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E-Textile and its Applications

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Abstract:
Electronic textiles also known as smart garments which are fabrics that enable digital components such as a battery and a light (including small computers), and electronics to be embedded in them. Smart textiles are fabrics that have been developed with new technologies that provide added value to the wearer. The advancement of sensing technologies, Nano-technologies, embedded system, wireless communication technologies and miniaturization make it possible to develop smart systems to monitor activities of human beings. The vision behind wearable computing foresees future electronic systems to be an integral part of our everyday outfits. Wearable systems will be characterized by their ability to automatically recognize the activity and the behavioral status of their own user as well as of the situation around her/him, and to use this information to adjust the systems configuration and functionality. It can detect abnormal and unforeseen situations by monitoring physical parameters along with other symptoms. This paper reviews the recent advances in the field of smart textiles and its applications in main fields.

Index Terms: E-textile, smart sensors, health monitoring, smart shirt, sporting technologies

I. INTRODUCTION

Smart Textiles are defined as textile products such as fibers and filaments, yarns together with woven, knitted or non-woven structures, which can interact with the environment/user. Smart textiles can be broken into two different categories: aesthetic and performance enhancing. Aesthetic examples include fabrics that light up and fabrics that can change color. The color changing and lighting scheme can also work by embedding the fabric with electronics that can power it. Performances enhancing smart textiles are intended for use in athletic, extreme sports and military applications. These include fabrics designed to regulate body temperature, reduce wind resistance, and control muscle vibration – all of which may improve athletic performance. Other fabrics have been developed for protective clothing, to guard against extreme environmental hazards, such as radiation and the effects of space travel. The health and beauty industry is also taking advantage of these innovations, which range from drug-releasing medical textiles, to fabric with moisturizer, perfume, and anti-aging properties. Many smart clothing, wearable technology, and wearable computing projects involve the use of e-textiles. Smart Textiles will serve as a means of increasing social welfare and they might lead to important savings on welfare budget.

They integrate a high level of intelligence and can be divided into three subgroups:

∟ **Passive smart textiles:** only able to sense the environment/ user, based on sensors;

∟ **Active smart textiles:** reactive sensing to stimuli from the environment, integrating an actuator function and a sensing device;

∟ **Very smart textiles:** able to sense, react and adapt their behavior to the given circumstances;

The first type of smart garments it is necessary to remove all the electronics. More innovative smart clothing can be washed entirely. As well, smart clothing has gone forward greatly. Various types of garments appeared. It's even possible to purchase smart insoles or scarf. Generally, smart garments follow up the diversity of ordinary clothing. The basic requirements for embedding electronic function in the clothing are flexibility, lightweight, comfort, conductivity, good process ability, good wear ability and low cost. Future applications for e-textiles may be developed for sports and well-being products, and medical devices for patient monitoring. Technical textiles, fashion and entertainment will also be significant applications.

II. GENERATION

The first generation of intelligent clothes (Passive smart textiles) are just able to perceive the data about the conditions or stimuli of the environment. Such type of textile contains only sensors. The examples are UV protective clothing, plasma treated clothing, fabric with optical sensors, etc. This approach is currently taken by sportswear brands such as Adidas, Nike and Under Armour. The second generation of smart textiles comprise both sensors and actuators.

Active smart fabrics can memorize shape, keep the chameleon effect, regulate temperature, resist water, absorb vapours, heat fabric of the suit and store it. It's literally "smart" fabrics. These are demonstrated by current products from Samsung, Alphabet, Ralph Lauren and Flex. The third generation of textiles is much more advanced. They can not only sense disparate data types but also make forecasts and fit external conditions without preliminary tuning. Such kind of textiles works like the brain due to a built-in microcomputer. The examples of this clothing type are spacesuits, I-wear, sport jackets, musical jackets, wearable computers and so on. A growing number of companies are creating pressure, strain and temperature sensors for this purpose.

III. APPLICATIONS

A. Medical Field:

Applications of Smart Textiles for Healthcare Smart textiles for healthcare include textile sensors, actuators and wearable electronics systems embedded into textiles that enable registration and transmission of physiological data, and wireless communication between the wearer and the 'operator', for example, patient and medical personal. Such systems ensure patients' mobility, thereby providing a higher level of psycho-physiological comfort, especially when a long-term bio-monitoring is required. Generally, applications of smart textiles for medicine and healthcare vary from the surgical applications of single yarns to complex wearable and axillary systems for personalized healthcare. There is no still classification of smart textile for these applications, but initially those can be described referring to commonly distinguished groups in conventional medical textiles. Of course, due to new functions, several new categories must be highlighted. Those are textile drug-release systems, textiles with biometric performance and active textiles for therapy and wellness. Electronic textiles used for medical applications and general well-being are extremely diverse; from electro-luminescent wire being explored to alleviate the symptoms of Seasonal Affective Disorder (SAD) by creating bedding that emits light; bras that have been developed that can detect early stages of breast cancer or vests that can monitor vital life signs; through heating system it can assist the aged or those with poor circulation to keep warm. The representative examples are given as follows:

- Wireless-enabled garment with embedded textile sensors for simultaneous acquisition and continuous Monitoring of ECG, respiration, EMG, and physical activity. The "smart cloth" embeds a strain fabric sensor based on piezo resistive yarns and fabric electrodes realized with metal based yarns.
- Sensitized vest including fully woven textile sensors for ECG and respiratory frequency detection and a Portable electronic board for motion assessment, signal pre-processing, and Bluetooth connection for data Transmission.
- Wearable sensitized garment that measures human heart rhythm and respiration using a three lead ECG shirt. The conductive fiber grid and sensors are fully integrated (knitted) in the garment (Smart Shirt).

The device called wearable "tricorder for babies" which tracks vitals as well as changes in body temperature rather than standard infant monitoring equipment that only allows you to listen. The growing health care needs and awareness is instrumental in bringing new possibilities and leading edge technologies in the healthcare sector. This is definitely going to change the clichéd definition of clothes, in the near future, and the ways in which our body can communicate better. Electronics and textiles, are nothing but technology at its best, and can work wonders for the healthcare sector.

B. Military/Defense Field:

Advancements in technology have led to the miniaturization of electronics that can be embedded into textiles and used by civilians or special personnel, such as soldiers. The integration of electronics into military textiles could assist soldiers in achieving levels of performance and capabilities never realized before on the battlefield. Soldiers on active duty can face varying threats, often unpredictable. In extreme environmental conditions and hazardous situations there is a need for real time information technology to increase the protection and survivability of the people working in those conditions. Improvements in performance and additional capabilities would be of immense assistance within professions such as the defense forces and emergency response services. The requirements for such situations are to monitor vital signs and ease injuries while also monitoring environment hazards such as toxic gases. The U.S. defense Department has about 10,000 items in its inventory made partially or entirely from textiles. About 300 of these items are regarded as "combat essential", including uniforms, protective clothing, parachutes, sweaters, socks, gloves, coveralls, sand bags, sheets, blankets and hospital supplies. The applications of the e-textile in military field may be divided into two categories:

- Personal protective clothing and individual equipment (battle dress uniforms, ballistic protection vests and helmets, chemical protection suits, belts, ropes, suspenders and field-packs),and
- Defence system and weapons (tents, parachutes, shelters, tarpaulins and textile composites).

If a soldier wears the "Smart Shirt" during war and gets injured, information on the wound and the soldier's condition would be immediately transmitted to a medical triage unit near the battlefield. This shirt can help a physician determine the extent of a soldier's injury based on the strength of his heartbeat and respiratory rate. This information lets physicians know the urgency of who to treat first. The soldier of the future is most likely going to be the protagonist in the practical application of wearable technology. Obviously, a lot needs to be done to develop better protective fabrics for the military personnel. Not only in terms of performance of individual aspects of protection but also integration of solutions into a protection but also integration of solutions into a protection but also integration of solutions into a protective system, which is economical, stress-free and performs optimally.

C. Sports field:

Smart textiles for sports have a potential to bring a dramatic change in the way athletes at all levels train. Most major sports already started taking advantage of the growing use of technology. Although it is still an emerging area, several products have already been introduced to the market, and the number of those is growing. Technology in sports is a technical means by which athletes attempt to improve their training and competitive surroundings in order to enhance their overall athletic performance. It is the knowledge and application of using specialized equipment and the latest modern technologies to perform tasks more efficiently. Examples of sporting technologies include golf clubs, tennis rackets, pole vault poles, athletic sports apparels (clothing and footwear), advanced computer stimulations and motion capture. Sports apparels such as clothing and footwear should be user-friendly and include valuable properties such as strength, flexibility, density, thickness, durability, toughness, resistance to moisture and more importantly cost. Sport Footwear is generally considered more for comfort and injury avoidance rather than performance enhancement, whereas sport clothing such as the full body suits used in swimming are often claimed to rationalise the competitor's performance times where winning or losing the race is measured in hundredths of a second. Sporting equipment such as the composite tennis racket has been created in order to provide enhanced ball speed, and reduce the potential vibration that can lead to a condition known as tennis elbow. [1] Textiles

are part of the shoes on the uppers (lining, body, shoelaces and other closures), soles (footbed, strobe layer). The shoes are also reinforced with fibres like Kevlar and breathable waterproof laminates depending upon the end use [4]. Athletic health can be maintained and observed, and injuries treated, through the production of modern sporting technologies such as heart rate monitors, pedometers and body-fat monitors. The innovation and research in the field of sports will be helpful for sport

IV. FUTURE TECHNOLOGY

One of the probable future scenarios of e-textile is that as the field of fibertronics becomes more mature, the hybrid structures will include more electronic functionality at the fiber level, until we eventually end up with electronic textiles where all advanced electronic function, such as batteries, lightning, communication and computing is all embedded in the textile fibers. The future of smart textiles is improvements on the current technology that we already have. The first would be waterproof and weather-proof systems. Additionally, since some smart textiles use Bluetooth technology, the use of the systems to collect data outside 4G networks. This will allow people to continually use the smart textiles even when there are no signals to deliver information. Secondly, the commercialization of smart clothing could help more people with health problems to have a faster way of obtaining data. This could then open up a gateway to have smart textiles for children. Since yearly calibrations have to be conducted, in the future automatic calibrations can be completed by the system. Additionally, we can hope to expect that the information gathered could be sent to the doctor by a smart phone or tablet application. This could let the doctor know real time information, rather than information that is days old.

V. CONCLUSION

This paper tries to summarize the main smart clothing applications developed in the last decade. Over the past decade, electronics have been reducing in size and extending in functionality. The idea for the most wearable system is to attach technological components to the textile in which transmission lines and connectors are embedded. Because the electronics are attached and separated freely, they can be defended from the physical pressures of laundering. Innovation in “smart textile” is often considered as already achieved, while in this very traditional sector (textile) the process is just at the beginning. It is expected that many more light-weight, high-performance wearable devices will be available for monitoring a wide range of activities. The challenges faced by the current design will also be addressed in future devices. The development of light-weight physiological sensors will lead to comfortable wearable devices to monitor different ranges of activities of inhabitants. The next step will be the integration of the existing wearable technologies in usable smart clothing and bring them from the lab to the field.

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