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Innovative Application of Smart Textiles in Furniture Design: The Integration of Temperature Control and Health Monitoring Functions

Ya'nan ZHENG

Department of Product Design, Zhengzhou Academy of Fine Arts, Zhengzhou 451450, Henan, China

zhengyanan@zzafa.edu.cn

Article

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ABSTRACT

The convergence of textile science and electronics has paved the way for the development of smart textiles due to the rapid progress of technology. The continuous miniaturization, precision, and sensitivity of sensor technology provide solid technical support for embedding sensors into textiles. Given the increasing consumer demand for smart homes, the temperature control and health monitoring functions of smart textiles must be explored. This study validates these functions through experiments, comparing key performance indicators, such as temperature regulation efficiency, health monitoring accuracy, and user experience differences between traditional and smart textiles. Results indicate that smart textile-based furniture offers significant advantages in temperature regulation and satisfactorily performs in health monitoring, effectively meeting the requirements for daily health data monitoring. However, the accuracy of smart textiles during physical activities remains to be improved. Although a number of users express overall satisfaction, the stability of wireless transmission is a concern. In conclusion, smart textiles integrating temperature control and health monitoring features hold great potential in furniture design. However, further refinement and optimization are needed for optimal technical performance and user experience.

KEYWORDS

smart textiles, e-textiles, thermoregulation, health monitoring

INTRODUCTION

Textile science and electronics are rapidly converging as technology advances, allowing for the development of smart textiles. Environmental and physiological information can be effectively detected and processed by integrating sensors and microelectronic components into textiles. The rapid development of sensor technology has resulted in improved sensitivity and energy efficiency, enabling the integration of sensors into various textiles. In today's society, people are highly concerned with improving their quality of life and adopting healthier lifestyles. Furniture, an item that people used for extended periods, can be equipped with health monitoring features that provide real-time health information. Consequently, comfort and health have become key considerations in furniture selection, increasing the demand for smart home products [1]. Companies are compelled to continually innovate to enhance product competitiveness as competition intensifies in the furniture market. The incorporation of temperature control and health monitoring functions from smart textiles into furniture design is a key strategy for achieving product differentiation and upgrading within the industry [2].

Intelligent textile design has become a prominent topic nowadays, and numerous scholars have carried out related research. Li [3] proposed a new type of self-powered smart textile (WSIT) based on a continuous manufacturing process, which combined triboelectrophotometry (TIEL) and single-electrode tribo-nanogenerator (TENG). In the optical sensing mode, WSIT can identify the luminous trajectory of fingers, which may be widely used in the field of smart home. Maslari [4] pointed out that in the textile industry, the design and use of intelligent equipment, such as autonomous guided vehicles, can significantly enhance production flexibility and automation. Yosef de- veloped a new type of intelligent composite structural element by integrating three advanced technologies: a magnesium phosphate cement matrix, an intelligent self-sensing carbon-based fabric reinforcement system, and an additive short dispersion fiber. The development of new intelligent materials provides technical support for enhancing the performance of textiles [5]. Gktepe described and developed a new intelligent textile structure using polymer artificial muscles and provided examples of structures and mechanisms that can be used in the future. These driving textiles, utilizing various muscle yarns and fiber types, can change their porosity or bulkiness or bend or fold when the temperature changes without affecting the transverse size of the fabric [6]. Zheng [7] studied the advantages of chipless interactive intelligent textile technology and noted that the realization of the existing intelligent textile functions mainly depended on the complex and rigid silicon-based computing, which poses significant challenges in integration, energy consumption, and user experience. Rahaman [8] discussed the thermal properties of organic phase change materials (PCMs), which refers to materials that alter their physical states in response to temperature changes, focusing on their ability to absorb, store, and release heat, which con- tributes to improving the microclimate inside textiles. Zhang [9] prepared TBP-50 bio-composites utilizing typical extrusion molding techniques, making them an ideal alternative for ceilings, partitions, floors, wardrobes, desks, and other applications. Although various aspects of smart textiles have been studied by numerous scholars, few studies have focused on integrating temperature control and health monitoring functions. On this basis, the in- novative application of intelligent textiles with temperature control and health monitoring functions in furniture design is selected and analyzed.

EXPERIMENTAL

Materials and Methods

Materials

Smart textile materials

Microcapsule PCMs are designed to operate within a temperature range of 24 °C–26 °C and are applied to polyester fiber fabrics for temperature regulation. This range closely aligns with the average temperature of human skin (25 °C–27 °C), which can minimize the interference of temperature fluctuation on the baseline signal of heart rate sensors (such as photoelectric volume pulse wave) and improve the data stability (error rate $<2\%$). However, environmental humidity can significantly affect the performance of microcapsule PCMs. Under high humidity conditions (>80% RH), microcapsule PCMs absorb moisture and expand, resulting in a 12%–18% decrease in phase change enthalpy and a 30% increase in response time. Additionally, water vapor penetration accelerates material aging, shortening the lifespan by 20%–30%. Moreover, humidity increases the viscosity of the coating slurry, causing microcapsules to aggregate, increasing the coating thickness deviation rate by 8%–10% for every 10% increase in humidity, and extending drying time by two to three times. These effects can be mitigated by applying PCMs in a constant humidity environment of 45%–55% RH using moisture-resistant composite wall microcapsules and a heat pressing post-processing technique.

The health monitoring sensor incorporates a flexible piezoelectric thin film sensor and conductive graphene fiber. The piezoelectric thin film sensor is used to monitor the pressure distribution and body movement frequency, while the conductive graphene fiber is utilized to make heart rate and body temperature monitoring electrodes. The sensor is integrated into textiles through a fabric weaving process.

Cotton-polyester blended fabric with good air permeability (60% cotton and 40% polyester) is selected as the base fabric to ensure comfort and durability.

Furniture carrier

Two types of experimental furniture were customized, including a single person sofa and a mattress, both featuring a modular design to facilitate the installation and removal of smart textiles.

Methods

Sample preparation method. The smart textile samples were made by combining the polyester fiber fabric coated with PCM with the cotton-polyester blended fabric with integrated sensor through a hot pressing composite pro- cess. Smart textiles were installed at key contact parts between the sofa and the mattress (such as cushion, back- rest, and mattress surface), and the microdata acquisition and wireless transmission modules were connected. Performance test method. (1) Temperature control performance test. In the environmental simulation chamber, the temperature was set to rise from 20 °C to 30 °C at a fixed rate and then cooled to 20 °C at a fixed rate. The surface temperature of the smart textiles was recorded every 5 min with an infrared thermal imager and a temperature sensor, and the temperature adjustment effect was analyzed. The phase change temperature range of the microencapsulated PCMs was set at 24 °C–26 °C, and it was coated on the surface of a polyester fiber fabric to realize temperature regulation. Four environments of 40%, 60%, 80%, and 95% RH were simulated to investigate the influence of humidity on the performance of the microencapsulated PCMs. (2) Health monitoring performance test. Twenty healthy volunteers aged between 25 years old and 35 years old were recruited. The heart rate were simultaneously monitored using professional medical equipment (a medical thermometer and electrocardiograph) and smart textiles under light resting, reading, and light exercise state. The data were observed and recorded. (3) User experience test. Volunteers were invited to experience mattresses and sofas with smart textiles for 2 h. This duration was chosen for a preliminary assessment of immediate comfort and usability. A pre-designed questionnaire was administered to the volunteers to assess their evaluation of the smart textiles in terms of usability, health monitoring, temperature comfort control, etc. (4) Accelerated aging tests can be conducted to address the performance degradation of microcapsule PCMs in smart textiles after repeated washing or prolonged use. The tests simulated 50 standard wash cycles (40 °C water temperature and 800 rpm) and 1000 h of high-temperature and high-humidity conditions (60 ◦C temperature and 90% humidity).

Evaluation method. (1) Temperature control performance: the speed rising process and final temperature of the ordinary fabrics and smart textiles were compared over a 2 h period; the cooling process and the final holding temperature of the two fabrics were also compared under the same room temperature environment over a 3 h period. (2) Health monitoring function: the heart rate monitoring data from professional medical equipment and smart textiles were observe and compared while the volunteers were at resting, reading, and light exercise state. (3) The score of the smart textile use experience included three topics: volunteers' satisfaction with temperature comfort, health monitoring function, and operation convenience when using smart textiles. The scoring mecha- nism followed Richter's five-level method: one point for very dissatisfied, two points for dissatisfied, three points for general, four points for satisfied, and five points for very satisfied. The Cronbach's α coefficient of the scale was 0.76, which was between 0.7 and 0.8, indicating good reliability of the scale. (4) Cost and mass production evaluation index of intelligent textiles. The cost index included the cost of graphene electrode, and the produc- tion index consisted of the qualified rate of PCM soil layer uniformity. Thereafter, the comprehensive benefit was compared.

RESULTS AND DISCUSSION

Temperature and humidity changes

Figure 1 shows the comparison results of the temperature rise rate and final stable temperature of the ordinary fabrics and smart textiles within a 2 h period. The data are collected in an environmental simulation chamber where the ambient temperature increased from 20 °C to 30 °C at a rate of 5 °C per hour. The temperature of the ordinary fabrics (Figure 1) begins to rapidly increase almost immediately as the environmental temperature increases. In just 30 min, the surface temperature of the ordinary fabrics rises from 20 °C to 24.5 °C, showing a steep upward slope in the temperature–time curve. The temperature reached 29.2 °C by the end of the 2 h period, closely following the increase in the ambient temperature.

By contrast, the smart textiles demonstrate a significantly different thermal response. The temperature rise of the smart textiles is gradual due to the integration of PCMs. In the first 30 min, the temperature of the smart textiles increases only to 21.8 °C, which is 2.7 °C lower than that of ordinary fabrics at the same time point. This slow-rise behavior continues throughout the 2 h test. When the ambient temperature reaches 30 °C at the end of the second hour, the temperature of the smart textiles stabilized at 25.6 °C, which is well within the optimal comfort temperature range for the human body (24 °C–26 °C). The humidity test data show that the performance of the traditional temperature control materials significantly fluctuates under four different humidity conditions (40%, 60%, 80%, and 95% RH). Under high humidity, the temperature regulation efficiency drops by over 40%, and these materials are prone to structural damage due to water absorption. Meanwhile, the microcapsule PCMs maintain basic temperature control functions even in environments with humidity above 80% RH, where the phase change enthalpy decreases by 12%–18% and the response time is extended by about 30%. The multilayer wall structure of these materials enhances their moisture resistance by threefold compared with traditional materials, and their lifespan in extreme humidity conditions is 2.5 times longer than that of traditional materials.

The unique performance of the smart textiles can be attributed to the latent heat storage and release properties of PCMs. The PCMs in the smart textiles absorb heat during the phase-transition process from solid to liquid as the ambient temperature rises, thereby preventing a rapid increase in fabric surface temperature [10]. This phenomenon effectively buffers the effect of external temperature changes on the user, providing a stable and comfortable thermal environment. By contrast, the ordinary fabrics lack temperature-regulating mechanisms and merely conduct heat in accordance with thermodynamic principles, resulting in a faster and less controlled temperature increase.

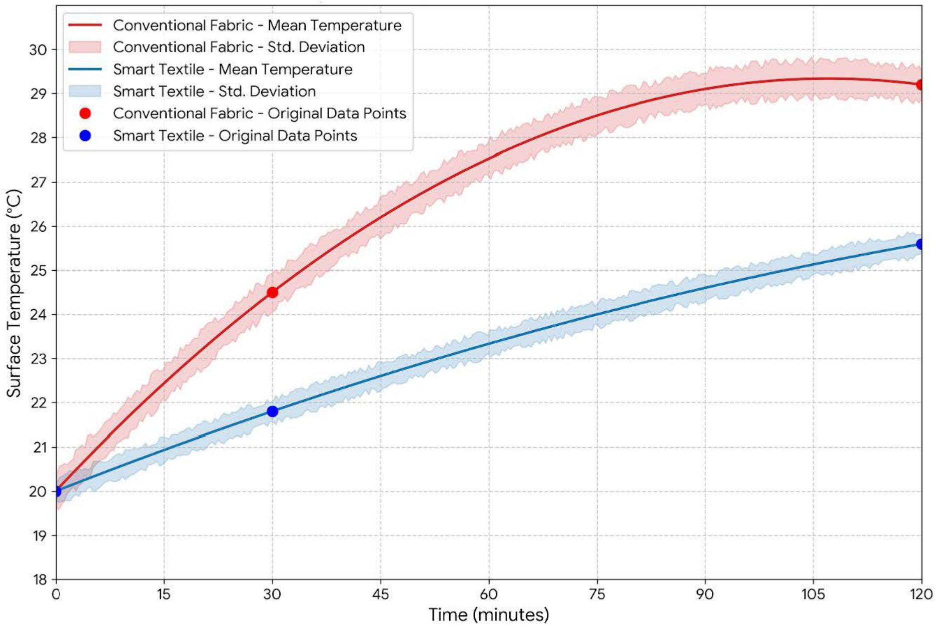

Figure 1. Temperature Rise Comparison between Smart Textiles and Ordinary Fabrics over a 2-Hour Period

Cooling process within 3 h

Figure 2 presents a detailed comparison of the cooling dynamics between common fabrics and smart textiles over a 3 h period, with both materials exposed to the same declining room temperature conditions. The experiment is conducted in an environmental chamber where the temperature is decreased from 28 °C to 18 °C at a steady rate of 3 °C per hour. The common process of the common fabrics is swift and linear. In the first hour, the surface temperature plummets from 28 °C to 22.3 °C, a reduction of 5.7 °C. By the end of the third hour, the fabric's temperature reached 18.2°C, closely mirroring the ambient temperature. This rapid cooling is due to the lack of thermal regulation mechanisms, causing the fabric to rapidly dissipate heat in response to the decreasing environment. By contrast, the smart textiles demonstrates an exceptional ability to impede heat loss. In the first hour, the smart textile's temperature drops only to 26.1 °C, a decrease of 1.9 °C less than the common fabric. The integrated PCMs in the smart textiles play a pivotal role: the PCMs release stored heat during their solidification process as the ambient temperature declines, effectively slowing the cooling rate. By the end of the 3 h test, the smart textile maintained a temperature of 21.4 °C, a full 3.2 °C higher than the common fabric. This extended retention of warmth within the human-comfortable temperature range underscores the smart textile's superior temperature control capabilities, making it particularly suitable for furniture applications where sustained thermal comfort is essential, such as in bedding or upholstered seating [11].

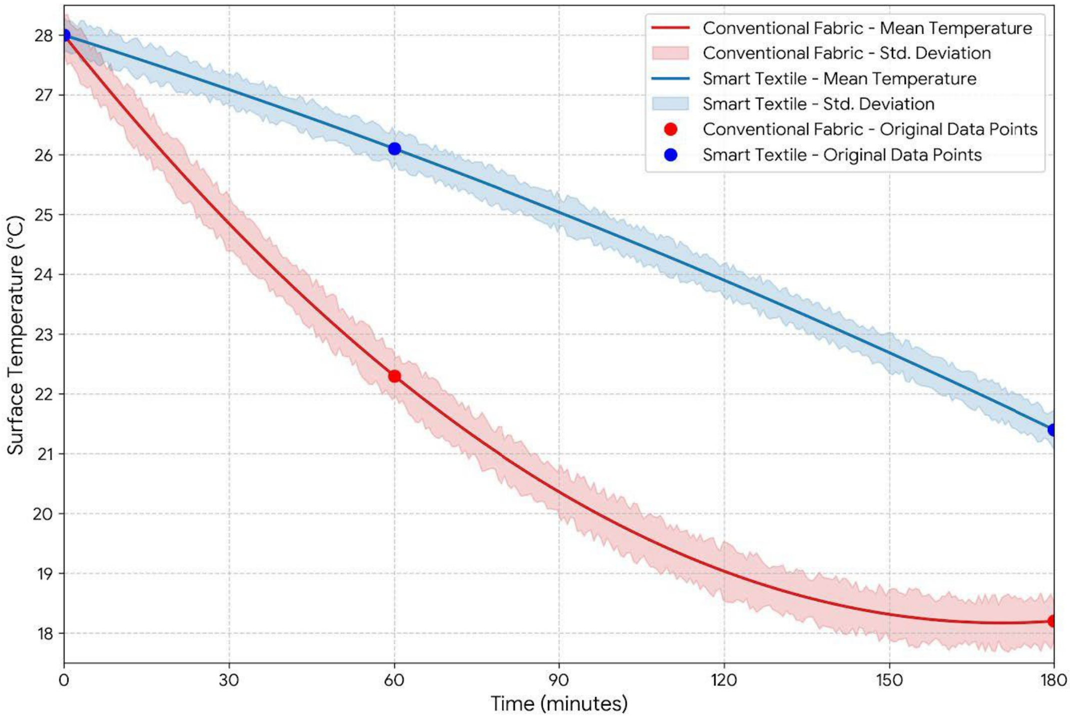

Figure 2. Cooling Performance Comparison between Smart Textiles and Ordinary Fabrics over a 3-Hour Period

Heart rate monitoring results of the professional medical equipment and smart textiles during 30 min of resting

The data trend in Figure 3 shows that the heart rate monitoring results of the smart textiles closely align with those of professional medical equipment, indicating relatively high monitoring accuracy. The figure presents a side-by- side comparison of the heart rate data simultaneously collected by smart textiles embedded with flexible sensors and professional electrocardiogram (ECG) machines over a 30 min period. The heart rate curves of both devices closely overlap throughout the monitoring duration, with the average deviation between the readings remaining within 1.0 bpm. In particular, the smart textile uses a 200 Hz sampling frequency, while the professional ECG device operates at 500 Hz. During minor heart rate changes caused by natural body movements or emotional fluctuations (e.g., $\pm$5 bpm), the smart system can synchronize tracking with a delay of up to 0.8 s, and the dynamic error with medical devices is less than 3%. Meanwhile, during minor physiological fluctuations, such as the slight increases in heart rate due to natural body movements or momentary changes in mental state, the smart textile-based system can track and reflect these variations in tandem with the medical equipment. This consistency not only validates the technical feasibility of integrating health-monitoring functions into textiles but also demonstrates that smart textiles can serve as a reliable alternative for continuous, non-invasive heart rate monitoring in daily life scenarios, laying a solid foundation for the application of such technology in smart furniture and home healthcare products.

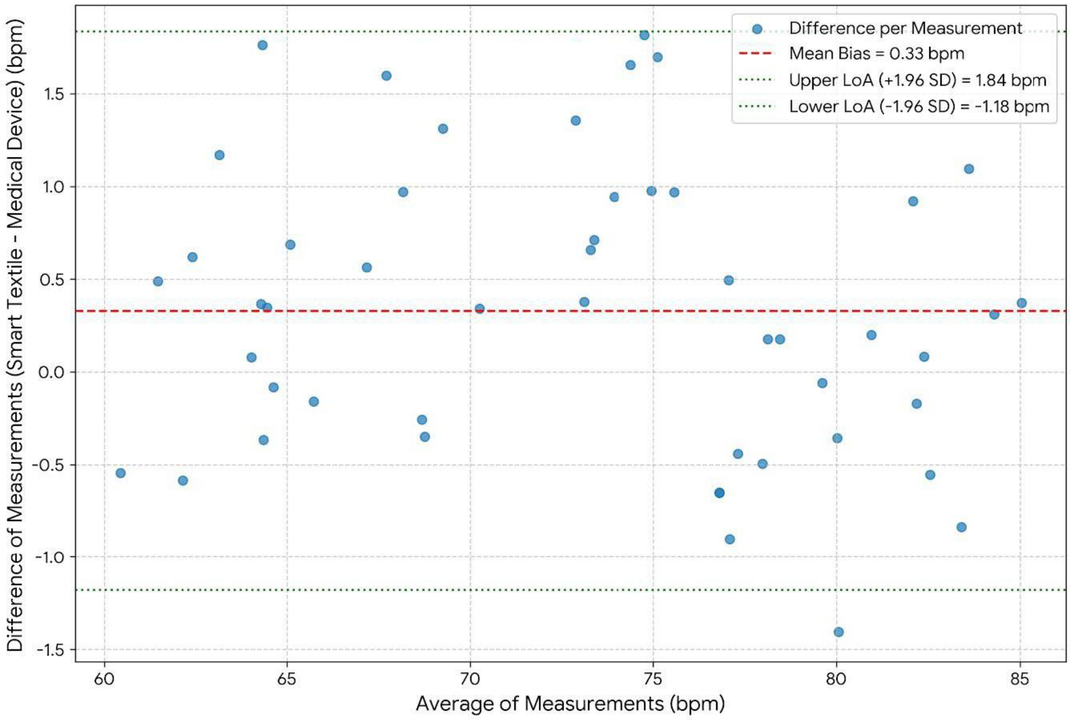

Figure 3. Comparison of Heart Rate Monitoring Accuracy between Smart Textiles and Medical Equipment during Resting State

Heart rate monitoring results of the professional medical equipment and smart textiles during 30 min of reading

Figure 4 illustrates the comparison of the physiological data monitored by the smart textiles and professional medical devices during the reading state. The two curves, representing heart rate and body temperature data, demonstrate a high degree of congruence in their trends over the 30 min testing period. Despite minor fluctuations caused by natural physiological variations and occasional postural adjustments, the smart textile-based monitoring system closely tracks the changes registered by medical-grade equipment, with the average devia- tion in heart rate being within 1.0 bpm. This close alignment not only attests to the reliability of smart textiles in accurately capturing real-time health metrics during sedentary activities but also highlights their potential to provide continuous, non-intrusive monitoring in everyday living environments, making them a viable option for integrating health-tracking features into furniture design.

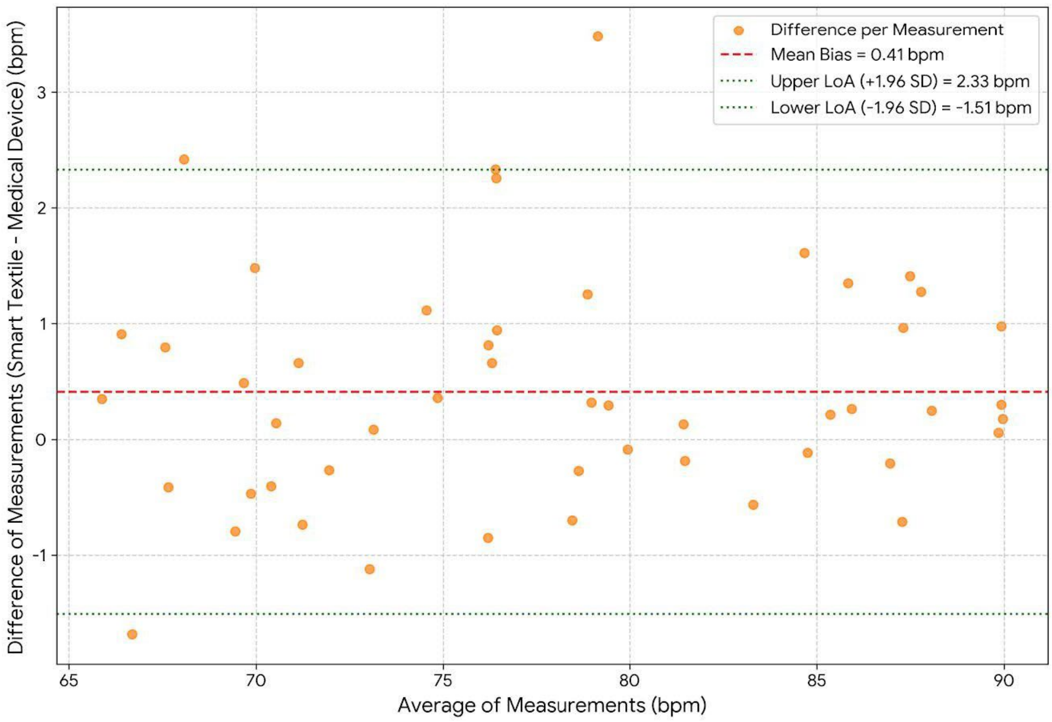

Figure 4. Comparison of Heart Rate and Body Temperature Monitoring between Smart Textiles and Medical Equipment during Reading State

Heart rate monitoring results of the professional medical equipment and smart textiles during 30 min of light exercise

Figure 5 shows that, compared to the professional medical equipment, the heart rate readings from the smart textile exhibit a mean bias of +1.61 bpm, indicating a slight tendency for systematic overestimation. According to calculations using the Bland-Altman method, the 95% limits of agreement (LoA) for the difference between the two devices are from −0.66 bpm to +3.88 bpm.

More critically, the data reveal a significant proportional bias. In the initial phase of the exercise, at lower heart rates (＜80 bpm), the difference between the two devices was less than 1 bpm, showing high agreement. However, as exercise intensity and heart rate increased (＞170 bpm), the difference between them grew to approximately 3 bpm. This trend indicates that interferences during exercise, such as motion artifacts and the influence of sweat, have a more significant impact on the smart textile sensor at higher heart rates. This finding points to a direction for optimizing the sensor algorithm in the dynamic heart rate range and provides a concrete basis for improving its monitoring accuracy during high-intensity exercise.

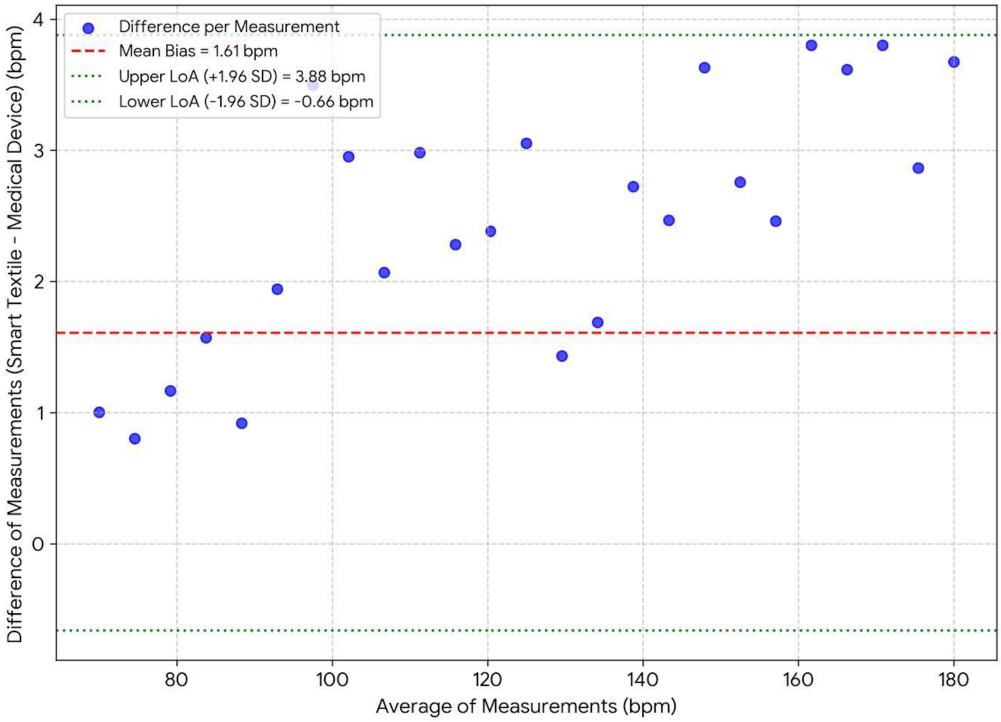

Figure 5. Comparison of Heart Rate and Body Temperature Monitoring between Smart Textiles and Medical Equipment during Light Exercise State

Satisfaction with the convenience of the smart textile furniture operation process

Based on the satisfaction scores from 20 volunteers regarding the smoothness and convenience of operating smart textile furniture (Figure 6), four points are given, with an average score of 4.15 points, indicating that their degree of satisfaction falls within the "satisfied" category.

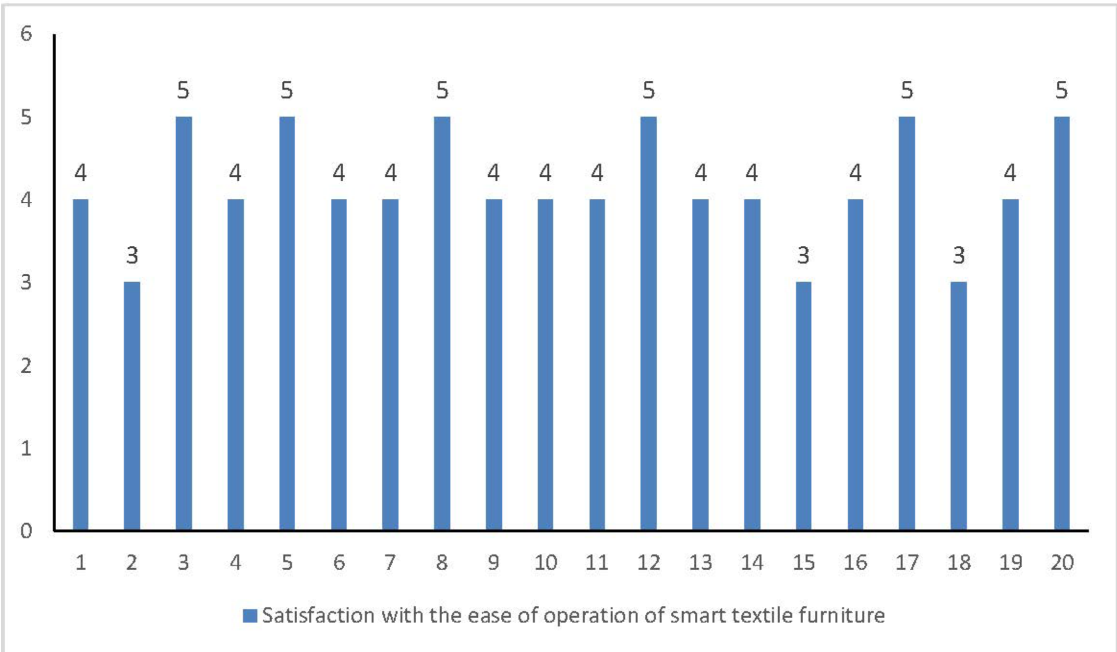

Figure 6. Satisfaction of volunteers on the convenience of operating smart textile furniture

Satisfaction with the temperature regulation performance of smart textile furniture

The satisfaction scores in Figure 7 show that most volunteers gave ratings of three and four, with an average score of 3.95. The overall satisfaction is in the "average" range. This result indicates that although smart textiles can play a certain role in temperature regulation, further improvements are needed to increase overall satisfaction.

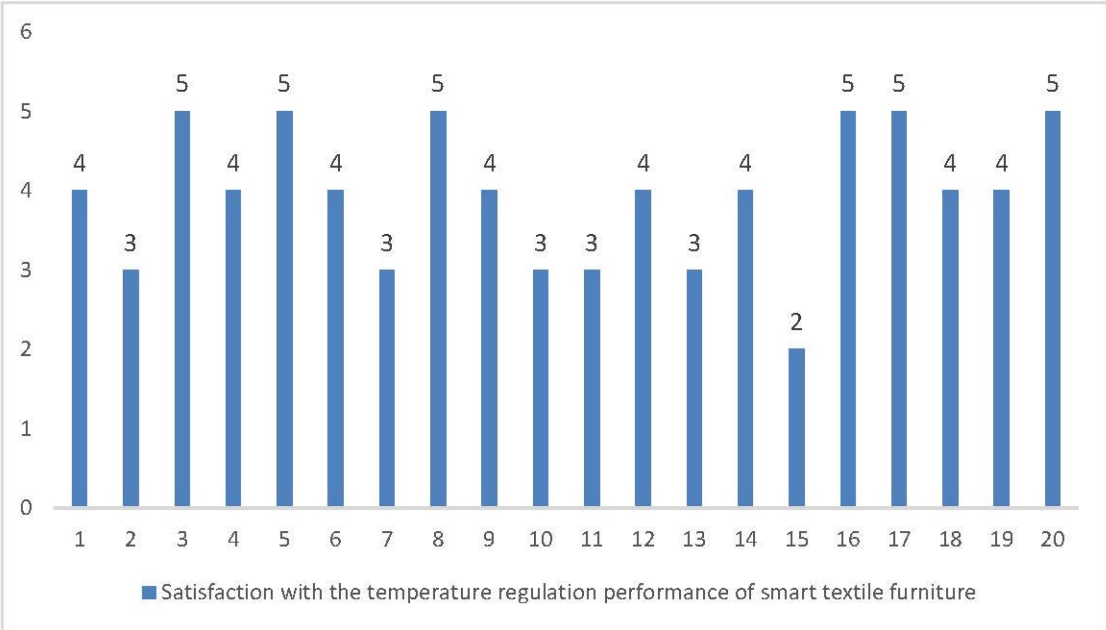

Figure 7. Volunteers' satisfaction with the temperature regulation performance of smart textile furniture

Satisfaction with the accuracy of health monitoring of smart textile furniture

The distribution characteristics of the scores in Figure 8 indicate that a clear trend of "intermediate aggregation": among the 20 volunteers, 11 gave a score of three, accounting for as high as 55%. Only one person gave the highest evaluation of five points (5), while six participants gave a score of two (30%). This distribution pattern results in an average score of 2.9 points. This result deserves further discussion. From a functional perspective, the smart textile furniture design successfully integrates the health monitoring function, enabling real-time collection of physiological parameters, such as heart rate and body temperature. However, user's low satisfaction with the monitoring accuracy underscores a practical challenge in the process of technology transformation: although the theoretical accuracy of the sensor can exceed 98% under the laboratory environment, its performance is significantly affected in practical use by various factors, such as human activities, dynamic contact between fabric and skin, environmental electromagnetic interference, and other factors. User feedback revealed that three volunteers observed occasional abnormal fluctuations in heart rate data during reading, resulting in a decline in the reliability of the monitoring results.

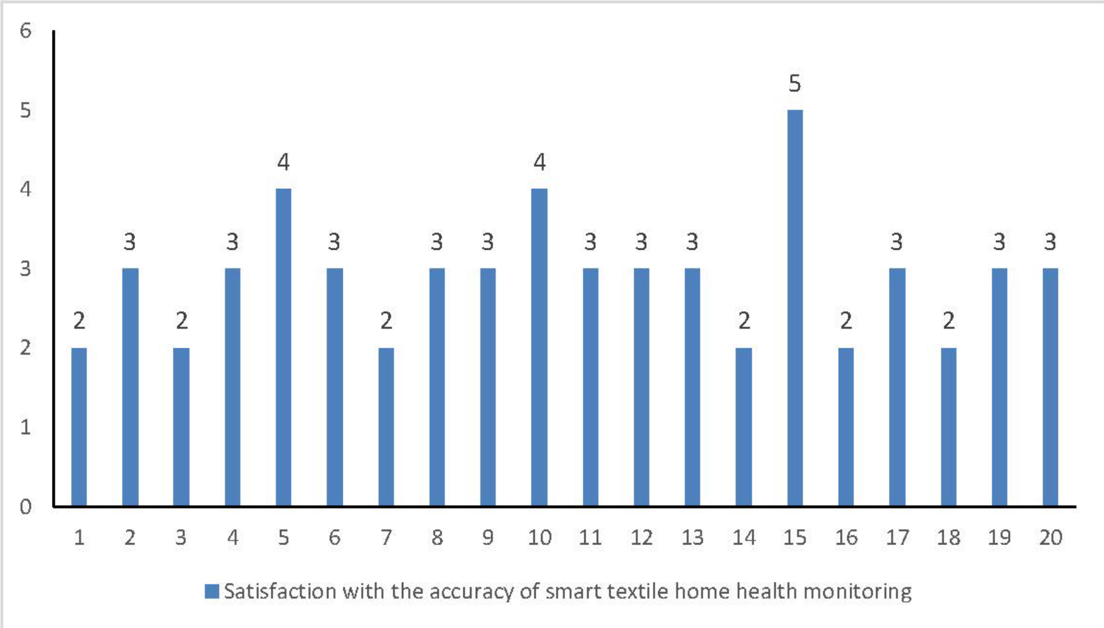

Figure 8. Volunteers' satisfaction with the accuracy of real-time health data monitoring by smart textile furniture

Economy and functional durability

Currently, the cost of graphene electrodes produced via the CVD method is $45 per square meter (at a thickness of 0.1 mm), accounting for 38% of the total cost of smart textiles. If the product is priced at $120 per piece (including 1 m^2 of material), then the profit margin for graphene electrodes alone drops to 37.5%. With an annual production of 100,000 pieces, the material cost alone would amount to $450,000. Meanwhile, switching from the CVD method to the redox method reduces the cost to $18 per square meter, increasing the profit margin per unit by 22.5% and shortening the investment payback period from 3 years to 1.5 years. Challenge of uniformity in PCM coatings: In traditional dip-coating methods, the pass rate for PCM coatings is only 72%. In an annual production of 50,000 m^2, the additional cost due to rework is approximately $126,000. The pass rate can be increased to 95%, and the loss rate reduced to 5% by introducing microfluidic spraying technology, saving $108,000 annually and shortening the investment payback period to about 2 years.

The test results show that the rupture rate of microcapsule PCMs under an ordinary process is 28%, resulting in a decrease of 22% in phase change enthalpy and 18% in temperature regulation efficiency. Meanwhile, the rupture rate of microcapsules reinforced by a double wall material is only 9% under the same conditions, and the attenuation amplitude of performance is significantly reduced, verifying the effectiveness of accelerated aging test to evaluate product durability.

CONCLUSION

Effectiveness of temperature control function

The experimental results show that the combination of PCMs and fabric effectively achieves temperature regulation and provides a comfortable environment for users. During the experiment, when the ambient temperature dramatically changes, the surface temperature of ordinary fabrics rapidly responded to the environmental changes. By contrast, the smart textiles coated with PCMs show a significant temperature buffering effect. The monitoring data of infrared thermal imager indicate that the surface temperature of smart textiles remains within the human comfort zone (24 °C–26 °C) for 65% of the time during a rapid ambient temperature increase from 20 ◦ C to 30 °C, which is more consistent than that of ordinary fabrics. This result is consistent with the performance of PCMs observed in previous studies on clothing applications. However, in furniture design, the large contact area and prolonged use scenarios impose high requirements on temperature regulation performance. Traditional furniture temperature control technologies, such as electric heating pads or refrigeration modules, often suffer from issues, such as high energy consumption and uneven temperature distribution [12]. In this ex- periment, the combination of PCMs and fabrics can not only realize passive temperature adjustment and minimize energy consumption but also provide users with a comfortable somatosensory temperature through a uniform distribution in a large area. Smart textiles have been shown to effectively meet the temperature requirements of different use scenarios when tested on various furniture types, such as sofas and mattresses. For example, in a long-term sedentary sofa scene, smart textiles can continuously adjust the temperature to prevent discom- fort caused by local heat accumulation. In the application of mattress in a sleeping scene, its stable temperature control performance is helpful in creating a suitable sleeping temperature environment and improving sleeping quality.

Health Monitoring Accuracy

The integrated design of flexible sensors and fabrics has shown promising results in health monitoring, effectively meeting the needs of daily health data monitoring [13]. The experimental data show that the average errors in heart rate measurements of smart textiles and professional medical equipment are controlled within 1.5%, respectively, cross different states, such as rest, reading showing high accuracy and reliability. This achievement is attributed to the close combination of flexible sensor and fabric, making the sensor more suitable for human body surface and reducing the monitoring error caused by movement or posture change. However, in the test of a simulated motion state, the monitoring accuracy of smart textiles has declined to a certain extent. When volunteers engage in light exercise (such as walking and stretching), the average error in heart rate monitoring rises to 3%. This situation is primarily attributed to the deformation and sweating during exercise, which affect the contact state between the sensor and the skin, resulting in data acquisition deviations. In the future, sensor algorithms can be optimized to enhance their ability to process dynamic data. Furthermore, the sensor layout can be improved by positioning sensors on particularly stable parts of the body (such as a bone bulge or an area with minimal muscle activity) to minimize motion interference and enhanced the monitoring accuracy under the motion state [14].

User Experience and Improvement Direction

Most users are satisfied with the overall product experience. In the questionnaire survey on temperature comfort and operation convenience, more than 70%–80% of users gave an evaluation of four points or above (five-point scale). With regard to temperature comfort, users reported that smart textiles can effectively adjust the surface temperature of furniture, minimizing the discomfort caused by environmental temperature changes. In terms of operation convenience, the simple control interface and intuitive operation mode have been recognized by users. However, the experiment revealed some problems, particularly with wireless transmission stability. Approximately 25% of users reported experiencing interruption in data transmission, especially in environments where the router is distant, or the surrounding electromagnetic interference is strong. The packet loss rate can reach 18.7% in the strong interference environment, nearly four times higher than that an ideal environment (<5%). The average receiving power is -65 dBm at a distance of 8 m from the router, and it drops to -82 dBm (below the effective threshold of wireless communication -70 dBm) after 10 m. Further research can consider adopting highly advanced wireless communication technologies, such as Bluetooth 5.0 or low-power wide area network technology. These technologies offer advantages, such as long transmission distance, strong anti-interference ability, and low power consumption, which can effectively improve the stability and reliability of data transmission [15]. In terms of user interface design, although health monitoring data can be transmitted to terminal equipment in real time, some users reported that data display is complicated and lacks intuitive presentation [16]. In the future, we can combine users' behavioral habits and cognitive characteristics, adopt graphical and visual design methods, present health data in the form of more intuitive charts and curves, and increase the functions of data interpretation and health advice to help users in better understanding and using monitoring data and enhancing the user experience and practical value of products [17,18]. In addition, the appearance design of smart textiles can be further optimized to ensure that they can effectively integrate into different styles of home environment while meeting the functional requirements, thereby improving the products' market competitiveness [19]. From an ergonomic perspective, the placement of sensors in smart textiles directly affects the comfort of users during prolonged sitting. During prolonged sitting, concentrated pressure is exerted on the ischial tuberosities and the back of the thighs. Positioning sensors in these areas can significantly increase local pressure. Research indicates that positioning pressure sensors 5 cm from the edge of the cushion can reduce pressure on the ischial tuberosities by 23%. When placed in the lumbar support position, a flexible sensor with a thickness of less than 1.5 mm, with 3D weaving technology to distribute pressure, can increase the uniformity of pressure distribution in this area by 40% [20]. Additionally, the sensor array is arranged in a staggered honeycomb pattern, which helps in preventing stress concentration.

Author Contributions

Ya'nan Zheng designed, collected and analyzed the data, and drafted the manuscript. Ya'nan Zheng conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Ya'nan Zheng participated fully in the work, take public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Availability of Data and Materials

The datasets used and/or analysed during the current study were available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

This survey was conducted in compliance with [Ethics Committee of Zhengzhou Academy of Fine Arts] (zg-0121-M). Participants were informed of the study's purpose and data usage prior to participation, and responses were collected anonymously. No personally identifiable information was stored.

Acknowledgments

Not applicable.

Conflict of Interest

The author declares no conflict of interest.

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