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Wearable technology and its barriers in healthcare

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Abstract

This review aims to introduce wearable technology in the field of healthcare and its barriers in this field from three aspects: (a) p-Health - a new paradigm in wearable system, (b) embedded wearable sensors - a feasible way, and (c) E-textile - a new wearable type. We then present the barriers of this technology which are to be overcome to reach its technical potentials. We use Monash library explores as a search engine to search relevant papers and use the literature research method to summarize the main achievement of the papers. In conclusion, although there are some barriers not to be overcome, the field of wearable technology in healthcare will have a bright future.

Key words: wearable technology, healthcare, medical system, wearable sensors, E-textile

Introduction

Wearable technology is taking the world into new realms, making technology personal and seamless to use. As an emerging transdisciplinary field, wearable technology mainly explores and creates some devices like clothes or accessories integrated directly in the body surface. Over the past decade, the world has witnessed a great deal of progress in this field of wearable sensors and systems. Recently, although the present researches are just a small step in the whole process and have some obstructions and challenges (Chan et al., 2012), wearable technology is playing a crucial role in people’s lives, especially having comforts in patients’ lives.

Scope and method

For this review, we consider the field of healthcare in wearable technology. We first provide a summary and then the three main aspects: (a) a new paradigm in wearable system: p-Health, (b) a feasible way: embedded wearable sensors and (3) a new wearable type: E-textile. Finally we discuss the barriers and give a conclusion.

We use Monash library explores as a search engine because it contains the most important publications from journals and conference proceedings. We search with the search condition “wearable technology” and “healthcare” to find the papers that have these words in title, abstract and keywords.

We use the literature research method to summarize the main achievement of papers in the references.

Body of review

Summary

According to the researches of new techniques, methods and materials, the gap between wearable and traditional technology is continuous large (Chan et al., 2012). Compare to the conventional hospital-centered methods, there is a new paradigm called p-Health can be built for monitoring somebody's health condition in healthcare system again the chronic diseases. For the sake of finding a feasible way to treat Tourette syndrome, wearable devices embedded with a sensor called accelerometer to detect and classify motor tics during standing and walking entertainment can be invented. According to the detection of the tics parameters, sensitivity, specificity, and accuracy, the researchers can find the performance optimization. In order to find a suitable material, researchers do experiments which focus on a new wearable technology materials woven electronics, with a model for a novel transistors to describe the electrical characteristics, to ensure the necessary attributes of drapability and integrate these applications for the body.

A new paradigm in wearable system: p-Health

The application of wearable technology has absolute advantages in current medical level. The capabilities of traditional technology are restricted to the increasing numbers of the patients' cases. In comparison, the new paradigm of p-Health aims to "encourage the participation of the whole nation in the prevention of illnesses or early prediction of diseases such that pre-emptive treatment can be delivered thus achieving a pervasive and personalized healthcare" (Teng et al., 2008). In this paradigm, the wearable medical system is considered to be an enabling technology monitoring health condition of the individual on the basis of continuous feeding information back to the user and the medical staff, and launch alarm signal when an adverse condition occurs (Teng et al., 2008). There are numerous signals and related parameters should be counted such as heart rate, blood pressure, blood oxygen saturation, respiration and several biochemical measurements like the electrophoresis have demonstrated potential for enhancing the efficiency of the extraction of body fluids through the skin which all contribute to p-Health. Therefore, from using this technology, medical staff have a better chance to handling their diseases. With the wearable medical system and novel methods, patients can find their diseases diagnosed early and adopt adequate treatment in advance. Some chronic diseases, for instance, Congestive Heart Failure, should be treated in the early stage. If the treatment is not timely, the symptoms of cardiac insufficiency is getting worse. This applications of wearable medical systems help people find their problems as soon as possible and have some certain therapies early. The application of p-Health also allows medical personnel to have a greater scope handling large quantities of patients. Because of various applications, this new medical technology seems better than only clinical technology. From a long distance, physicians enable to monitoring patients efficiently (Teng et al., 2008). With these wearable systems built, monitoring patients' physiological condition and behavior patterns can be accomplished in remote

supervision. In a long period of time, physicians enable to monitoring patients timely. Aim at the seasonable response, the character of real-time feedback seems very important. It strengthens information timeliness and could acquire the most actual situation. The healthcare systems achieve it successfully.

Although the development of wearable medical system can solve most of the comprehensive development of current challenges and innovation of medical system and the novel method p-Health, there are also three critical problems have met in the development of wearable medical systems such as low power consumption, low cutoff frequency and complex physiological mechanism.

A feasible way: embedded wearable sensors

Sensor is a kind of transducer and its purpose is to sense some characteristic of its environs. It detects the characteristics of the event or the change of the quantity, and provides the corresponding output, usually as a electrical or optical signal. Embedded with various wearable sensors, the wearable devices will have different functions to handle various problems. For instance, some smart clothes could enable ongoing health monitoring, such as, the classic wearable device in cardiovascular medicine called Holter electrocardiogram monitor can provides continuous recording and a realistic report. Wearable sensors can divide into several parts, such as accelerometers, gyroscope, magnetometer and pressure sensor. By means of the accelerometers which are often used for activity recognition, supervising Tourette Motor Tics becomes advantageous while observing the feedback consequence of automatic tic detection (Bernabei, 2010). Wearable instruments with embedded multi-axis accelerometers are used to detect and classify motor tics in standing and walking entertainment. There is also an algorithm designed to analyze the acceleration data according to the indexes such as eliminating noise, peak detection and pathological events, classification of the intensity and frequency of the motor tics into quantitative score. There are three subjects to do for the novel method for monitoring Tourette Motor Tics, they are gross acceleration signal, tic recognition and tic classification. Motion data, videotape recordings and triaxial acceleration signals can be collected and use the Bluetooth for remote transmission. Then the researchers use the algorithm to process the receiving data from the aspects of sensitivity, specificity and accuracy percentage performances of the automatic tic-recognition. In addition, the researchers performed a least-squares regression analysis and Bland-Altman plot20 frequency values (in the tic/s) from the method (Bernabei, 2010). At last, they can differentiate the tics movements due to the above three aspects. Then the novel wearable measurement system with automatic recognition and classification of motor tic feature can be built.

However, there are also some shortages in this approach. One is lack of standard due to just optimized three performance indicators over the whole population such as sensitivity, specificity and accuracy. The second is system is not designed specially face detection and assessment of the emotion. And the third is poor relationship with tic rupture because of only one sensor fixed on the trunk of the patient.

A new wearable type: E-textile

E-textile era soon become a reality. In recent age, e-textile products are being developed for their application in the field of biomedical monitoring and high-risk tasks. For fabric become feasible electronic platform, a lot of work to be done and it has already prepared for going to our daily life. In healthcare system, wireless sensors networking and other computing prepare for new possibilities. The integration and miniaturisation of sensors, embedded microcontrollers and some new materials, such as fabrics, textile and membrane, have become more precise with continuous automatic processes in wearable technology. There is a new product called woven electronics which brings s new perspective for wearable technology. In the experiments, an example of organic field effect transistor (OFET) characterized by a size and geometry with the textile process fully compatible, the device uses a cylindrical metal fiber with a diameter of 45 um with a cover by a uniform layer of polyimide of about 1 um so that this yarn is very flexible and can be employed, twisted to a cotton fiber, in textile processes. According to the methods that evaporating gold electrodes during evaporation procedure or using a soft lithographic process for transferring a thin layer of the conductive polymer on the surface, the device using novel materials can be setup step by step. Then the researchers build a model for cylindrical thin film transistors to describe the electrical characteristics with cylindrical geometry. At last, a cylindrical organic thin film transistor can be gained due to its form factor and the employed materials which is fully compatible with a textile process (weaving and knitting equipment) (Locci et al., 2007). The experiment can properly describe the physical behavior and the cylindrical device electrical characteristics. From the transistor, the three electronic parameters such as mobility, threshold and Ion/Ioff ratio are typically similar to planar devices. For such a complete model, so that the behavior of the cylindrical structure has been successfully developed and used for fitting the experimental results.

The results are very promising application of innovative technology in the field of smart textiles. Especially, the realization of distributed transistor in the textile and sensor networks is the most important.

Barriers

Although some reasons show that wearable technology is widely used in people’s daily life especially healthcare fields, there are still some problems in its primary stage and development process. Developers are not yet ready to complete the work plans which related to wearable technology in detail (Chan et al., 2012). There are very few industrial designers participated in the field who understand “wearability”. Due to lacking technological capabilities, standard and guide of current situation in clothing design, these researches on wearable technology is hard to continue. Moreover, the protocols and algorithms with various parameters involved in the wearable systems are always complex which giving another problem for making the work plans. There are some obstacles in manufacturing process of wearable devices (Teng et al., 2008; Bernabei et al., 2010). Most of the equipment are charged with a short time and built with a heavy weight. It is confusing issue to building a

suitable device for real need. If the data through the process are delivered very quickly, some units will get an under-reaction, so it is important to fabricate delicate techniques of sensors for obtaining useful data. Most of the wearable products have less practical functions and even worse than smart phone (Chan et al., 2012). The current functions of mobile phone are multiple and practical. Some wearable equipment has the troubles in dealing with gathering patients' behaviors fluently and other tiny variations. Generally, wearable devices have low sensitivity and huge energy consumption. Meanwhile, the cost of this new technology is high but the result will be less effective.

Conclusion

As can be seen, although there are some barriers not to be overcome, the further development of advanced wearable monitoring devices with advanced materials is a critical element in the next era of diagnosis and treatment of disease and the scientists or physicians eventually conquer them with the evolution of the wearable technology. We will meet various challenges in the way, because these challenges will be met by advances in areas such as materials sciences, information technology, however their widely application will reshape the traditional approach to the examination, evaluation, and treatment of patients with disease or in need. Advantages in the field of healthcare have already demonstrated that this field becomes the most impacted side in wearable technology. What's more, still there is a plenty of scope for development while the technology is improving gradually.

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