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Innovations and Developments in Smart Textiles

Harsh Thakkar*

Department of Textile Science, SVKM's NMIMS Mukesh Patel School of Technology Management and Engineering, Shirpur, India

Abstract

In the twenty-first century, product making has evolving widely in all such field of engineering and technology. Textiles are not lagging on the marathon of such development and making. Smart textiles are the exciting innovation in the field of textiles and clothing. It can sense and analyze the signals and responds in a perfect way and the response which was being made can be electrical, thermal, mechanical, chemical, magnetic or from other source. The extent of smartness can be divided into three subgroups such as passive smart textiles, active smart textiles, and very smart textiles. Now it is not just seen in the Hollywood movies, it is not only limited in our world of fantasy, but also it comes in our day-to-day life with at most perfect possibility. It is now commonly used in numbers of fields. So, it can also be called the next generation clothing. This review aims to show the story of smart textiles, its types and functions. Present smart textiles products and their applications as well as market overview of smart textiles have also been discussed.

Keywords: Smart textiles • Clothing • Sensors • Technical

Introduction

Clothing considering one of the three most basic human needs. From ancient age, textile or clothing is used for apparel purpose which was reached to housing and domestic use with progressive innovation. From a long time, textile is used number of forms such as sail clothing, tent clothing, defense clothing, etc. basically these were all technical textiles and were mostly used for their productive exhibition. A smart textile is a product or a structure that detects and responds to natural conditions or stimuli, for example those from mechanical power, thermal power, chemical energy, electrical energy, magnetic effects or from some other biological effect. Textile science in today's world stands on a fantasy and unexplored horizon which needs serious innovation.

These bunch sciences are mixed with one another to produce fashionable and easy to use textiles which make our lives comfortable and luxurious. Smart textiles, however, are not just limited to clothing and apparels but also to many other applications like automobiles, robots, vehicles, medications, and surgeries etc. The importance of these materials is so significant at some places (e.g. military battlefields) that they virtually act as lifesaving materials.

Literature Review

History

In 1968, the museum of contemporary craft in New York city held a historic show called body covering that concentrated on the relationship between technology and clothing. The event showcased astronauts' space suits along with clothing that could inflate and deflate light up, and warm up and cool down itself. Specifically, this was the work of Diana dew, a designer who created a line of electronic fashion, including electroluminescent party dresses and belts that could sound like alarm horns [1].

In 1985, an inventor, name, Harry Wainwright invented the first fully animated sweatshirt having of fiber optics, LEDs, and a microprocessor unit to control single frame of animation which showed in a full color cartoon on the surface of clothing. Wainwright went on to invent the first machine in 1995 which enables fiber optics to be machined into fabrics, the steps needed for manufacturing enough for mass markets and hired a German machine designer. The first ECG Bio-physical display jackets containing of LED/Optic displays were made by Wainwright and David Bychkov, the CEO of Exmovere at the time in 2005 using GSR sensing methods in a watch connected with a bluetooth to the embedded machine with a washable screen in a jacket and were showcased at the smart fabrics conference held at Washington D.C. May 7th, 2007. Additional smart fabric technologies were further researched by Wainwright at two flextech flexible display event held at phoenix, AZ, showcasing infra-

***Address to Correspondence:** Harsh Thakkar, Department of Textile Science, SVKM's NMIMS Mukesh Patel School of Technology Management and Engineering, Shirpur, India, Tel: 7211167201; E-mail: tharsh083@gmail.com*

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red digital displaying screens machine made into fabrics for identification of friend or foe which were later on shared to BAE technical systems for consideration in 2006 and were honored with an honorable mention award from NASA in 2010 on their technical briefs, namely, “design the future” contest. MIT personnel bought number of fully animated coats for their researchers to wear at their orientations in 1999 to draw attention to their “wearable computer” research. Wainwright was dispatched to talk at the Textile and colorists conference in Melbourne, Australia on june fifth, 2012 where he was mentioned to exhibit his texture manifestations that modify color using any smart phone or any such gadget, indicating callers on mobile phones without a digital display, and contain WIFI security options that protect wallets and personal stuffs from theft [2].

A three decades before, a team of MIT researchers led by Steve Mann, Thad Starner, and Sandy Pentland began to develop what they termed wearable computers. These projects consisted of traditional computer hardware attached to and carried on the body. In response to technical, social, and design challenges looked by these analysts, another gathering at MIT, that included Maggie Orth and Rehmi Post, started to investigate how such devices might be more gracefully inherited into clothing and other soft items. Among other researches, this group of people invented integrating digital electronics with conductive fabrics and made a method for embroidering electronic circuits.

Types of smart textiles

Actually, there is no proper classification for smart textiles though; they are usually divided by their functionality to three types.

The first generation. Passive smart textiles: Passive smart textiles are just able to review the information about the conditions or stimuli of the environment. Such type of textiles includes only sensors. The examples are Ultra Violet protective clothing, plasma treated clothing, fabric with optical sensors, etc.

The second generation. Active smart textiles: The second generation of smart textiles or active smart textiles comprise of both the sensors and the actuators. Active smart fabrics can memorize shape and structure, keep the chameleon effect, regulate consistent temperature, resist water, absorb vapors, heat fabric of the suit and store it. It’s actually a “smart” fabric.

The third generation. Ultra-smart textiles: The third generation of textiles or the ultra-smart textiles is much more advanced. They can not only review number of data types but also make forecasts and fit external conditions without predetermine tuning. Such kind of textiles works like the brain due to a built in microcomputer. The examples of this clothing type are used as spacesuits, I-wear, sport jackets, musical jackets, and wearable computers and soon.

Functions of smart textile

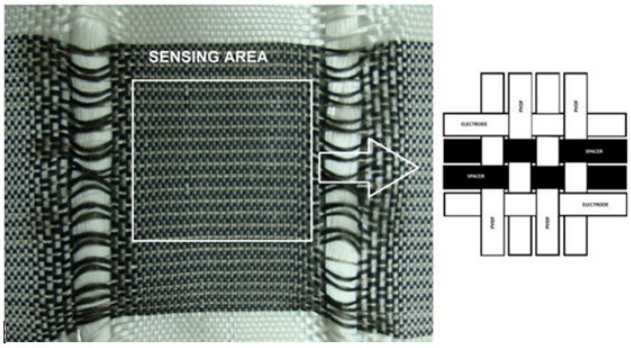
Smart fabrics can detect diverse ecological conditions and intelligent textiles or electronic textiles can not only detect natural changes, but can instantly react to their surroundings or stimuli, such as thermal, chemical, or mechanical changes, as well.

The micro porous Gore-Tex membrane, planned by Wilbert and Robert Gore in the 1970’s, and engineered by a same method and process to Teflon, was originally made to show the body to inhale while being fully wind and waterproof, and thus was commonly used for rainproof wearing product. Materials for astronauts and day to day life clothing for use in extremes of cold temperatures were also made, and more recently Gore-Tex fabrics have been used for medical used products and in the opposing the spread of virus and bacteria on medical aid in hospitals [3].

Electronic or smart textiles, for example heat and light delicate products, were firstly made as smart apparel for the sportswear showcase, and made textures for items that were intended to inherit computing or digital products.

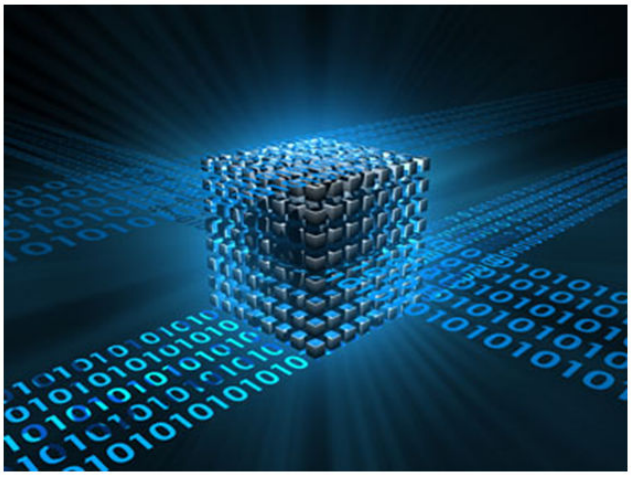
Sensors

The primary role of a sensor is to detect a signal and transform into another signal that can be detect and read by any user, which can be a digital device or a human being. As for digital devices, mostly signals are being transferred into electric ones. Since, textile materials cover a major surface area of the human body; consequently, they are the best tool one can use [4].



Data processing

Data processing is one of the segments that are needed only when dynamic processing is essential. The primary bottleneck at present is the understanding of the information. Textile sensors could countless information. Aside from this, the textile material itself does not possesses any computing power at all.



Actuators

Actuators react to an impulse resulting from the sensor data, maybe after the process of data processing. Since, its ability is to

respond to a heat change or a temperature change, a shape memory material can be utilized as an actuator and joins up completely with the necessary stuff given to smart textiles.

Storage

Smart suit frequently requires some storage limit. Storage of information or data is most common, detecting, data processing, actuation, communication; they usually need energy, mostly electrical power.

Communication

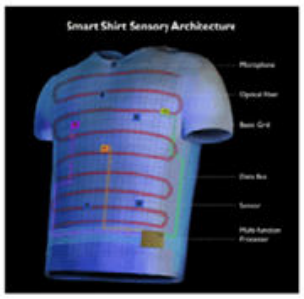
For best textiles, communication has number of faces: it may be needed within one element of a suit, or between the separate elements in the suit, or from the wearer to the suit to pass information, or from the suit to the wearer or his surroundings to pass the data.

Application

Smart textiles are on the global market since the 1980's. Their usage is getting wider and wider since then. These days, it is not difficult to get self-cleaning mattress, shape memory and natural-responsive textiles, temperature regulating suit and shoes. They are on usage in geo textiles, bio medical textiles, sports apparel, protective wearing, and casual wearing, especially for winter wears.

Gore-Tex smart fabric, jacket: It is the first authentic smart textile designed by Gore Company in the year 1978. It has the power of letting water and moisture flow in one direction and not in the opposite and this property tells it waterproof, windproof and breathable.

Wearable motherboard: The garment uses optical fibers to observe bullet marks and some qualified sensors that connect internally in order to have a look at vital signs during combat situations.



Smart running shoes: Adidas's smart shoes came to the market in year 2004 and it was remarked the first smart shoe. It has a microprocessor, electric motor and sensor into the real material. This product lets the wearer in the running methodology.

Bio-sensor underwear: By printing the sensors on the elastic bands in men's undergarment, the researchers and inventors ensure the sensors maintain tight contact with the skin. This test indicated that the sensors could relate the mechanical stress of a wearer's daily activity (flexing and stretching) with small effects on the measurements.

Smart bra: The Smart Bra will tighten and loosen its straps, or stiffen and relax its cups to stop breast motion, restricting breast pain and sag. The materialistic polymer coated fabrics will be taken in the making of the smart bra.

Motion detecting pants: This special feature in the pants of the developed smart fabric is to observe the movement, speed, rotation and location of the wearer wearing it.

NASA aero gel jacket: Aero gel materials are the best insulation product for smart clothing. Due to their much low density, weight and appearance, aero gels are usually called solid smoke.

Sensory baby vest: The sensory baby vest is made with sensors that is used for the constant viewing of vital functions such as heart, lungs, skin and body temperature which can be observed in the early detection and monitoring of heart and circulatory illness.

Firefighters: The thermal sensors inherited with the interior and exterior layers of the jacket so as to maintain the temperature near the fire-fighter and inside of the jacket close to the body. The sensors joined to two LEDs, on both the sleeves and one on the back.

Fashion: The variety of functions for these clothing has been diverse as some clothing helps in controlling of integrated music players, some are meant to display human feelings and emotions, and some just purely showcases the capabilities and potential uses of smart textile clothing.

Market overview

As per US reports brought by venture development corporation, the smart clothing and quality textile (smart textile) market sum up to $248 million in 2004 and $304 million in 2005, with thinking that it would grow to $ 642 million in 2008, with a yield of a compound

yearly growth rate of 27%. The global market was worth more than $2.5 billion in income in 2012 and is required to cross $8 billion in 2018, developing at a healthy CAGR of 17.7% from 2013 to 2018. As far as considering the items, wrist-wear represented for the largest market revenue in 2012, with complete income of the most renowned wearable electronic products wrist-watches and wrist-bands both, crossing $850 million. Out from application area, customer applications recorded for the biggest revenue share, with market reaching to $2 billion, as of 2012. Though, that to the enterprise and industrial usage is considered to rise at the largest CAGR (more than 21%), while the forecast session of 2013 to 2018. North America, with U.S. considering for more than 80% of the market is the only largest revenue base for this world market, and is expected to continue its dominance during the forecast session as well. Still, the revenue in Asia–Pacific region, with China leading the project, is considered to grow at the highest CAGR during the next coming years. Smart textiles is now limited in the developed nations. It will be the next generation's product. So, there is possibility of developing nations to earn huge margin of profit. But they even need more research, study and as usual funding as well as technologies to make this innovation [5,6].

Market segmentation

This system is classified upon given application sectors: consumer items, military & defense/public safety usage, computing, biomedical, and vehicle safety & security, others (logistics, hospitality & supply chain management, and signage, also among others). Major geographical areas contain North America, Asia Pacific, Europe, and Rest of the World.

Major players

Some of the important key players holding this textile industry are E. I. Du Pont De Nemours and company, intelligent clothing Ltd., interactive wear ag, international fashion machines Inc., Kimberly-Clark Health Care, Milliken and Company, Noble Biomaterials Inc., Outlast Technologies Inc, QinetiQ North America, Royal Philips Electronics N.V., Toray Industries Inc, and others [7,8].

Discussion

This review aims to show the story of smart textiles, its types and functions. Present smart textiles products and their applications as well as market overview of smart textiles have also been discussed.

Conclusion

Smart textiles are the most innovating idea in the branch of textile engineering. The making of smart textiles goes far and far maybe the beyond imagination. Some tales may seem to be science fiction or fantasy. The economic value and result of smart textiles is giant and gigantic. The advent of smart textiles keeps it possible for being the traditional textile place to a level of high technological market. Moreover, it seems to appear that this is only possible way by intense co-operation between people from various places and backgrounds and disciplines such as microelectronics, computer science, material science, polymer science, biotechnology, etc. Also more research is needed to make it more convenient in our practical life. Thus, smart materials have to be intelligently made to be used as textiles and their products. Specifically, if these items are to be used as clothing, then a lot of areas of interest like feel, density, aesthetic value, processing (during manufacturing and after use) need to be considered. We are not just here in making fancy electronic components and products, but in making fabrics which can be used like ordinary apparels though having the specifications of electronics and base systems. Present research in smart textiles all over the globe focuses on the number of broad areas which should be everlasting.

References

1. Schwarz A, Van Langenhove L, Guermonprez P and Deguillemont D, et al. A roadmap on smart textiles. *Text prog* 42 (2010): 99-180.
2. Veske P and Ilén E. Review of the end-of-life solutions in electronics-based smart textiles. *J Text Inst* 112 (2021): 1500-1513.
3. Mohammadi RA, Shirazi M, Moaref R and Jamalpour S, et al. Protective smart textiles for sportswear. *Prote Text Natu Res* (2022): 317-345.
4. Coyle S and Diamond D. Medical applications of smart textiles. *Adva Smart Med Text* (2016): 215-237.
5. Gugliuzza A and Drioli E. A review on membrane engineering for innovation in wearable fabrics and protective textiles. *J Membr Sci* 446 (2013): 350-375.
6. Joyce K. Smart textiles: transforming the practice of medicalisation and health care. *Sociol Health Illn* 41 (2019): 147-161.
7. Farrer J. Smart dust: Sci-Fi applications enabled by synthetic fiber and textiles technology. *Textile* 8 (2010): 342-346.
8. Sahin O, Kayacan OZ and Bulgun EY. Smart textiles for soldier of the future. *Def Sci J* 55 (2005): 195.

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