platform Kickstarter, we can see the hot attitude of crowdfunding for smart clothing from all over the world, and in domestic Jingdong and Taobao crowdfunding, we can also see successful cases of crowdfunding for smart clothing. This shows that people have great enthusiasm for the development of smart clothing. However, analysis shows that the easier it is to disassemble the electronic components of smart clothing, the easier it is to clean smart clothing, the easier it is to charge and maintain the hardware of smart clothing, and the easier it is to use, the more popular it is with crowdfunding. For example, the smart coat released by Hefei Xiuxutang Trading Co., Ltd. on Jingdong Crowdfunding was well received by the public.

4.4 Emotional Design of Body Temperature Monitoring Clothing

Emotional design is a design concept that is sought after by consumers in today's technological development. With the improvement of people's material consumption level, people's emotional needs have received unprecedented attention. In the industrial era, people deal with cold machines all the time, while humanized design will let people experience more human warmth and emotion when using the designed products. Intelligent clothing for temperature monitoring requires designers to take into account the combination of temperature monitoring hardware when designing innovations, so that the clothing can be more practical with emotion and the monitoring device can play its role more accurately in daily use. In fact, many design fields have begun to gradually promote emotional needs and emotional design. For example, in an industrial design case, there is a table designed for the blind, which looks no different from an ordinary dining table, but the designers have made special treatment of the handle of the table so that ordinary people do not understand the mystery of it. In the field of stationery design, Hobo, a famous Japanese notebook brand, not only attracts people with its branding and appearance, but also with its precise design and production in terms of paper selection, table arrangement, font layout, and grid size. The product has essentially transcended the constraints of appearance and shape to give it a new meaning and inner satisfaction. Similarly, in the process of designing security apparel for sensing devices, designers not only need to consider whether the operation is ergonomic and humane in terms of materials, but also need to increase the affinity of the apparel so that users can experience the temperature of an object when wearing and using it, which is also the embodiment of the "people-oriented" spirit. At the same time, the real-life environment and human behavior are in constant change, so the combination of clothing and electronic components needs to be adaptable and versatile, so as to improve the efficiency of the use of intelligent monitoring clothing under the sensing device and extend the use time of intelligent monitoring clothing under the sensing device. For temperature monitoring clothing, emotional design is a factor that designers should pay attention to, and the intelligence of smart clothing is the embodiment of emotion, so that the cold device better care for the idea of people is what designers need to study more deeply.

5. Conclusion

In this paper, we study temperature monitoring smart clothing and try to apply temperature monitoring clothing to clothing that can serve people's life. Through the collection of literature, the survey of the market demand for health monitoring smart clothing, the summary of design elements, and the application of design elements, the following conclusions are obtained. In the opening chapter, the author compares the development history and current research status of temperature monitoring smart clothing and concludes that temperature monitoring smart clothing is not just a concept, but there is a great market demand for temperature monitoring smart clothing as a new type of clothing, which can be used in real life to serve people's daily life. Some researchers and companies are also doing research and improving the price, appearance and function of temperature monitoring clothing. However, since the research and design of temperature monitoring smart clothing is an emerging and interdisciplinary field, there is not enough theoretical research in China and the theoretical guidance for design is not sufficient, and the products that have been marketed still have poor performance, high prices and difficulties in updating. To address the existing problems, the paper analyzes the actual research and data to find out that people have realistic and psychological needs for temperature monitoring clothing, and through data analysis, it is concluded that different target groups have different needs for temperature monitoring clothing and need to do targeted innovation research and development according to different target groups. This thesis integrates the research data and extracts the design elements, including comfort design, functional design, aesthetic design, convenience design and emotional design elements. Based on the concept of human-centered design and respecting the needs of consumers, the author has designed the intelligent clothing for temperature monitoring from each design element and come up with ideas to solve the problems of appearance, function and convenience through practice. In the innovative research on the design and structure of wearable temperature monitoring products for different groups of people, the thesis has organized the innovative research ideas based on the analysis of the needs, and designed temperature monitoring clothing for two different groups of people: children and women, using ergonomic pressure testing, selection of fabrics and materials, and the combination of hardware and clothing. The sales and user feedback of the innovative practice results confirm the feasibility and application value of the smart clothes designed based on the market demand for temperature monitoring. Through this innovative practice, the design method of temperature monitoring smart clothing is summarized, so that the theory of this paper corresponds to the practice. This paper summarizes the design ideas for temperature-monitoring smart garments and provides an optimal solution for the design of temperature-monitoring smart products under the current technological and production conditions, and provides new thinking for the development of the current garment industry. It also provides some references for innovation and interdisciplinary research methods in related industries.

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