ENHANCING ELDERLY MOBILITY IN NIGERIA THROUGH THE USE OF INTERNET OF THINGS IN TEXTILES

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ABSTRACT
The global ageing population and the rising average life expectancy present significant social and economic challenges. Ensuring prolonged independence and mobility for older adults is essential to reduce unnecessary institutionalisation and hospitalisation. One promising solution lies in the integration of the Internet of Things (IoT) with textiles, leveraging the close and constant contact individuals have with clothing. This paper reviews current developments in IoT-enabled textiles aimed at enhancing the mobility of the elderly. The findings indicate that this is an emerging area of interest; however, dedicated research focusing explicitly on mobility enhancement remains limited. While some existing studies suggest potential for supporting physical capabilities, they were not specifically designed for that objective. This paper argues for a targeted approach to addressing elderly mobility through IoT-based wearable technologies, emphasising the broader societal implications of neglecting this issue.

Keywords: Internet of Things (IoT), Smart Clothing, Smart Textiles, Mobility, Elderly

Introduction
The average life expectancy of the world population has increased (Commission, 2016), generating an increase in social concerns with the elderly. The increasing number of elderly people generates the need to create various supporting infrastructure to support this age group. Older people have specific characteristics, such as an increase in diseases, reduced mobility, physical changes, etc. Walker, (2014). All these features reduce the independence of the elderly who see their mobility reduced by fears of falling, physiological changes associated with some chronic disease, fear of being lost due to loss of cognitive abilities, etc. The IoT (Internet of Things) Figure 1, presents several opportunities that allow for supporting the elderly in their everyday life, increasing their mobility and, in consequence, increasing their quality of life.
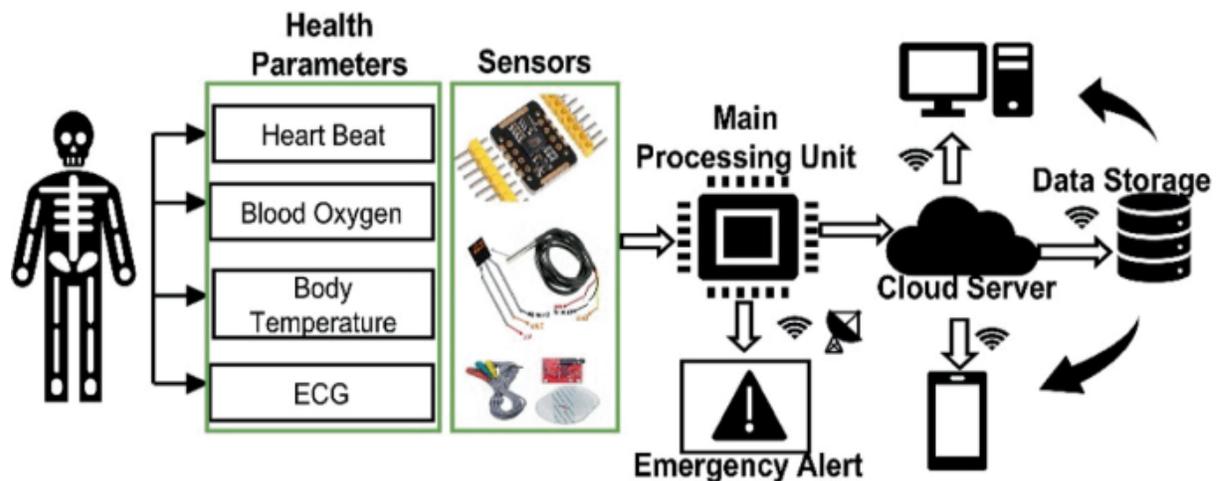

Fig. 1: IoT-Based Smart Health Monitoring System: Design, Development, and Implementation (Mamun et al., (2023).

The quality of life of the elderly is related to their health, to their physical limitations, but also to the loneliness factor (Taube *et al.,* 2016). In his study, Farquhar concluded that elderly people consider their social contact as important as health for quality of life (Farquahar,1995). In the same study, one of the very elderly respondents said: "I miss someone to be able to talk to, to make decisions with. I don't like to be so lonely" (Tiang, 2016). The reduction of their mobility will make them live increasingly in solitude, and this is one of the most important problems of older people (Gabriel and Bowling, 2004). The use of IoT can allow the elderly to move without fear, because different information about them can be monitored remotely by caregivers, family members or doctors.

How IoT Works
The IoT use tiny sensors Figure 2, connected to the internet, allowing the transmission of information. The sensor converts the mechanical measure into an electrical output. The use of elements that are applied directly in the body of the elderly for capturing/communicating data, such as sensors, may bring problems of skin sensitivity, because of the characteristics of the skin of the elderly, which is more sensitive and more susceptible to allergies. Thus, the use of clothing, which is part of the everyday life of persons, appears to be the most natural form to integrate de electronic devices. For example, the use of a bra that has an embedded control device and transmits the information on the rate or cardiac changes, has no inconvenience to the elderly women and is part of their daily dress (Gabriel, 2008)

Fig. 2: The Smart Bra prototype, which uses ultrasound to detect possible tumours in 30 minutes. Results are sent to a phone and can be transmitted to a doctor

Smart textiles are textiles that feel and respond to the changes that occur in their environment. There are two types of smart textiles: passive and active. The active smart textiles are fitted with sensors and actuators to receive the change and transmit the information. The market of IoT expects about 30 billion devices connected in 2020, with about 10% being clothes. The 3 billion clothes connected will use smart textiles, improving the industry (Koncar, 2016)

Literature Review on IoT and Smart Clothing for Elderly Mobility
A literature review was conducted to study the research published regarding the use of IoT in clothing for the elderly with the objective of promoting their mobility.

Performance and Integration of Antennas in Smart Textiles
This study shows that the textile works like a dielectric and doesn't affect the performance of the antenna. The lamination is preferable to embroidering because it's more plane, although, in the case of embroidering, the number and directions of the stitches can influence the signal, increasing the conductivity of some elements. The integration of the electronic device for communication in the garments by printing on the clothes is more discreet and comfortable for the user. The evolution of antennas, making them smaller, cheaper and flexible, is very important because it permits that they can be incorporated in clothing (Loss *et al.,* 2016).

Technical Requirements for Sensor Integration in Wearable IoT
To integrate sensors in smart clothes they have to be small, the antenna has to be small and flexible, the capacity of alimentation of the device must be guaranteed but small at the same time, the distance between the sensors and the body and between sensors and the skin nodes must be short, and there are questions of information security (Kim *et al.,* 2016).

Flexible Textile Biosensors and Physiological Monitoring
For WBSN (Wireless Body Sensor Networks) applications there are flexible textile biosensors: woven/knitted metal electrodes (surface electrode as sensor), electroactive polymeric fibre (piezoresistive sensor as sensor), PVDF film or woven patch (piezoelectric microphone as sensor), etc. Biosensors permit to measure the respiration, blood oxygenation, skin temperatures, skin electrical impedance, heart sound, etc. (Kim *et al.,* 2016).

Emotional Connectivity Through Smart Clothing

Chen *et al.,* (2016), used smart clothing in a study to collect the small electrical changes that occur in the skin of humans as a consequence of the activity of the human heart electrocardiogram (ECG). Those measures permit the evaluation of users' emotions. The objective of using smart clothing, where the sensors are integrated to collect the body signals, is to maximise the comfort of the users. In this research project, the authors designed a CP-Robot system that allows, using smart clothing, smartphones and assisted by the cloud, two users to connect with the real perception of the mood/emotions of the other person (Chen *et al.,* 2016).

The Role of IoT and AAL in Supporting Elderly Independence

Older people want to be independent, live in their homes with their family and not in an institution (Ziefle *et al.,* 2016). The enormous development in ICT (Information and Communications Technology) will help to maintain older people's independence and mobility for longer. The use of sensors and IoT to support living at home changed the concept of Ambient Assisted Living (AAL).

Challenges and Acceptance of Smart Textiles in the Home Environment

Although what seems to be a response to the problem of older people living alone can also become a challenge. The existence of "too much" technology inside homes, especially for the elderly, may not be accepted by everyone. Ziefle tried to assess whether the introduction of smart textile input devices would be accepted in an AAL. The study used a wide range of ages to evaluate differences between younger and older people. Results show that smart textiles were considered less enjoyable in the kitchen and bedroom, but more acceptable in the living room. The use of smart textiles integrated in clothes was found to be more enjoyable. Regarding the influence of age, no relation was found between age and acceptance of this technology (Dewsbury *et al.,* 2001).

The Future of E-Textiles in the Traditional Textile Industry

Zheng defines e-textiles as smart fabrics that can incorporate electronic devices, inter-connectors, and power supplies, which are foundational materials of IoT. The textile industry has the capability to produce such smart fabrics but must understand all the components integrated into the e-textiles in order not to damage the electronic compounds. This presents a challenge to traditional textile industries, but also an opportunity for product differentiation, which is the future of textiles (Zheng, 2011).

Conclusion

Given the daily familiarity humans have with textiles, integrating electronic devices into clothing is a natural and promising approach, especially for elderly care. Studies show that smart textiles are generally well accepted by older adults, regardless of age, and offer significant potential to enhance their independence and mobility. These technologies can improve safety through features like GPS and emergency alerts, and even help reduce loneliness by facilitating emotional connection. Ultimately, smart clothing supported by IoT can improve the physical and psychological well-being of the elderly, contributing positively to both individual quality of life and broader societal outcomes. As the global population ages, the development and adoption of these technologies are expected to accelerate.

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