

# Innovation in Textile using E-textile

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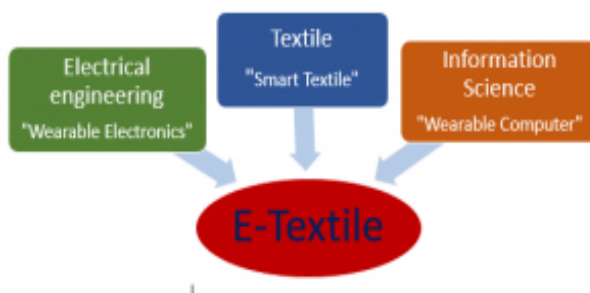
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**ABSTRACT:** E-textiles are fabrics that feature electronics and interconnections woven into them, components and interconnections are intrinsic to the fabric and thus are less visible and not susceptible of becoming tangled or snagged by surrounding objects. E-textiles can also more easily adapt to fast changes in the computational and sensing requirements of any specific application. In general, the development of electronic textiles not only supports the idea of wearable properties but also do the functional purposes. [5]The current research and innovation in e- textiles is addressing the matters in computing the infrastructure, and examining the applications. Software/ hardware architecture of an e- textile using defined percept would facilitate the future research, and produce applicable models [22]

Currently, the industry is still emerging, and companies interested in this area will improve their chance of success if they are aware of the challenges they face from advanced technology, business, regulatory and marketing perspectives. This paper focuses on current developments and recent innovations in e-textile.[3]

**KEYWORDS:** smart textiles, electronic textiles, wearable systems, embedded system, innovation.

## I. INTRODUCTION



The paper wishes to focus on innovation in e- textiles, therefore the whole paper is dedicated to this. Definitions, working conditions, purpose and applications in various fields of e-textile are included here. As well as the future of e-textile also given in brief. E-textiles, refers to fabrics that can function electrically as electronics and behave physically as textiles Electronic-textile research is closely related to wearable computing research, but in many ways its own distinct field. Wearable computing explores technologies that are portable and attached to or carried on the body, but e-textile research has a slightly different focus: investigating electronic and computational technology that is imbedded into textiles. E-textile researchers strive to build devices that are as soft, flexible and comfortable as traditional cloth artifacts. Using Sensors provide a nervous system to detect signals, thus in a passive smart material, the existence of sensors is essential and wireless option gives the ultimate availability to measure information or to send data instantly.[5]

Electronic textiles (e- textiles) are the textile fabrics with electronics and interconnections woven in their structure. Components and interconnections are intrinsic to the fabric structure with reduced chance to be seen, tangled together or snagged by the surroundings.[22]

The paper wishes to give a good overview of innovative idea about future textile with human. An electronic textile is a fabric that can conduct electricity. If it is combined with electronic components it can sense changes in its environment and respond by giving off light, sound or radio waves. An electronic textile refers to a textile substrate that incorporates capabilities for sensing (biometric or external), communication (usually wireless), power transmission, and interconnection technology to allow sensors or things such as information processing devices to be networked together within a fabric.[1]

E-textiles, also known as electronic textiles or smart textiles, are fabrics that enable digital components, and electronics to be embedded in them. Many intelligent clothing, smart clothing, wearable technology, and wearable computing projects involve the use of e-textiles. Electronic textiles can be created by using minute electrically



conductive fibers. Today, metallic fibers are finding new applications in the development of electronic textiles. Electrically conductive fibers can be classified into two general categories, those that are naturally conductive and those that are specially treated to create conductivity.[16]

The convergence of textiles and electronics (e-textiles) can be relevant for the development of smart materials that are capable of accomplishing a wide spectrum of functions, found in rigid and non-flexible electronic products nowadays. [2]

The design process of an e-textile should appreciate the complexity, cost, and effectiveness of system. Software/hardware architecture of an e-textile using defined percept would facilitate the future research, and produce applicable models. An understanding of theories, fabrics, embedded conductive threads/fibres, and the connections in electronics and fabric are significant in producing a prototype. Future studies and advancement in the area of electronic textiles would introduce numerous applications ranging from simple computing devices to advanced protective and sensing textiles. Embedded system technologies and smart materials can be integrated and interfaced in e-textiles; such design will accommodate hardware and software applications.

Sophisticated fibre technology is introducing new fibres that may function as batteries, durable wires, and speakers. The current research and innovation in e-textiles is addressing the matters in computing the infrastructure, and examining the applications. There are two areas where textiles and electronics are taking the directions. First the smart textile interface fabrics are adding value in electronics. In the other area, electronics are enhancing the functional textiles; for example, the sensor and communication technology are used in protective wear, outdoor sports, children wear, and medical applications.[22]

Electronic textiles or more often called e-textiles are the textiles that have electronics and interconnections. These electronics are woven into the fabric to make e-textile wearable. With advancement in this sector you can get from very simple computing devices to large and complex sensing and protective textiles.[18]

## II. PROPERTIES AND TYPES OF E-TEXTILE

An electronic textile (E-textile) is a type of fabric that contains electronic elements. In general, the development of electronic textiles supports the idea of wearable computing, or electronic devices worked into garment designs.[12] E-textiles are also called conductive clothing, electronic clothing, and soft circuits. Electronics, small computers, or other digital devices are built into in them. Special conductive thread or paints can be sewn or applied to the fabric as well.[11]

Electronic textiles, or Intelligent textiles, are a new emerging inter disciplinary field of research, bringing together specialists in information technology, Microsystems, materials, and textiles. E-textiles offer the following advantages:

- Flexible
- No wires to snag environment
- Large surface area for sensing
- Invisible to others
- Cheap manufacturing

### II(a) Properties of Electronic Textile:

**Electrical properties:** Conductivity is the most important factor. Electrical resistance low enough to allow a flow of electric energy, such as for power or data transmission, is critical. Metal, carbon, or optical fibers are typically well-known conductors. Conductive yarns are either pure metal yarns or composites of metals and textiles. Metals are superior in strength and fineness, and textiles are selected for comfort. **Mechanical Properties:** E-textiles should be bendable, stretchable, and washable while keeping good electrical conductivity.

**Flexibility:** Flexibility can be understood as the resistance to permanent deformation under stresses such as folding or bending. Flexibility of yarns can be improved through textile processes such as spinning or twisting.[16]

### II (b) Types of e-textile:

The field of e-textiles can be divided into two main types:

E-textiles with classical electronic devices such as conductors, integrated circuits, LEDs, and conventional batteries embedded into garments.

E-textiles with electronics integrated directly into the textile substrates. This can include either passive electronics such as conductors and resistors or active components like transistors, diodes, and solar cells.

Most research and commercial e-textile projects are hybrids where electronic components embedded in the textile are connected to classical electronic devices or components. Some examples are touch buttons that are constructed completely in textile forms by using conducting textile weaves, which are then connected to devices such as music players or LEDs that are mounted on woven conducting fiber networks to form displays. Printed sensors for both physiological and environmental monitoring have been integrated into textiles including cotton, Gore-Tex, and neoprene. [1]

The focus of this new area is on developing the enabling technologies and fabrication techniques for the economical manufacture of large-area, flexible, conformable information systems that are expected to have unique applications for both the consumer electronics and aerospace/military industries.[6]

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.[10]

E-textiles are smart fabrics in which digital components are embedded. It is also known as smart garment, smart clothing, electronics textile, smart fabrics. It can be used for wireless communication can transform its shape and have the ability to conduct energy. [7]



Fig.: 1 E-textiles



Fig.: 2 Optical Fibers

### III.OPTICAL FIBERS

Plastic optical fibres may be easily integrated into a textile. They have the advantage of not generating heat and are insensitive to EM radiation. Optical fibres may serve a number of functions in a smart garment - transmit data signals, transmit light for optical sensing, detect deformations in fabrics due to stress and strain and perform chemical sensing. Plastic optical fibres can be woven into a textile, however bending of the fibers is an issue during the manufacturing process and also with the end product as mechanical damage causes signal loss. Commercially available Luminex ©fabric is a textile with woven optical fibers capable of emitting its own light. While this has aesthetic appeal for the fashion industry it is also used in safety vests and potential to be used for data transmission. [8]

### IV.ADVANCEMENT

E-textile products are being explored in many exciting niches, from body motion capture, to prevention of multi-billion dollar diseases and side effects, to improving road safety, and many more [21] Some of the most advanced functions that have been demonstrated in the lab include: Organic fiber transistors: The first textile fiber transistor that is completely compatible with textile manufacturing and that contains no metals at all. Organic solar cells on fibers [1]

E-Textile means Electronic Textile. It is also known as smart textile. Electronic textiles are the textile fabrics with electronics and interconnections woven in their structure that enable the integration of electronic functions and attachments. Today, metallic fibers are finding new applications in the development of electronic textiles. Electrically conductive fibers can be classified into two general categories, those that are naturally conductive and those that are specially treated to create conductivity.[9]

The design process of an e- textile should appreciate the complexity, cost, and effectiveness of system. This process must be based on a set of precepts derived from the experience and developing concepts. Software/ hardware architecture of an e- textile using defined percept would facilitate the future research, and produce applicable models.

An understanding of theories, fabrics, embedded conductive threads/ fibres, and the connections in electronics and fabric are significant in producing a prototype.[9]

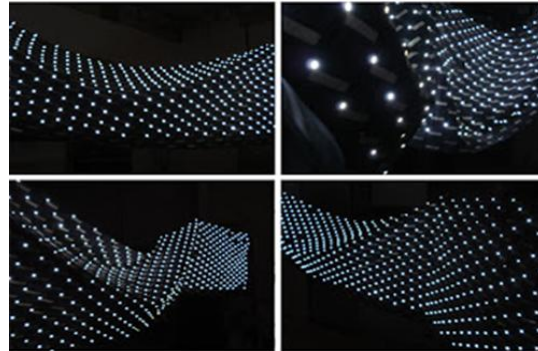


Fig. 3: Advanced E-textile products

### V. CURRENT RESEARCH

#### V.(a) Making E textile using a pad

It is the another way to make smart textile adding sensors, wireless circuit, LED etc. these parts come with extra features like heart bit sensor, temperature sensor, walking calculating sensor, and wireless computing through Wi-Fi, Bluetooth, internet ,and SMD LED for display etc. Recently E-Textile based electronic shop started their business making their moto “Plug & Play”. KeKePad is a new generation of wearable and e-Textile platform, it uses super thin & flexible Ke cables to replace conductive thread. Ke cable is the thinnest 3-pin thread-like cable in the world. This pad can be used in any parts of garments like button, zipper, box plate, button plate etc. Actually depends on what will be the end uses suppose(i) if we want to get heart bits or blood circulation rate than it will attached in the zipper or box plate of a shirt to get the result (ii) if we want to get walking calculation than it will be attached in socks (iii)if we want to know body temperature than it will be attached anywhere of garments.[5]

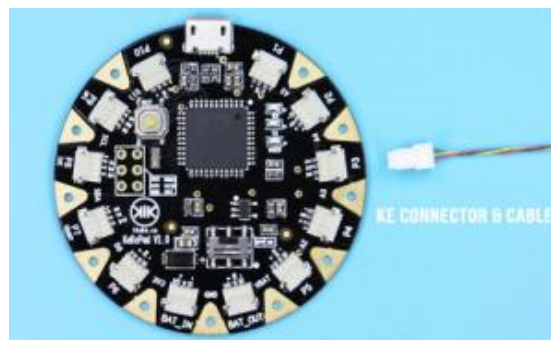


Fig. 4: E-textile using a pad

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Academic research in e-textiles is now world-wide and can be found across material science, computer science, electrical engineering, textile design, interaction design, fashion design, and many other communities. Listing individual research labs or even academic journals is impractical, but research at the intersection of computational



audio and e-textiles is regularly published at the ACM International Symposium on Wearable Computing and ACM International Conference on Tangible, Embedded, and Embodied Interactions.[13]

Conductive fibers and textiles can be applied in various areas such as static dissipation, signal and power transfer in low resistance versions, EMI shielding, and as a heating element in higher resistance versions. An example of a recent beneficial application of conductive textiles is Taser-proof clothing, which could have applications in the police force. Organic Textiles and FurtherInnovations: There is a lot of research happening in the area of organic textiles, the result of which is the creation of the first organic fiber transistor, which is completely compatible with textile manufacturing and that contains no metals at all. Scientists are interested in embedding organic solar cells on fibers, and creating solar power wires based on organic photovoltaic materials. Researchers are also working on creating three-dimensional polymer micro-electronics, using large-scale circuits that can be designed and integrated directly into three-dimensional structure of woven fibres.[15]

There are two main ways to make an e-textile: embedded and laminated.

Embedded e-textiles mean that the circuit is knit or woven into the textile to become part of the fiber of the cloth. This can also include directly printing a conductive pathway onto a textile to give it conductive properties. This branch tends to be more of a derivative of textiles than electronics. Laminated e-textiles mean that you are printing or manufacturing circuitry on a non-textile substrate and then adding it to a textile using sewing or bonding. This branch tends to be more of a derivative of electronics than textiles.[14]

#### V.(b) E textile categories

There are three general categories into which e-textiles can be divided:

- Textiles embedded with classical electronic devices such as integrated circuits, LEDs, conducting wires, and traditional batteries.
- E-textiles with advanced electronics (such as pure wires, conducting textile fibers, transistors, diodes, and solar cells) fitted directly on the textile fibers.
- Hybrid structures using both the above concepts in varying measures [15]

Construction of electronic function on textile fibers requires the use of conducting and semi-conducting materials. There are a number of commercial fibers today that include metallic fibers mixed with textile fibers to form conducting fibers that can be woven or sewn. However as both metals and classical semiconductors (such as Si) are stiff material they are not very suitable for textile fiber applications where fibers are subjected to large stretch and bending during use.

Another class of electronic materials which is more suitable for e-textiles is the class of organic electronics materials, (also referred to as conducting plastics, or inherently conducting polymers). As organic electronic materials can be both conducting, semiconducting and designed as inks and plastics, they are more suitable for making electronic fibers.[19] Ever-shrinking electronic components have been a key enabler of the current generation of wearable technologies. Smarter and smaller microprocessors are also becoming more power-efficient with every release, so even data-hungry devices like activity trackers, which need to be “always-on” to be effective, can use much smaller batteries than smartphones.[4]

The introduction of Bluetooth Low Energy (BLE) has been one of the most important breakthroughs, allowing wearable devices to connect to smartphones as “hub” devices and transmit/receive high volumes of data over higher ranges (up to 100 meters) with a much lower amount of power than any previous versions. This technology alone has enabled many devices to use smaller batteries, making the devices smaller and easier to wear, but more critically, it has cut the need for frequent re-charging from hours or days to weeks or even months.[4]

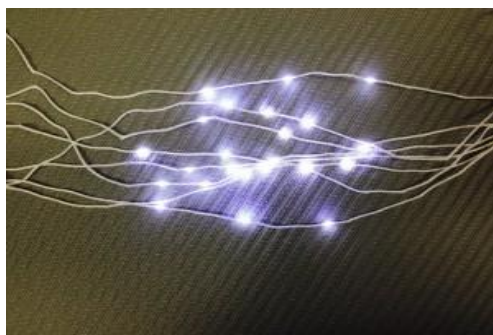


Fig. 5: Conductive E-Textiles smarter and smaller

### V. (c) Conductive E-Textiles

Researchers move from making batteries from paper to making batteries from cloth. A team of Stanford researchers is producing batteries and simple capacitors from ordinary textiles dipped in nanoparticle-infused ink. The conductive textiles - dubbed "e-Textiles" - represent a new class of integrated energy storage device, born from the synthesis of prehistoric technology with cutting-edge materials science. While conventional batteries are made by coating metallic foil in a particle slurry and rolling it into compact form - a capital-intensive process - the new energy textiles were manufactured using a simple "dipping and drying" procedure, whereby a strip of fabric is coated with a special ink formula and dehydrated in the oven. The procedure works for manufacturing batteries or supercapacitors, depending on the contents of the ink - oxide particles such as LiCoO<sub>2</sub> for batteries; conductive carbon molecules (single-walled carbon nanotubes, or SWNTs) for supercapacitors. Up to now, the team has only used black ink, but Cui said it is possible to produce a range of colors by adding different dyes to the carbon nanotubes. The lightweight, flexible and porous character of natural and synthetic fibers has proven to be an ideal platform for absorbing conductive ink particles, according to postdoctoral scholar Liangbing Hu, who led the energy textile research.[19]

### V. (d) Nanotechnology: E-Textiles for biomonitoring and wearable electronics

Early e-textiles were bulky and not very user-friendly garments, full of wires and sensors, and they were not suitable for mass production. But as researchers have started to make transistors in yarn form, public funding for this field increased (see for instance the European project PROETEX), advances in nanotechnology promise to dramatically advance the development of futuristic electronic textiles. Point in case is a recent research report that proposes to make conductive, carbon nanotube-modified cotton yarn. This would offer a uniquely simple yet remarkably functional solution for smart textiles – close in feel and handling to normal fabric – yet with many parameters exceeding existing solutions.[19]

### V.(e) Virginia Tech Computer Engineers

Constructed a functioning 30-foot swath of acoustic array fabric with interwoven wiring and integrated microphone sensors and circuit boards. The original stainless-steel thread (inset) was found to fray and create shorts, so it was replaced with the purple insulated thread shown here.[19]

## VI. APPLICATIONS AND FUTURE PROSPECTS OF E-TEXTILES

### VI. (a) The future of specialized fabrics E-textiles can be used

- To sense tank movements,
- To monitor homes for noxious chemicals
- Help firefighters manoeuvre in smoky buildings, and perhaps help stroke victims recover their function.
- They can also be used in a smart home to detect the movement of people and adjust the lighting or sound systems.
- For sensor network communications
- Physical therapy
- Act as batteries or chemical sensors [19]

### VI. (b) Future prospects

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 field of fibertronics is therefore a crucial field for the developments of future e-textiles [19]

## VII. CONCLUSION

Over the past decade, electronics have been shrinking in size and increasing 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. [5]

E-textile describe the convergence of electronics and textiles into fabrics which are able to sense, compute, communicate, and actuate. This paper has provided a review of the current innovations in e-textiles from a manufacturing and performance assessment point of view. Current advances in textile technologies, new materials, nanotechnology, and miniaturized electronics are making wearable systems more feasible. Overall, the desired outcome is to seek proper materials capable of interfacing with the textile structures. [3]

Finally, we consider relevant that the development of e-textiles requires a multidisciplinary approach in which knowledge of circuit design, smart materials, micro-electronics and chemistry are fundamentally integrated with a deep understanding of textile fabrication.[2]

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