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Digital-Insole: An Interactive System of Foot Acupoint Physiotherapy for Office Workers

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Abstract. the pace of life and work is accelerating, and urban office workers are constantly affected by various rich and noble diseases, chronic diseases and civilized diseases. In order to prevent and treat some chronic diseases such as self-discomfort, fatigue, sluggish response, reduced vitality and adaptability, often in a state of anxiety, some dysfunctional diseases such as pain, poor blood supply and insomnia, and help office workers regulate the human endogenous system and accelerate blood circulation, this paper designs and develops an interactive system based on the plantar massage therapy in traditional Chinese medicine physiotherapy, It is named digital insole. The system consists of a pair of insoles with massage effect, external rechargeable battery hardware and an application program. In the application process of the system, the insole hardware and application program will give real-time data feedback according to the user's massage duration, massage frequency, massage strength, massage acupoints and problem disease monitoring and other related actions and functions. in addition, the application will also display the relevant information of plantar acupoints, meridians and massage energy levels in the user's use. We also conducted a preliminary user test of the digital insulin interactive system. The results showed that users showed high recognition in the process of participating in the design and use of the system, and paid more attention to the importance of plantar massage and their own health problems.

Keywords. Digital-Insole, office worker, TCM physiotherapy, plantar acupoint massage, interactive system

1.Introduction

With the prevalence of new coronal pneumonia, health problems have become the primary problem in human work and life, and more and more frequently bring trouble to people. The World Health Organization defines health as "not only the absence of disease or weakness, but also the complete physical, psychological state and social adaptability". According to experts, according to the health definition of the World Health Organization, about 70% of the population in China is in a "sub-health" state. Therefore, the care of human health problems and disease prevention become particularly important. With the development of digital technology, more and more

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human-computer interaction products gradually enter people's life and work. The application of technology and scientific means to prevent and treat people's chronic diseases will become more reasonable and efficient. This paper introduces the digital insole interactive system, the hardware system and software system composed of a pair of insoles with pressing function embedded with sensors and an external charging module fixed at the shoelace. The system is an application that gives real-time feedback of acupoint massage (duration, frequency, strength data, etc.) and problem disease monitoring data. (Hardware system and software system can be connected via Bluetooth or Wi-Fi). In the process of interacting with digital insole, users can learn plantar acupoint atlas and select plantar massage energy level (three levels in total) through the application. The application also has three modes of rotary massage, vibration massage and monitoring massage to meet the needs of multi-layer users. Finally, the system will feed back users' plantar health massage data in real time through the application. In the early stage of the design and creation of digital insight interactive system, we visited TCM acupoint physiotherapy experts, AI engineers, design professors and plantar masseurs, conducted in-depth interviews and discussions, and produced a system model. To test the user's understanding of digital insole. For the user experience of OLE interactive system, we selected some representative users and conducted a preliminary user study. The results show that users show high recognition in the process of participating in the design and use of the system, and pay more attention to the importance of plantar massage and their own health problems. Our main contributions are as follows:

- we designed an interactive system, including a hardware module, an external battery module and an application program, to help young office workers perform plantar acupoint massage through TCM acupoint physiotherapy and record the health status of users with real-time feedback data;
- Through the study of plantar acupoint atlas knowledge and plantar physiotherapy health massage, it is helpful for users to prevent and treat various sub-health chronic diseases;
- In order to demonstrate the effectiveness of the digital insight interactive system, we not only interviewed TCM acupoint physiotherapy experts, AI engineers, design professors and plantar masseurs, but also received positive feedback from users in the process of user participation and discussion of user experience in the early and late stages of design.

2.Related work

There are few relevant researches on the physiotherapy of plantar acupoints and meridians in academic circles. Generally, it can be summarized as acupoint physiotherapy technology and its application fields, while the research on Intelligent insoles is relatively mature.

2.1. Plantar acupoint physiotherapy technology and application fields

In the past five years, the literature of plantar acupoint physiotherapy technology and application field is relatively small. Wanghuabin and others developed a new type of

foot acupoint physiotherapy instrument for Taichong and Yongquan acupoints. This research provides a certain reference value for the application of TCM Massage theory in product design [1]. Tagaraja Co., Ltd. has found three studies comparing acupuncture and standard treatment and one study on real acupuncture and sham acupuncture. They believe that although acupuncture and moxibustion can relieve plantar fasciitis pain in a short time, there is not enough evidence to clarify the conclusion of its long-term effectiveness [2]. Z. Bolush et al. Systematically evaluated the scientific basis of minimally invasive non-surgical treatment of plantar fasciitis [3]. Christina et al. Carried out a prospective randomized controlled study on the initial treatment of plantar fasciitis. Compared with radio wave therapy, the effect of non-invasive nerve stimulation is better in terms of functional score, pain improvement and the use of non-steroidal anti-inflammatory drugs [4]. Lichengxun et al. Evaluated acupuncture and related interventions effects (benefits and hazards) of measures (such as acupoint pressing, electrotherapy and moxibustion) in the treatment of adult plantar and heel pain [5]. Renshuheng et al. Developed an intelligent acupoint magnetic therapy instrument for physical therapy and simultaneous magnetic therapy of acupoints with multiple acupoints, and developed its monitoring system. Based on the meridian theory of traditional Chinese medicine, we can design health preservation mode, self-defined magnetic therapy, common disease auxiliary medical treatment, etc. [6]. Feng, C, et al. explained the beneficial influence of AI technology on the treatment results of traditional Chinese medicine from the experience of famous and senior traditional Chinese medicine such as acupuncture, massage and Qigong. This research also focuses on the urgency of developing treatment models using artificial intelligence technology, with the theme of "treating diseases before they occur". In addition, the study also discussed the main bottlenecks and future prospects of the development of intelligent TCM treatment strategies [7]. Jia Yawei and other researchers found that the laser speckle blood flow imaging system can greatly evaluate the changes of skin blood flow during physiotherapy. This method is effective in the detection of TCM physiotherapy efficacy [8].

2.2. Research on Intelligent insole products

In recent years, the academic research on smart insoles is relatively mature. For example, zhouzhihao showed a waterproof intelligent insole based on triboelectric nano generator, which is used for efficient and powerful human biomechanical energy collection. The insole is reasonably designed as a composite structure to make full use of the foot pressure distribution of wearable power generation, and provides up to 580 μ Power output of W [9]. Linzhiming et al. Developed an intelligent insole based on triboelectric nano generator (Teng) for real-time gait monitoring. Due to the novel pneumatic driving structure design, the sensor based on elastic Teng has remarkable characteristics, including simple manufacture, fast response time, high durability and good mechanical robustness [10]. Lichengxin et al. Proposed a gait classification method based on deep learning, which uses intelligent insoles with various sensor arrays [11]. Taojuan et al. Designed an intelligent insole system that can distinguish various standing and yoga postures, and can recognize the change of center of gravity during walking. This intelligent insole system provides great feasible supervision for health monitoring, injury prevention and athlete training [12]. Evcimios ziacas and others developed a new tool for analysis: smart insole podo smart [13]. Joan challon and others introduced the equipment specification, technology selection and the design

of two versions of intelligent insoles, and the method for measuring the required settings [14]. Francescoalaimo et al. demonstrated the scalable roll to roll manufacturing of strain sensing wires, and then used them to realize intelligent insoles for gait monitoring [15]. Cuishangri and other researchers can recognize individuals through gait patterns, and the multimodal features proposed can recognize more than 95% of the high accuracy from the walking gait pattern data of 14 participants [16].

3.Design process

In the process of designing and creating digital insight interactive system, we invited TCM acupoint physiotherapy experts, AI engineers, design professors and foot massagers to jointly discuss the design and technology.

3.1. Discussion on design and technology with experts

We had in-depth discussions and explorations with four experts (2F, 2M, average age =50) from Guangdong Provincial Hospital of traditional Chinese medicine, E1, E2, AI engineer of Zhongkai College of agricultural engineering, E3, Professor of design at Macau University of science and technology, and E4, foot massager of Guangzhou College of traditional Chinese medicine. The exchange seminar lasted for more than 3 hours. From the introduction of design concepts to chronic health diseases, plantar acupoint knowledge and massage technology, as well as the exchange of design experience, they studied the analysis of our design model layer by layer. They unanimously agreed on the starting point of the design scheme: "it has become an objective trend that most urban office workers are in a state of chronic disease and sub-health. The application of digital technology in the design and development of human-computer interaction system has strong feasibility and innovation". The suggestions are as follows: (I) E1, E2, E3 and E4 are all recommended to popularize health prevention education and TCM acupoint physiotherapy experience for urban office workers. (II) E1, E2, E3 and E4 all propose that during the travel of urban office workers

And the office scene should take better care of their health. (III) E1, E2, E3 and E4 all found that people were at a loss about how to cope with healthy lifestyles and chronic diseases. (IV) E1 indicates that TCM acupoint meridian physiotherapy, especially plantar massage, is one of the most beneficial ways for people's physical and mental health. (V) E2, E3 and E4 indicate that the convenience and effect of physiotherapy products will become a difficulty in the interactive system. After all, the effectiveness of the product interactive system will become the focus of users' concern.

3.2. design goal

In order to prevent and treat the chronic diseases of sub-health status of urban office workers, according to the research, analysis and discussion of experts in relevant fields, we set the following key goals to achieve the rational design of the interactive system:

- targeted design innovation in health prevention education and acupoint meridian therapy of traditional Chinese medicine to achieve the goal of prevention and treatment. As (I) in 3.1(IV) it is suggested to popularize health prevention education and TCM acupoint physiotherapy experience for urban

office workers. Plantar massage is one of the ways that are extremely beneficial to people's physical and mental health.

- Interactive experience, data feedback and health science popularization education are realized on the application, which greatly increases the interest of interaction and helps to improve the cognition of urban office workers on the effect of plantar massage meridian physiotherapy. just as Cognition, user experience, applicability and physiotherapy effect feedback proposed in (II), (III) and (V) in 3.1 will become one of the important objectives of the innovative design of the interactive system.
- The product carrier of the interactive system should achieve the design goal of low cost, high technology, high quality and high aesthetics, because it involves the success or failure of the production and commercial operation of the interactive system.

4.Interactive system description

The pace of life and work changes so fast that people's physical state has been exhausted for a long time. In order to deal with the harm of this trend of "sub-health" and "chronic disease", according to the map of plantar acupoints, combined with the principle of traditional Chinese medicine acupoint physiotherapy, so that people can timely and conveniently become self-health physiotherapists, designed a pair of digital insole that conforms to the appearance aesthetics and has the effect of plantar physiotherapy massage. Digital nsole is composed of two independent and connected hardware and software (Figure 1). The hardware is composed of a pair of insoles with pressing effect embedded with sensors and an external charging module fixed at the shoelace. The software system is an application program for giving real-time feedback of acupoint massage (duration, frequency, strength data, etc.) and problem disease monitoring data. Plantar massage energy level (three levels in total) can be selected. The app also has rotary massageThere are three modes of vibration massage and monitoring massage. Two independent and connected hardware systems and software systems can be connected via Bluetooth or Wi-Fi. On the method of digital nsole innovative design, we not only have a professional in-depth discussion with experts, but also use user interaction experience test to obtain quantitative data feedback experimental results. Further demonstrate the rationality and innovation of the interactive system.

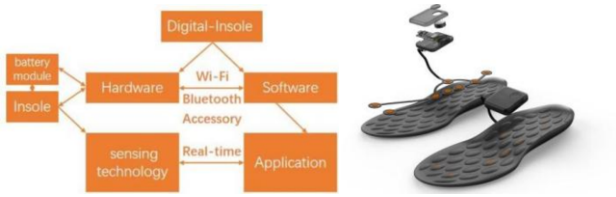

Figure 1. conceptual framework of digital insight

4.1. Application App Design

The application app interacts with the hardware system to form a larger human-computer interaction system, which is committed to the prevention and treatment of chronic diseases. The hardware is divided into a system module combining rechargeable batteries and insoles, which acts on people's plantar parts and has the effects of rotation, vibration, hyperthermia and monitoring. The application app realizes the user's operation comfort and various functions of operation experience, and also obtains the sensor data information of insole hardware, Analyze the physiotherapy effect and health indicators of users. Realize the digitization and informatization of people's plantar acupoint physiotherapy and health indicators. On the app, users can realize popularization of acupoint health knowledge, select massage energy level (three-level optional) and physiotherapy mode (rotary physiotherapy, vibration physiotherapy and monitoring physiotherapy). (Figure 2).

Figure 2. interface of digital insulin app

4.2. Design of hardware system

The hardware part of the interactive system consists of an intelligent insole and an external charging module. The intelligent insole is equipped with corresponding physiotherapy modules according to the plantar acupoints, and the appearance is made of an oval array with appropriate size (taking the size 42 shoes with a relatively large proportion as a reference), so as to ensure basic human-computer harmony and aesthetics. The external charging module is fixed at the position of the shoelace, and the internal structure is composed of rechargeable battery, Wi-Fi or Bluetooth connector and micro circuit board, which can supply power to the insole and realize the functions of data transmission and Wi-Fi or Bluetooth connection. (Figure 3).

Figure 3.the design of hardware system

4.3. Hman computer interaction and data processing

The digital insight interactive system uses the micro customized development board provided by pain sensors (Guangzhou Yuandian Digital Technology Co., Ltd.), which can identify potential feelings from extreme conditions such as external temperature and pressure, and generate early warning signals to transmit to the central nervous system to generate data. Pain sensors sends digital conversion signals to the back-end server through the Wi-Fi module, and the app on the mobile phone obtains back-end services through HTTP requests.

The digital conversion signal on the device outputs real-time state switching to electrical signal. Smart hardware and application coordination start. The layout of pain sensors is precisely arranged according to the plantar acupoints, which can accurately identify the two behavior states of users' walking or sitting. Technical support to achieve easy user experience effect of interactive system. (Figure 4).

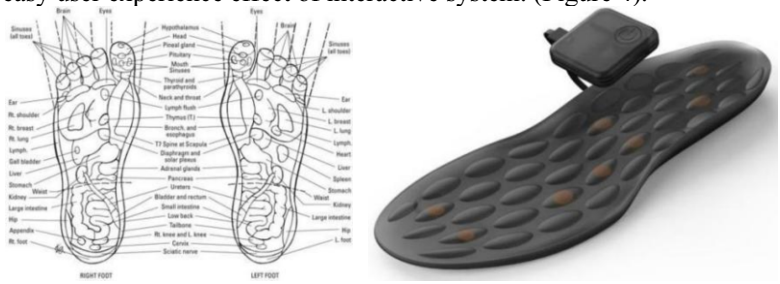

Figure 4. layout of pain sensors according to plantar acupoints

5.Preliminary user study

In order to confirm how people interact with digital nsole interactive system and their views on digital pen, we conducted a preliminary user study. We randomly invited five users A, B, C, D, E (3F, 2M, average age =35) among urban office workers. All links of each participant (PA, PB, PC, PD, PE) evaluating the interactive system design (popularization of plantar acupoint knowledge, rotational physiotherapy, vibration physiotherapy and monitoring physiotherapy) were conducted under the guidance of designers and experimenters.

5.1. program

The experiment was conducted in the office scene. First of all, we briefly introduce the basic situation of this research, the design prototype and the use of interactive system. After that, participants are allowed to experience and learn using the digital insight interactive system, and have a comprehensive communication and use test with participants in about an hour. We also consider the accuracy and recall rate of data acquisition of pain sensor [17]. After the experiment, we suggested that the participants take the digital nsole away for further experience and use. Three days later, we summarized and discussed the participants' feelings with Likert questionnaire (Table 1): (1) their feelings after using the digital nsole interactive system; (2) Design suggestions for future improvement of digital insight interactive system; (3) The difference between traditional insole and digital insole interactive system.

5.2. result

As shown in Table 1 (9-point Likert scale), all participants were willing to use the digital nsole interactive system when wearing shoes, and showed a high willingness to use the digital nsole interactive system. However, they are lack of confidence in using digital insole interactive system to prevent and treat chronic physical diseases when wearing shoes. For example, A, C and E all indicate that the digital insight interactive system needs a larger base of user testing and market information feedback to make an objective and effective evaluation. A. D scored 8 points in Q (II). They felt that the interactive mode and functions of digital insight were too redundant. All five users pointed out that real-time feedback was useful in the process of plantar acupoint physiotherapy (the average score was 8.8). howeverHowever, a and e think that it needs further practical verification to improve people's health cognition. When participants were asked about their experience of using digital nsole and subsequent design improvements, B said, I think digital nsole will be a particularly interesting interactive system, and I really want to have it to quickly improve my "sub-health". A,C and E put forward suggestions for improvement: health data feedback is really good, the comfort of intelligent hardware needs to be strengthened, and there may be some problems in the accuracy of sensors and battery life of interactive systems. In general, all participants are willing to use the digital insole interactive system when wearing shoes. The results show that the digital insole interactive system is an effective tool to prevent and treat potential "chronic diseases" of urban office workers.

Table 1. results of user questionnaire

Questions	Female A	Female B	Female C	Male D	Male E	Average
I Are you will to use digital insight interactive	9	9	9	9	9	9
System while putting on your shoes?						
(1:unwilling-9:willing)						
II Is it easy for you to understand how to use	8	9	9	8	9	8.6
Digital insight interactive system while putting on						
Your shoes? (1:difficult-9:easy)						
III What do you think of digital inner real time	9	9	8	9	9	8.8
Data feedback and foot acustructure therapy when						
You put on your shoes? (1:useless-9:helpful)						
IV Do you think science popularization of plant	8	9	9	9	8	8.6
Acupunture points can improve people's health						
Awareness? (1:useless-9:helpful)						
V Do you have confidence that you can improve	8	9	8	9	8	8.4
Your body health by using digital insulin						
Interactive system while putting on your shoes?						
(1:unconfident-9:confidential)						

6.Limitations and future work

In the process of research, we found some limitations: (1) during the epidemic, we only found four experts as the object of in-depth study. In the future, it is necessary to communicate with more experts and collect more relevant information and subject knowledge; (2) In the experiment, the base for user testing is not enough, so it is difficult for the system to make further feedback after correction according to the user's design suggestions. In the future, we will further improve the interactive system, and use more user experience and feedback to improve the digital insulin interactive system. It is expected that in the future work, we will continue to improve the integration of digital technology and art design to solve the hidden problems of more users using the product, and we will try to recruit more users to participate in the early design of the system research.

7.Conclusion

We designed, created and introduced in detail the digital insight interactive system, which helps urban office workers effectively develop the habit of plantar acupoint physiotherapy and real-time feedback of physical health data in the work and out scenes, and realize self-health monitoring and disease prevention and treatment by using digital technology. Digital nsole can choose from three programs according to real-time feedback of body data, rotation, vibration and monitoring, so that users can develop the good habit of plantar acupoint physiotherapy and prevention and treatment of chronic diseases. The user test results show that the digital insight interactive system is an important tool to prevent and treat the potential "chronic diseases" of urban office workers, and can improve users' correct cognition of plantar acupoint physiotherapy. This may also provide more possibilities and reference data for further design and development and research in the field of acupoint physiotherapy of traditional Chinese medicine. We believe that the digital insight interactive system can reflect important value in solving the health problems of sub-health and chronic diseases of urban office workers.

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