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The Role of Smart Textiles in Enhancing Security in Nigeria: Applications in Medicine, Fashion, and Home Economics

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ABSTRACT

The security situation in Nigeria has become increasingly alarming and is a matter of grave concern. This pervasive insecurity has negatively impacted every aspect of life in the country and has persisted for over two decades. The situation continues to deteriorate, with the proliferation of armed groups in various regions, leading to frequent occurrences of kidnapping, insurgency, and attacks on lives and property. Despite the government's efforts, including military interventions and other strategies, little progress has been made. A comprehensive approach to addressing Nigeria's security challenges is urgently needed. One promising avenue involves the integration of smart textiles, which are advanced textile products—such as fibres, filaments, and yarns—that are woven, knitted, or non-woven and can interact with their environment. These textiles have the potential to perform functions related to communication, energy transformation, and conduction, and even to adapt or grow in response to stimuli. Smart textiles are capable of sensing and reacting to environmental conditions or stimuli from mechanical, thermal, chemical, electrical, magnetic, and other sources. This paper explores the potential of incorporating smart textiles into fields such as medicine, fashion, and home economics as part of a broader strategy to combat insecurity in Nigeria. It recommends that the government prioritize improving the standard of living, particularly for the youth, and that the fashion industry focus on producing clothing embedded with smart textiles to enhance safety, particularly in military uniforms and protective outfits. Additionally, smart textiles should be utilized in healthcare settings to monitor biological factors, facilitate health therapy, and improve the accuracy of surgical procedures, thereby making medical care more efficient and precise.

Keywords: *Smart textiles, Security challenges, medicals, fashion.*

Introduction

Security challenges in Nigeria have lasted for more than two decades and it is getting worse by the day. It has become a recurring phenomenon that remains a threat to all citizenry. Insecurity has different faces in different society and different parts of the nation. Security challenges have negatively affected every facet of life as well as the general development of the nation (Isah, 2018). Several measures such as border closure, purchase of arms and ammunitions and formation of Joint Task Force (JTF) among others have been taken by the government to address insecurity, yet a lot still needs to be done, due to the magnitude of the situation. The government has employed the military, and several other convectional channels like dialogue, amnesty and prisoner exchange to curtail security challenge in the country. However, the situation persists in an alarming rate. Human society is a web, where everything affects everything (Adedokun, 2012), therefore in curtailing the challenges of security there is need for an encompassing and holistic approach that will bring on board every segment of the society (Adedokun, 2012).

Home economics deals with human development, personal and family finances, consumer issues, housing and interior design, nutrition and food preparation, as well as textile and apparel. Human development has to do with a holistic component that affects individuals and the society as a whole, while the textiles and apparel aspect entails human appearance and the items an individual puts on which is the complete clothing.

This paper explores the potency of smart textiles in addressing security challenges in Nigeria. Smart textiles are products such as fibres, filament, yarn that are woven, knitted or non-woven which can interact with the environment or the body of the wearer. In smart textiles, a combination of electronics applied before, during or after the production of textile materials which enables the textile to be able to detect the environment, regulate the body temperature and in some cases lightens up the surroundings (Dilan, 2020).

Fashion simply put, is being first with the latest garment, apparel or clothing. Fashion is a social phenomenon per excellence (Sellerberg and Patrick,

2015). Fashion is a distinctive or peculiar prevailing style, social standing, and prominence of dress during a particular time, in a particular place, among a particular group of people. Fashion changes with time due to many factors and reasons. The current technological growth and changes is also one of the influences of change in the fashion world, other factors that influence fashion change are; social, economic, political, climatic change, culture, human society, creative explorations, innovations and designs. Today, the materials used to produce the e – textiles or smart textiles can be introduced into fabrics during the production process which will serve dual function. Smart textiles contain three components, which gives it ability to do many things that the ordinary textiles cannot do, these components include; sensors, actuators and control.

Technology plays an important role in fashion change, and this has increasingly influenced the world of styles and wearable fabrics used in different fashion (Alicia & Emily with Calderin, 2013). The incorporation of smart textiles with solar panels into the construction of fabric enhances the wearers comfort by changing colour or texture of fabric based on the environment. This paper will discuss the introduction of some electronic wearable devices into wearable fabrics that will help to sense the environmental condition and alert the wearer of surrounding dangers. This will in return help to inform individual of the security challenges and dangers that has become an everyday occurrence in Nigeria.

Smart textiles are suitable in the area of health care; they can be programmed to monitor one's medical conditions such like; the biometrics (heart rate) or body temperature in both athletes and patients. These are done through digital components embedded into fabrics either as batteries, led, electronic chips or a sensor using the conductive fibres or multilayer 3D printing methods. This offers an added value to the user or wearer in terms of pleasure, performance or safety.

Therefore, the functionality of smart textiles in medicals, fashion and home economics cannot be over-emphasized. It's utility and role in addressing security challenges in Nigeria if adequately applied, will go a long way in fighting and reducing security threats in the society to a great extent.

Smart Textile: An Overview

Clothing is one of the basic needs of mankind apart from food and shelter, and with the recent security challenges and advancement in technology, smart textile is needed to interact with the environment and improve in the wearers' performance. Smart textiles are materials and structures that sense and react to environmental conditions or stimuli, these stimuli can be from mechanical, thermal, chemical, electrical, magnetic or other sources (Koncar, 2018). That is to say these textiles are made up of materials that can react to the surrounding changes or external signals and changes.

Textilemates (2022) also stated that; smart textiles are a broad field of studies and products which extends their functionality and their use. They are textiles products which includes fibres, filaments and yarn which are woven, knitted or non-woven that can interact with the environment. These textiles are developed with new technologies that provide added value to the wearer. This makes the wearer to sense danger in the environment and can change the wearers clothing to blend with the environment, enables digital components and electronics in its self.

Textilemates (2022), classified smart textiles into four types these include; passive smart materials, active smart materials, very smart materials and materials with higher level of intelligence.

Passive smart materials: These are materials which sense the environmental condition or stimuli such as changing colour, shape, thermal and electrical resistivity. E.g., apparel with in-built thermistors to log body temperature over time.

Active smart materials: These can sense and respond to external conditions or stimuli e.g., a shirt which senses the temperature in the surrounding; it reacts in the form of rolling up the sleeves when the temperature gets hot.

Very smart materials: These materials are able to execute three functions; to receive signals, give reactions based on the received signals, adapt and changes the shape, size, colour or act according to the given function. Materials with the higher level of intelligence: develop artificial intelligence to the computers, these are achieved with advancement in computer interface.

Dilan, (2020) (Not in the list of references) classified smart textile into two categories; mainly the aesthetic smart textile which use the technology for fashion design, this has the ability to light up and change colour, light-emitting clothes and luminous dresses. Performance smart textile there are; passive smart textiles, active smart textile and ultra-smart textile. For passive; they are protecting clothing, sensors, conductive fibres, plasma – treated and water proof. Active smart textile can sense the stimuli from the

environment and also react to them, while the ultra-smart textiles sense, react, monitor and adopt themselves according to the stimuli or environmental conditions (it works like the brain).

According to textilemates, materials used to manufacture products of wearable smart textile include; metal fibres, chromic materials, organic semiconductors, optical fibres, inherently conductive polymers, conductive inks, coating with nano-particles, shape memory materials, quantum tunneling composites and conductive thread. These are used in technical areas such as garments, military uniforms, medical appliances and electronic manufacturing.

Smart textiles in medicals

The use of smart textiles to enhance wearable medical devices for health monitoring and treatment options are improvements and innovations in medical and healthcare (Mohammad, 2020). Smart textiles can be used in various fields in medical care such as; infant monitoring, healthcare monitoring, clinical trials, disease monitoring, obstetrics monitoring, athletic monitoring, healthy lifestyle monitoring, rehabilitation, surgery, drug release system, therapy and wellness as depicted in Fig.1.

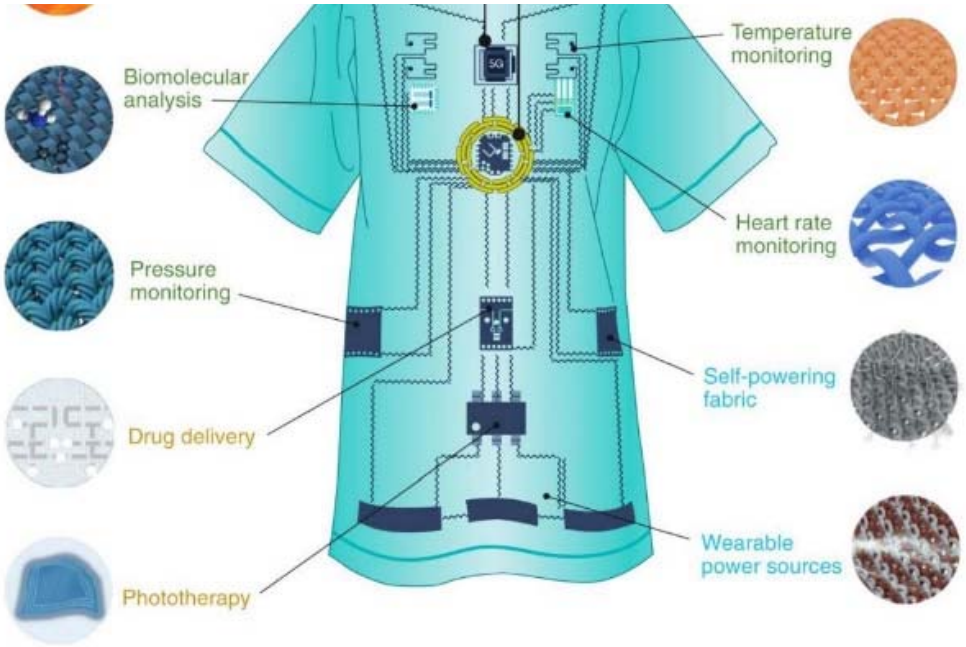

Figure 1: A textile body area network on clothing, enabling diagnostic, therapeutic, energy harvesting, and data processing capabilities. Jun Chen Lab/UCLA.

Smart textiles are integrated into medical and healthcare to make treatments easier and more accurate. This process is converted into readable data or sensors which would be;

1. Fibre based; single yarn
2. Textile structured; when all the compounds of transducer are made of textile material.
3. Textile integrated; when textiles act as a carrier aid.
4. Textile based; when textiles are a non-sensitive but inseparable compound of a transducer.

Sensors and their Applications

1. Temperature Sensors: Provides data for heat production and heat loss in smart textile, it provides evaluation of temperature on the skin surface and in the body.
2. Respiration Rate Sensors: The rate of taking oxygen and removing carbon dioxide from the body cell. The smart textile does the role of telemetric monitoring during sleep and respiratory disorder.
3. Kinematic Analysis: The smart textile is used for physiological analysis, rehabilitation and skeleton position during therapy.
4. Humidity Sensors: Used for monitoring sweat rate, moisture in wounds and ulcer prevention.
5. pH Sensors: Used for wound healing process and sweat monitoring etc.
6. Medical implants made by smart textile include; Artificial knees, Artificial eye lenses, Artificial tendon, Skin, Heart, Kidney and lungs, Hips, Heart valves, Vascular grafts, Ligaments

Smart Textile in Fashion and Home Economics

Textile industry has been one of the oldest industries that existed in the history of mankind, from simple to complex fabrics and from natural fabrics to synthetic fabrics in nature. According to Albert, (2022) fabrics are being developed with in-built sensors in order to improve the quality and performance e.g., photochromic fabrics change colours when they are exposed to a new light sources or thermal regulating fabrics can dissipate heat emitted from the body to cool the body down.

Figure 2: Smart Fabric Textiles (Júnior et al., 2022)

These responsive elements are integrated into the fibres of the fabric through coating, films, weaving, braiding or knitting processes as shown in Fig. 2. The University of Cambridge predicted that the market of wearable products using smart textiles will reach 70 billion US dollars by the end of 2022. And this innovation will develop in the direction of lightweight, fashionable, personalized, low- cost and communication functions. Callus and Waters, (2022); also added that the wearability of clothing means that smart textiles need to incorporate all the other characteristics we expect from our clothing such as; comfort, durability and overall appearance.

Smart textiles do not need to be switched on or off like other gadgets. They function through a combination of sensors, that detects stimuli and act on data such as voice command or change in heart rate, because the functionality is built into the base structure of the garment. There is no need for wires or circuit board, this allows the fabric to be flexible and comfortable (Callus & Waters, 2022). According to Barrera, (2021); smart textiles are used in fashion to provide the garments with an enhanced aesthetic, improved performance and interaction capabilities with the environment and external devices.

Figure 3: Smart Textiles for Protective Purposes Mazharul, 2023)

Aesthetic smart textile fabric lights up and change colour or alter in response to their surroundings. Performance enhancing innovative fabrics provides the user a one-of-a-kind experience based on their intended application. This includes; regulating body temperature, monitoring heart rate or muscle exertion

Integrating Smart Textile in Addressing Security Challenges

Security challenges can effectively be addressed using the smart textile because of its functions. Fig. 3. According to European Defence Agency, smart textiles are new generation of materials and system with multi – functional properties which has the ability of being integrated into uniforms. In 2018, European Defence Agency launched a project called STILE "Smart Textile in Defence" looking at the soldiers of the future, led by the Spanish Research Institute in collaboration with two Portuguese organization. They were able to come out with a smart textile uniform that is able to;

1. Serve as a camouflage of soldier in combat zones, in both static and moving positions monitoring of environmental parameters, by integrating several specific sensors in the combat uniforms that is able to detect the presence of hazardous agents in environment surrounding the soldiers.

2. Improved mobility in terms of the weight, comfort, modularity, freedom of movement based on the body, temperature regulation, water and moisture repellence, physiological monitoring, communication and wireless exchanging data. These were able to send data through a wireless network.

With this development and technological advancement, it is possible to fight security challenge from a distance, because these data and information are monitored from a smart phone or by means of a mobile app that can show valuable information in a user – friendly interface.

Conclusion

Smart textiles are advanced fabrics with integrated technology that offer various benefits across different sectors. These versatile materials can be used in healthcare for improved diagnosis and treatment, fashion for enhanced comfort and style, and even in military and police uniforms for better communication and data collection. Essentially, smart textiles are a promising technology with the power to transform multiple industries and address societal challenges.

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