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FUTURISTIC TRENDS IN ARTIFICIAL INTELLIGENCE: WEARABLE TECHNOLOGY ANDSMART TEXTILES

Abstract

An expanding field of interdisciplinary research called wearable electronic textiles necessitates innovative design methodologies. To create a breakthrough in the creation of wearable electronic devices, this difficult interdisciplinary study field brings together experts in electronics, information technology, micro systems, and fabrics. Wearable electronic textiles are an important component of many different technologies. (Clothing, communication, information, healthcare monitoring, military, sensors, comfort clothing etc.). This review paper sheds light on the application of AI to the creation of intelligent and smart clothes. In an effort to give a succinct introduction to the sector of wearable and intelligent textiles and apparel, this analysis has attempted to look at the obvious increase in interest in portable technology over the past few years, which has been driven by the introduction of many "landmark" gadgets to the commercial sector as well as an environment that is more dependent on mobile devices and connectedness. The market for wearable technology goods has shown an exponential growth as well.

Keywords: micro systems, information technology, comfort clothing, wearable electronic textiles

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I. INTRODUCTION

One of its three fundamental necessities of humans is clothing. Textile has been used for clothing since the dawn of civilization, and as civilization advanced, it was also employed for domestic and home purposes. Textiles were employed in a variety of ways thousands of years ago, including sailcloth, tents, protective clothing, ropes, etc. These textiles were all essentially technical and were primarily used for their technical quality. [3]

Materials and constructions that can perceive and respond to environmental cues or stimulation, such as those from magnetic, thermal, mechanical, electrical, chemical or other sources, are referred to as smart textiles. Today's state of textile science is innovative, uncharted, and dream-filled. textiles with independent thought! The concept itself is quite forward-thinking, and such textiles are in fact both technically and commercially feasible today.

Similar to other post-World War I advancements, smart textiles were created to satisfy military requirements. For instance, the US army worked with a number of industrial companies to develop clothes that can change color to create camouflage effects for protection. A wide range of industries use smart fabrics. Some of the major ones are-

1. After the creation of synthetic fibers, one anticipates that smart textiles will bring aboutthe next major change in the textile sector.

2. On the industrial front, the textile sector has seen significant transformation in the last tenyears as a result of increased focus on smart textiles.

When compared to the traditional clothing industries, the western world now places a great deal of emphasis on research and uses of smart textiles. The smart fiber industry is predicted to soar to incredible heights in the upcoming years that it will become vital to people.

The market for intelligent textiles embodies 21st-century textiles, apparel, and accessories. In the upcoming few years, this sector has the potential to completely revitalize the global textile industry. Overall, this industry looks to have an extremely bright future, and it is expected that its products will soon start to enter households. In the last 20 years, wearable technology has clearly undergone exponential growth.

Diagram to help distinguish and clarify terms within wearable technology and Smart Textiles & Apparel (*Picture courtesy*-An Introduction to Wearable Technology and Smart Textiles and Apparel: Terminology, Statistics DOI: http://dx.doi.org/10.5772/intechopen.86560)

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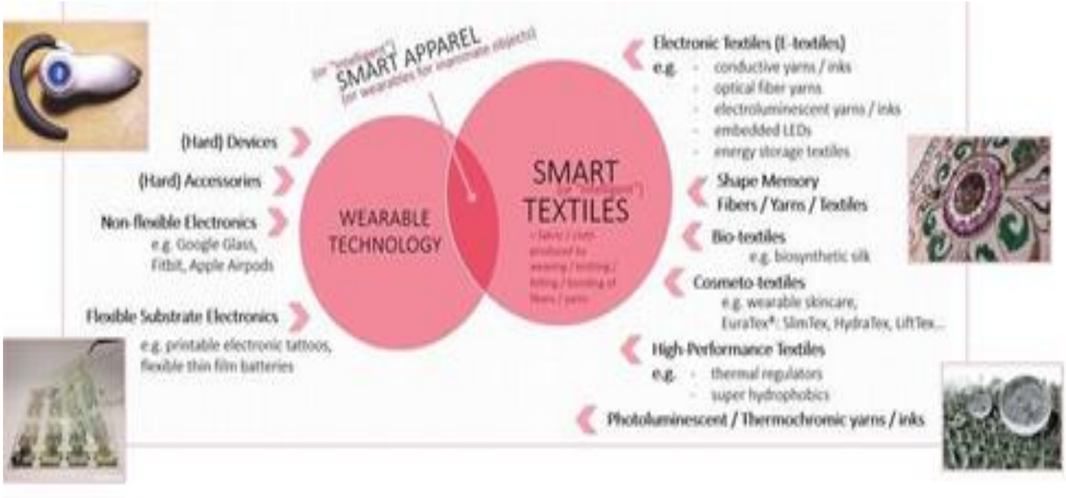

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Recent wearable market study also predicts continued growth over the next few years. Numerous articles have leveraged this expansion of wearable technology—exemplified by goods hitting the market and university research output—to support the need for more research in the area. Nevertheless, according to a number of statistics, the wearable technology market segment symbolized by smart textiles and apparel is still significantly smaller than that segment defined by (tough) accessories and devices, such as smart watches and earbuds, which are currently monopolizing the wearable landscape.

1. **Essential Application:** Textiles that have the ability to sense and respond to environmental cues or stimuli from mechanical, thermal, magnetic, chemical, electrical, or even other sources are referred to as smart textiles. They possess the capacity to perceive and react in a preset manner to inputs from the outside world. Smart textiles are those items made of cloth that may operate differently from typical fabrics and can usually fulfil a specific job.

- **Components in smart textiles**: Three components may be present in smart textiles(materials)
  - Sensors
  - Actuators
  - Controlling units

A nerve system for signal detection is provided by the sensors. Certain materials just function as sensors, whereas others function as both actuators and sensors. Actuators respond to the signals and collaborate with the main controller to provide the desired output. The three subdivisions of smart textiles are passive smart textiles, proactive smarttextiles, and ultra/very smart textiles.

- **Passive smart materials**: Materials or systems that are passively intelligent only sense external inputs or environmental circumstances. Simply put, they are sensors. They manifest what has happened to them by changing their color, shape, thermal conductivity, and electrical resistance. These textile types are roughly comparable to high performance and functional fabrics.

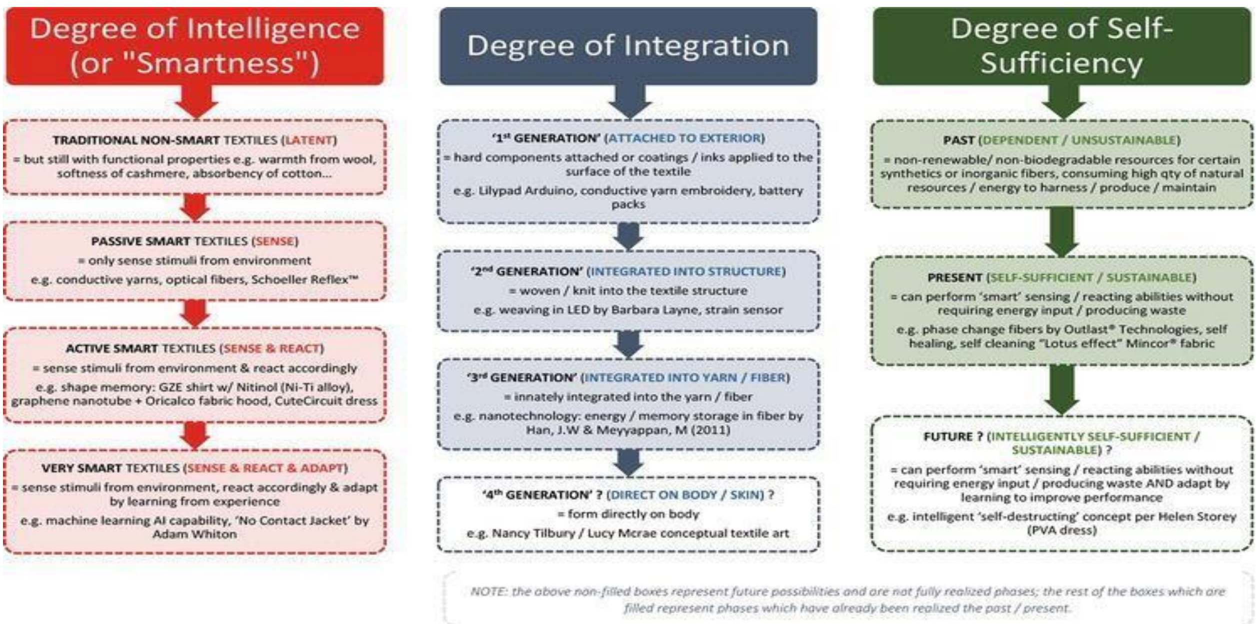
- **Active smart materials**: Intelligent and proactive smart materials are those that can sense and react to environmental stimuli or situations. Their primary roles are perceiving and responding to inputs.

- **Ultra-smart materials**: In order to be considered very smart, a material or system must be able to perform three functions: first, they must be sensors that can take in environmental stimuli; second, they must be able to respond to those stimuli; and third, they must be able to adapt and change their shape in response to the environment. This system can be compared to that of the chameleon animal, which has the ability to absorb the color of its environment and then adapt by altering the color of its own skin to match it in order to defend itself from predators.

Since the terms "wearable technology" and "smart textiles and apparel" have already attracted a lot of interest and grip in the industry and in educational studies, it is important to define and distinguish the phraseology used in the context of this review in order to avoid misuse or misunderstandings.[1]

2. **Evolution:** Knowing how Intelligent Textiles & Apparel has changed through time will help you predict the path and growth potential for the future. A review of the literature ledto the conclusion that smart textiles and apparel have changed in three distinct ways

- their level of integration,
- their level of intelligence (or "smartness"), and
- their level of independence. [1]



(Picture courtesy-An Introduction to Wearable Technology and Smart Textiles and Apparel:Terminology, Statistics DOI: http://dx.doi.org/10.5772/intechopen.86560)

3. **General methods of incorporating smartness into textiles:** A sensor, an activator (for active smart textiles), and a controlling unit are necessary for a textile to behave intelligently (for very smart textiles). Fiber optics, phase-change materials, shape-memory materials, thermochromic dyes, miniature electronic components, etc. might all be included in these components. These elements can be introduced into the base in any of the following layers and become an integrated component of the textile structure.

   - Fiber spinning level
   - Yarn/fabric formation level
   - Finishing level

Prior to spinning, the active (smart) material can be added to the spinning material or polymer chips, for example, lyocell fiber can be changed during manufacturing by adding electrically conductive components to create a cellulosic fiber that is electrically conductive. Activators and sensors can also be woven into the structure of the cloth during the weaving process. There are numerous developed active finishes that are applied to the material during finishing. During completing, the electronically controlled units can be synchronized with one another. Smartness-enhancing materials are typically incorporated into the textile substrate using techniques like microencapsulation. However, it is important to choose the right material and approach, taking into account a number of factors.

4. **Applications of smart textiles:** Applications for smart textiles are numerous and range from commonplace to high-tech. We can now go over a number of significant uses for these textiles. The following main categories of textiles would be included in our analysis:

   - **Comfort /Ease wear-**

     Multiple layered complex yarns and textiles: With the use of internal sweat absorbent layers, multiple layered complex yarns and textiles show a potential for achieving wear comfort by absorbing perspiration emission from the human skin surface.

     Fragranced textiles: Textiles used in cosmetic often have compounds like cyclodextrin incorporated within them, giving them an inherent smell as well as various massaging and soothing benefits.

     Brainy bra: At the University of Wollongong in Australia, researchers are working to develop a smart bra that can alter its characteristics in reaction to breast movement. When active women are in motion, this bra will offer better support. Smart bras have adjustable straps and cups that may be stiffened and relaxed to limit breast movements and prevent soreness and sagging. The creation of smart bras uses textiles covered with conductive polymers. The conductive polymer deposited on the primary cloth can detect the strain being applied to it. Depending on the amount of strain they are under, the textiles' elasticity may change. The smart bra may stiffen the cups or immediately tighten and adjust its straps.

     Resistance against bacteria: Clothing, towels, and other items for NASA crew members on an underwater expedition were treated with AgION all-natural antibacterial technology, which is derived from a silver-based substance, to provide protection against bacteria. This offered defence against the development of harmful and odor-producing bacteria. Ag, one of the earliest antibacterial substances known to science, has been shown to be effective against more than 650 kinds of harmful and odor-producing bacteria, yeast, fungi, and mould. AgION antibacterial, which is a compound of Ag ions, can be added to fabric either during the fibre extrusion process or by a finishing process. This uses an active substance that has been chemically attached to ceramic material. Low level release from ambient air moisture keeps the antibacterial surface intact. When there is greater humidity present, more Ag is released (which could be a reason for more microorganism growth). As a result, protection from germs and mildew isoffered.

- **Heat protection**

UV protective clothing: Typically, electromagnetic energy with a wavelength between 4 and 400 nm is considered to be ultraviolet light. Only a small portion ofthe sun's UV rays make it to the surface of the Earth and are harmful. Smart clothing is available that can passively retain heat by reflecting or absorbing harmful UV rays. This is because textile products have a large number of pores created by bulked and microfiber constructions. Utilizing UV-absorbing compounds also makes it easier to retain heat. The cloth, which contains UV absorbers, can be given a specialized finish.

Ceramic coated textiles: High-performance coating systems are used, according to NASA, to shield materials from intense heat and cold. For both heat protection and thermo ceramic construction, the fluid ceramic can be used as a ceramic coating. The foundation for liquid ceramics is created by dispersing a particular synthetic resin in the form of ceramic bubbles that are vacuum-formed silicon micro bodies with greatly reduced energy. In combination with bubble partial vacuum, the accurate indicator of the diffusion coating (formulation of adhesives, filling agents, pigments, and the unique ceramic bubble state) can be matched to each other in order to develop new and more benefits, characteristics, and features.

Heat regulated textiles: The primary goal of heat storage or thermally controlled textiles is to keep the person in a state of chronophysiological comfort under the broadest variety of workloads and environmental circumstances. Novel textiles known as "heat storage" and "thermos controlled" textiles have the ability to collect, distribute, and release heat through the phase shift of low melting materials, in response to changes in ambient temperature, or by other mechanisms. The so-called Phase Transition Materials (PCMs) are essentially included into the architecture of these fabrics. Thus, when added to textiles, phase change elements can serve as heat buffers. By heating up in the inactive form or releasing it, they maintain a consistent body temperature. The nanocomposite should be designed toundergo a phase change at or somewhat close to the 33.4°C optimum bodytemperature.

Shape memory materials: Polymers that are durable at several or more temperature states are known as shape memory materials (SMMs). In addition to their true, transitory shape, SMMs are able to memories a second, permanent shape. Such a material can be converted into its remembered, permanent shape in response to an external stimulus, such an increase in temperature. The martensitic phase change underlies the shape memory phenomenon (solid-solid phase transformation). Materials with hard and soft segments, such as polyurethane, polyester ether, styrene-butadiene copolymer, etc., are known as shape memory polymers. This is such that the shape memory materials can be used in many ways in smart systems. These innovative performances include sensitivity, actuation, damping, and adaptive responses to outside inputs including temperature, illumination, stress, and field. Different characteristics apply above and below the degree at which an elastic material is active. The substance is easily deformable below this temperature. The polymer exerts pressure to return to a previously chosen shape and stiffens significantly at the activation temperature.

- **Medical applications**

Textile sutures- Some surgical sutures have the potential to be thought of as intelligent fibers. A stitch is a piece of fiber used to join tissues or bind blood vessels. Absorbable materials, which include many different kinds of sutures, are thought of as intelligent materials since they keep the sides of the incision together until it has healed sufficiently. The suture is only truly absorbed into the body's system after that. Over the course of several weeks, the suture's tensile characteristics gradually lessen as the wound heals. The suture's bulk, however, has remained constant during this time. Subsequently, considerable hydrolysis takes place, followed by absorption into the body's system. Up to three months after the suture was placed, the full disintegration of the suture frequently happens.

Data wear- Each body joint has sensors built into the Data wear that plot the position of each joint on a graph that a computer can calculate. The conductive elastane used to make the sensors. The TCAS (supplier) system analyses the degree of each of the joints to calculate their absolute location. Data wear clothing is made up of several magnetic position sensors (i.e., of each of the limbs). The placement of the detectors can be tailored to the needs of each application. The jackets, pants, and gloves that make the information wear body unit are electronically circuited or wired to communicate with computers. In digital data, diagnostic imaging, assessment, ergonomics, biomechanics, robotics, and animation, data wear is used to track the position of the limbs. Data wear can track the entire body, which is especially useful for studying biomechanics and sports injuries.

Sensors for recording human physiological parameters- The American Sensatex company made this type of apparel, often known as "life shirts," popular for use asan undershirt. Its structure is spirally plaited using optical fibers. Using a unique weaving process, the entire undershirt was created in a single piece without any cutting or seams. This smart shirt's primary function is to track vital signs including heart rate and body temperature. Not just optical sensors but also other textile sensors can be employed with it. Adding sensors to the textile framework will allow you to detect the presence of dangerous gases in the air. The sensors send data to the information Centre after collecting it in a central unit. Wireless data transfer is used.

- **Military applications:** These materials have the peculiar trait of having a negative poison ratio, or becoming broader when extended and narrower when compressed. Other beneficial characteristics of these materials include great resistance to fracture, indentation, and energy absorption. As a result, they hold promise for clothing as well as a wide range of possible uses, including helmets and vests that are bulletproof as well as products that are impact resistant. Auxetic is a type of synthetic material thatis widely used, and auxetic fibers may soon be available.

- **Computing textiles:** There are two extreme ways to incorporate functional electronics into textiles. The first is to create a piece of clothing or technical fabric before integrating the electronic components. The alternative is to generate conductive yarns, which I do when making textiles, and then design fabric structures with electronic capabilities1. Depending on the application, intended use, type of cloth, cost, etc., either method could be utilized.

- **Fashion**

Chameleonic textiles: Such textiles are intelligent because they react to temperature changes by changing their color thanks to the surface dye. Chromic materials are collectively referred to as such because they are affected by external stimuli such pressure, sunlight, heat, electricity, solvent, and color to radiate, erase, or just alter their color. The application of thermochromic dyes, whose colors change at specific temperatures, is primarily responsible for the color change. It may be possible to distinguish between the crystalline kind and the chemical rearrangement type of thermochromic devices that have been effectively used in textiles. In both instances, the dye is applied to the fabric of the garment inthe form of tiny capsules, similar to a color in a resin binder. The so-called cholesteric forms of liquid crystals, in which nearby molecules are organized in such a way as to form helices, are the most significant types for thermochromic systems. The liquid crystal's selective light reflection causes thermochromism. The liquid crystal's refractive index and the degree of the spiral configuration of its molecules control the wavelength of light reflected. Since the pitch length fluctuates with temperature, the reflected light's wavelength likewise changes, causing a shift in hue.

Musical jackets: An ordinary jacket is transformed into a worn musical instrument via a musical jacket. Any instrument that is accessible in the general musical scheme can be used to perform notes, harmonies, rhythms, and accompaniment when wearing a musical jacket. To power these components, it incorporates a fabric keypad, a sequencer, a synthesizer, boosting loudspeakers, conductive organza, and batteries. The smart suit is made up of electrically heated fabric panels for warmth, a worldwide smartphone system for communication, and a functional architecture for navigation. The sensory system consists of two impair detecting sensors, a conductivity sensor, a heart rate monitor, three orientation and motion sensor, ten temperature sensors, and a sensor for measuring temperature.

- **Aviation:** The ability of flaps located at the back or side force of the wings to move greatly affects the mobility of the aircraft. It is crucial that these flaps operate effectively and consistently. Today's majority of flying aircraft control their flaps using complex hydraulic systems. Large centralized pumps are used in these hydraulic systems to keep momentum, and hydraulic lines are used to transport the pressure to the actuators for the flaps. It is necessary to run multiple hydraulic lines to each set of flaps in order to preserve operation reliability. The upkeep of this intricate network of pumps and cables are frequently both challenging and expensive. The aerospace industry is looking into a number of alternatives to hydraulic systems. Piezoelectric fibers, electrical resistivity porcelain, and elastic alloys are some of the most promising substitutes.

- **Space research**: In order to minimize overheating, the initial versions of the Apollo spacesuits had an innermost surface of nylon fabric and a network of thin-walled plastic tubes that cycled chilled water around the astronaut. After this comfort layer of thin nylon fabric with textile ventilation system, the pressure garment was created using a three-layer approach. Then, four spaced layers of Dacron were combined with aluminized Mylar for heat protection. These were protected from abrasion and flame by a Teflon-coated beta cloth covering. Teflon communication cloth made up the top layer. A life support system including oxygen, water, and radio communications was built within the backpack unit. The market for intelligent textiles embodies 21st-century textiles, apparel, and accessories. In the upcoming few years, this sector has the potential to completely revitalize the global textile industry. Overall, this industry looks to have a really bright future, and it is anticipated that its products will soon start to enter households.

II. CONCLUSION

With numerous new developments in the works, the intelligent textile sector is still in its infancy. But it will undoubtedly alter the way we perceive fabrics. These fabrics from the twenty-first century will represent the real fusion of the textile and digital industries. A motivated researcher may find intellectual satisfaction in the subject of e - textiles. Since we are discussing the usage of materials like textiles in addition to smart materials, it is somewhat challenging. Thus, intelligent engineering of smart materials is required for their use in textiles. Numerous elements, including feel, thickness, aesthetic value, and treatment (while production and after usage), must be taken into account, especially if such fabrics are to be utilized as clothing. We are not only interested in creating elaborate electronic components; we are also interested in creating fabrics that may be worn like regular clothing yet include electronic system features. The following main areas are the focus of current smart fabrics research worldwide.[3]

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