International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 05 Issue: 05 | May - 2021 ISSN: 2582-3930

Smart Textiles for Indian Army

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Abstract - Smart Textiles are the fabrics that have been designed and manufactured for security forces include technologies that provides the wearer increased functionality during battle combat. Smart textiles have designed with the advance health monitoring system, Advance communication and smart Sensing system. Today's dynamic market segments such as digital, health, transportation, energy, or security have an important added value that will be captured by textiles as support. Textiles covers more than 90% of human body surface area so this can add advantage to make it smart way to utilise textile to sense and monitor body status. In this smart textile advanced sensor can be fabricated in the textile with electrical track on textile itself.

For Smart textile two important aspects of the human must be considered: I. Body size II. Human motion. Both will affect the sensor placement on the garment as well as its relative position with human body.
[8]

Keywords:- Smart textile. Health Care and Safety for Security Forces ,Nanotechnology, Camouflage , Sportswear

I. INTRODUCTION

The term ‘Smart Textiles’ is derived from intelligent or smart materials. The concept ‘smart material’ was defined for the first time in Japan in 1989. The first textile material that, in retroaction, was labelled as a ‘smart textile’ was silk thread having a shape memory effect (by analogy with the better known ‘shape memory alloys’). The discovery of shape memory materials in the 1960s and intelligent polymeric gels in the 1970s were, however, generally accepted as the birth of real smart materials. It was not before the late 1990s that intelligent materials were introduced in textiles. It is a new type of product that offers the same potential and interest as technical textiles.
[2]

Smart textiles can be described as textiles that are able to sense stimuli for the environment, to react to them and adapt to them by integration of functionalities in the textile structure. The stimulus as well as the response can have an electrical, thermal, chemical, magnetic or other origin.
[9]

The original function of textiles was to shield man from cold and rain. Later , in history aesthetic aspects also came to play a role in clothing. Much more recently a new generation of textiles has arisen; smart and interactive textiles. Interactive textiles are a relatively new discipline in the textile sector. They are active materials that have sensing and actuation properties.
[5]

II. BLOCK DIAGRAM (Soldier wearing smart cloths to monitor body parameters at base camp)

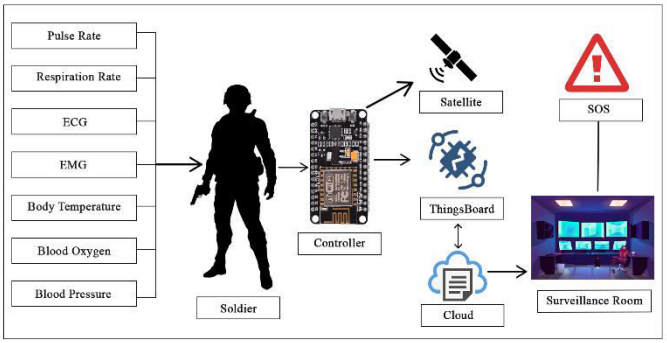

Fig no.1: Block Diagram

One could think of smart clothing that makes us always feel comfortable, during any activity and in any environmental conditions, a suit that protects and monitors, that warns in case of danger and even helps to treat diseases and injuries.

Some of the more important efforts include applications that aid in patient health monitoring through sensor embedded garments that track and record biometric data, helps to improve athletic performance both by analysing sensor data and adapting to changing conditions.

Toimprove performance over the time. Provides environmental sensing and communication technologies for military defence and other security personals. Present new structural and decorative solutions for fashion design. The smart textile can sense and react to environmental conditions or stimuli from mechanical, thermal, chemical, electrical, magnetic or other sources. Three components must be present in smart textiles. i.e., sensors, actuators and controlling units.

Modified textile material and miniaturized electronic devices create smart cloths. These cloths are like ordinary cloth providing special function in various situations according to the design and application.
[citation]

In this project a prototype for security forces which will help the soldier in the battle combat is made. For Prototype the Nylon-Polyester Fabric is selected , it has the ability which can sustain in the heavyrains and winter season. It protects soldier from rain as well as keep soldier warm in the winter. These clothes are useful not only soldiers but for all. In this project smart shoes and helmet also added as a part of smart cloths for soldiers.

III.Smart Materials and Fibers used in Smart textile

Smart materials, also called intelligent or responsive materials,

are designed materials that have one or more properties that can be significantly changed in a controlled fashion by external stimuli, such as stress, moisture, electric or magnetic fields, light, temperature, pH, or chemical compounds. Smart fibber-reinforced composites, such as long fiber or textile-reinforced polymers are often functionalized by integration of piezoelectric transducers to realize sensory and actuator tasks like condition and structural heath monitoring, energy harvesting or active vibration damping.

Materials such as metallic, optical fibers and conductive polymers may be integrated into the textile structure, thus supplying electrical conductivity, sensing capabilities and data transmission. Organic polymers may provide a solution to overcome the stiffness of inorganic crystals such as silicon. These materials are light, elastic, resilient, mechanically flexible, inexpensive and easy to process.

IV. FABRIC CLASSIFICATION

1.Metal Fiber :-

Metal threads are made up of metal Fibers which are very thin metal. The fibers are produced either through a bundle-drawing process or else shaved of the edge of thin metal sheeting. Metallic threads and yarns may be knitted or woven into a textile and used to form interconnects between components (FigNo.2). They may also be used as electrodes for monitoring electrical physiological activity such as electrocardiogram (ECG) signals.
[12]

Fig no.2 :- Metal fibers

2. Optical Fiber :-

Plastic optical fibers may be easily integrated into a textile. They have the advantage of not generating heat and are insensitive to EM radiation. Optical fibers may serve a few 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. Commercially available Luminex ®fabric is a textile with woven optical fibers capable of emitting its own light (Figure 3). While this has aesthetic appeal for the fashion industry it is also used in safety vests and potential to be used for data transmission.

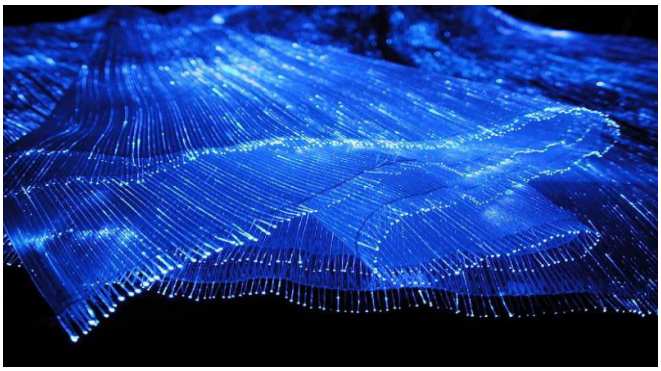

Fig no.3 :- Plastic Optical Fibers

3.Self- healing fabric :-

Self-healing materials are artificial or synthetically created substances that have the built-in ability to automatically repair damages to themselves without any external diagnosis of the problem or human intervention. Generally, materials will degrade over time due to fatigue, environmental conditions, or damage incurred during operation. Cracks and other types of damage on a microscopic level have been shown to change thermal, electrical, and acoustical properties of materials, and the propagation of cracks can lead to eventual failure of the material. In general, cracks are hard to detect at an early stage, and manual intervention is required for periodic inspections and repairs. In contrast, self-healing materials counter degradation through the initiation of a repair mechanism that responds to the micro-damage. Some self-healing materials (Fig No. 4)are classed as smart structures and can adapt to various environmental conditions according to their sensing and actuation properties. [13]

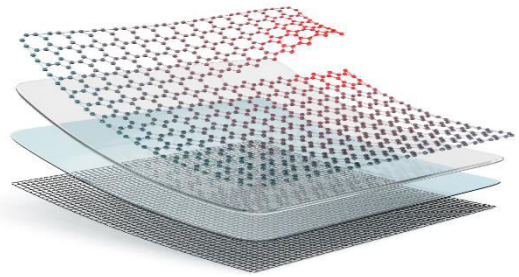

Fig no.4 :- Self-healing Fabric

V. Fabrication flow Chart :-

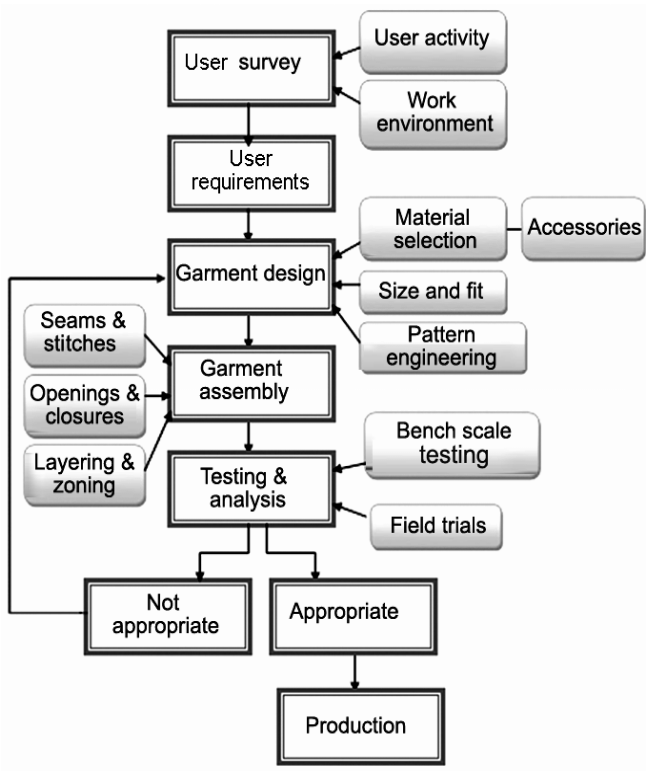

Fig no.5 :- Fabrication flow chart[11]

VI. Smart Shoes and Helmet :-

In this project shoes and helmet of a soldier is modified to accommodate some smart features. Soldiers are continuously running or keeping into motion into the battlefield. So, their footsteps can be used to make generator with helpof piezoelectric sensor for generating electric energy, which will increase the battery life of smart textile. It is a one type of power generation method. Following fig no.6 shows the shoes with piezoelectric chip and signal conditioning circuit.

Fig no.6 :- Smart shoes

For helmet , Hd Night-Vision Camera (wide angle) is fitted, which will capture the real time visuals and send data to the control room for monitoring the combat situations. Also, Hd headset is implemented in helmet which give the audio signals to the control room as well as teammates. Along with this feature,in this project advance environmental and gas sensors are inserted which would measure the various gases contents present in the environment like LPG, butane, CO, smoke,etc.

Due to all these modifications soldier becomes more advance and powerful for critical missions.

Following figure shows the modified helmet:-

Fig no.7 :- Modified helmet

VII. Future Scope :-

Future technology used in smart textiles increases the power of security forces during Surgical strikes , Critical situations. For examples given as follows:-

1.Sensors Fabricated on Textile with Conductive Tracks

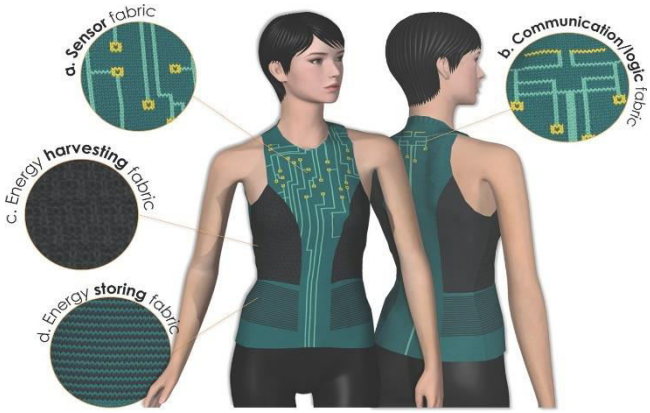

Fig no.8 :- Smart textile with conductive tracks

Digitally printing electrically conductive materials is a new technology. Profactor is using several possibilities to apply these materials onto textiles or 3D printed objects. Inkjet printing is usually used in home office; however, a lot of development is done in functional inks like silver and copper inks to print with inkjet printers.
[4]There is the possibility to use inkjet print heads in bigger devices for large area, or even mounted on a 6-axis robot to print on any complex structures. The inks for digital printing

are filled with metallic nanoparticles. They form the basis for the process of additive manufacturing and are applied in the form of conductor tracks to the corresponding carrier materials in an energy-saving manner only where they are needed. However, the applied structures do not yet have the desired electrical properties. The printed structures only become electrically conductive through thermal post-treatment. Dispensing is another possibility at Profactor and uses a single nozzle, compared to inkjet printing. However, for conducting paths, often no high resolution is necessary. [4]

2. Nano -Technology textile :-[1]

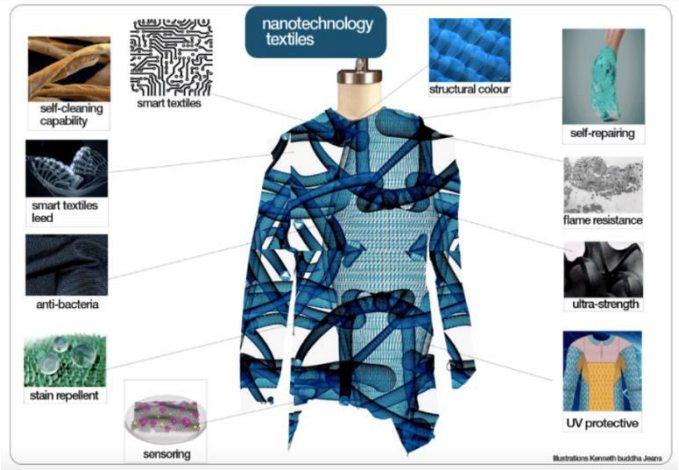

Fig no.9 :- Nano-technology Textile

Nanotechnology is a growing interdisciplinary technology often seen as a new industrial revolution. Nanotechnology (NT) deals with materials 1 to 100 nm in length. The fundamentals of nanotechnology lie in the fact that the properties of materials drastically change when their dimensions are reduced to nanometre scale. Nowadays also the textile industry has discovered the possibilities of nanotechnology.

So, we can define nanotechnology in textile as the understanding, manipulation, and control of matter at the above-stated length, such that the physical, chemical, and biological properties of the materials (individual atoms, molecules, and bulk matter) can be engineered, synthesized, and altered to develop the next generation of improved materials, devices, structures, and systems. It is used to develop desired textile characteristics, such as high tensile strength, unique surface structure, soft hand, durability, water repellence, fire retardancy, antimicrobial properties. [1]

3. Camouflage textiles :-

Fig no.10 :- Camouflage Textiles

Camouflage clothing gives a unique effect to the personnel or equipment by making them appear as a part of the natural surroundings. This provides concealment that allows soldiers, military vehicles, or other objects to remain unnoticed by blending with their environment. Camouflage uniforms enable soldiers to blend into their surroundings and so minimize their risk of being seen by an enemy.

[6]Camouflage patterns aim to visually disrupt the shape of the body, so that the body outline is less easily recognized , and to provide colours or areas of light and dark which approximate their surroundings. Camouflage is achieved by :

- General resemblance to background
- Disruptive patterning (breaking up outline)
- Eliminating shadow

VIII. Result :-

Fig no.11 :- Market Analysis

Global Smart Textile Market size is expected to reach $5,369 million by 2022 from $943 million in 2015 at a CAGR of 28.4% from 2016 to 2022. Smart textiles are fabrics that are manufactured to include technologies that provide the wearer with increased functionality. It senses and reacts to stimuli or environmental conditions, such as those from thermal, mechanical, chemical, magnetic, and other sources. The global demand for various smart textile products has increased continuously due to their expanding base of applications in

end user industries. Most of the demand for smart textile comes from end use industries such as military and defence and healthcare. Both developed and developing countries, will witness the increase in demand with innovative trends. This can be attributed to the factors such as increase in standard of living, rising incomes, awareness of safety and environmentalism, advances in medical technology, expanding automotive sectors, and increased spending on healthcare.
[7]North America was the highest revenue-generating region in 2015, which is expected to grow at CAGR of 27.9% during 2016 to 2022. Moreover, North America is expected to maintain its dominant position over the forecast period. Europe and Asia-Pacific are the second and third leading regions for smart textile marketrespectively.

Integration of smart textiles & wearables, use of nanotechnology in textiles, applications in smartphones, wearables in healthcare sector, and application in the military, defence & sports sector are the major factors that drive the smart textile market across the globe. Increasing research and development in the smart textile market along with the growing demand in emerging economies such as India and China are acting as major opportunities in the global smart textile market.
several government institutions are investing in smart clothing industry to develop military uniforms that are technologically advanced and can also provide insights on the health of soldiers, injuries, the impact of bullets, explosions, and the like. This would generate lucrative growth prospects for smart clothing industry expansion in the military sector. As per estimates, the military and defence application within smart clothing market is estimated to witness the highest annual growth rate of 55% over 2017-2024.

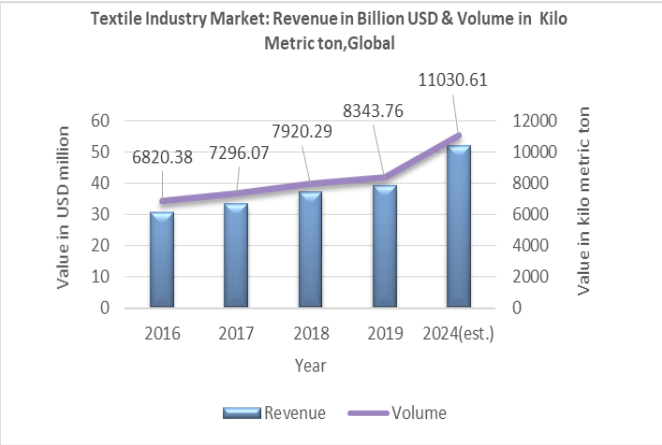

Fig no.12 :- Revenue chart[7]

IX. CONCLUSION

This article reviewed the past, present and future of smart wearable and clothing, providing a holistic approach on the topic.
It is believed that Smart textiles will be perfect solution for our Indian armies. It will monitor the soldiers health parameters during battle combat. It gives assistance in battle combat with précised surveillance that will take our soldiers capabilities to highest level. The useful features that are incorporated into Smart textiles bring market advantages in several areas, such as sports and healthcare.

X. REFERENCE :-

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