Intellicare

SMART TEXTILE FOR AGING COMMUNITY

Home care is becoming an increasingly popular choice for elderly people, but it comes with limitations and challenges for family caregivers. However, the emergence of intelligent textiles and wearable technology provides a promising solution to alleviate the pressure on caregivers and enhance the quality of care.

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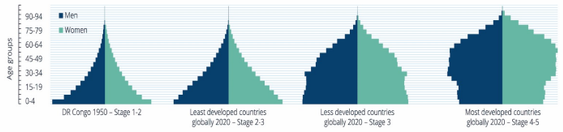
ADVANCED SMART WEARABLE TEXTILES

This section will describe the recent research progress, mainly focusing on the progress of smart wearable textiles in TENG energy supply and the use of MXene materials. At the same time, several innovative constructions of smart textiles for healthcare systems are expounded.

Home care is the provision of medical and non-medical services by family members or paid caregivers to individuals in the home who need assistance, with specialist services for elderly care if necessary. It is necessary for maintaining an acceptable level of health, hygiene, dignity, safety, and comfort. (DoH, 2018)

The aging population worldwide is imposing a significant burden on healthcare and welfare systems. By 2100, some of the world's most populous countries may have an inverted population pyramid. (Statista, 2022b)



Home care offers personalized attention and is more cost-effective than institutionalized care. It helps to alleviate the financial burden on individuals and their families. (Singh et al., 2022)

Advancements in technology, such as smart clothing and systems, can alleviate the challenges of providing care for elderly individuals. These technologies monitor physiologiÅ cal parameters and physical activity, enabling remote monÅ itoring and analysis of patients' health status, thereby reducing caregiver burden.

OVERVIEW OF THE HOME CARE INDUSTRY AND ITS GROWTH

Domiciliary Care in the UK - Market Size (£ million)

Figure 2.1

Based on revenue, the market size of the home care industry in the UK is expected to reach £5.5 billion by 2023, with an estimated growth of 1.3%. This growth rate is faster than that of the overall economy, indicating a promising future for the home care industry. Furthermore, between 2018 and 2023, the market size of the UK home care industry has been increasing at an average annual rate of 2.8% (see figure 2.1).

Furthermore, with the steady and continuous growth of the global market for assistive technology for disabled people and the elderly, it is expected to reach nearly $50 billion by 2030 (see figure 2.2).

. At the same time, the global shipments of wearable medical sensors and devices are projected to increase to 160 million by 2024, with a compound annual growth rate of 19% during this period (see figure 2.3).

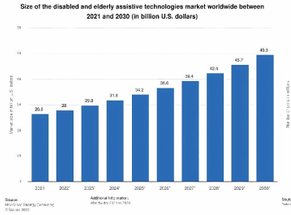


Figure 2.2

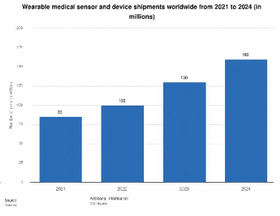


Figure 2.3

SWOT

Here is a SWOT analysis for the use of smart clothing/systems in the home care market for elderly people in the UK:

Strengths:

- Elderly patients can be monitored and tracked remotely to improve the quality and efficiency of care.
- Caregivers and medical staff can be alerted to any problems or changes in a patient's health or behavior for timely intervention.
- Can help reduce healthcare costs by reducing readmissions and emergency room visits.

Weaknesses:

- Older patients may be resistant to new technology, making it difficult to implement smart clothing/systems.
- There may be concerns about privacy and data security.
- Not affordable for all older patients or their families, creating inequities in access to care.

Opportunities:

- The use of smart clothing/systems in home care may create new business opportunities for technology companies and healthcare providers.
- The growing elderly population in the UK may increase demand for innovative home care solutions.
- Advances in technology may lead to more sophisticated and user-friendly smart clothing/systems.

Threats:

- The market for smart clothing/systems in home care may become saturated, leading to increased competition and decreased profit margins.
- Negative publicity or concerns about the efficacy or safety of smart clothing/systems could harm their reputation and adoption rate.

TECHNOLOGICAL APPROACHES IN USE

The technologies used in smart healthcare are divided into two categories, the first category is for monitoring physiological parameters such as heart rate, respiration, thermographic analysis, blood pressure and body temperature. The second category is for assessing body movement such as fall monitoring, GPS, gait analysis, etc.

01 GPS Technology

The Global Positioning System (GPS technology) is a navigation system that uses satellites, receivers, and algorithms to synchronize position, speed, and time data for air, sea, and land travel. GPS consists of three different components that work together to provide location information, they are Satellites, ground control, and user equipment(Kyes, 2020). GPS technology has been used in the apparel field, but it is not yet mature and is not widely used in the medical apparel industry.

Satellite ranging process

Smart wallet using RFID technology in the market

02 Gait Analysis

Gait analysis is the systematic study of human motion, using the eye and the brain of observers, augmented by instrumentation for measuring body movements, body mechanics, and the activity of the muscles. In addition, gait analysis can also monitor some geriatric diseases such as Parkinson's, cataracts, and CSVD(X.M et. al., 2019)
Gait analysis insoles and Pedal pressure sensor insoles are now widely used in the market.

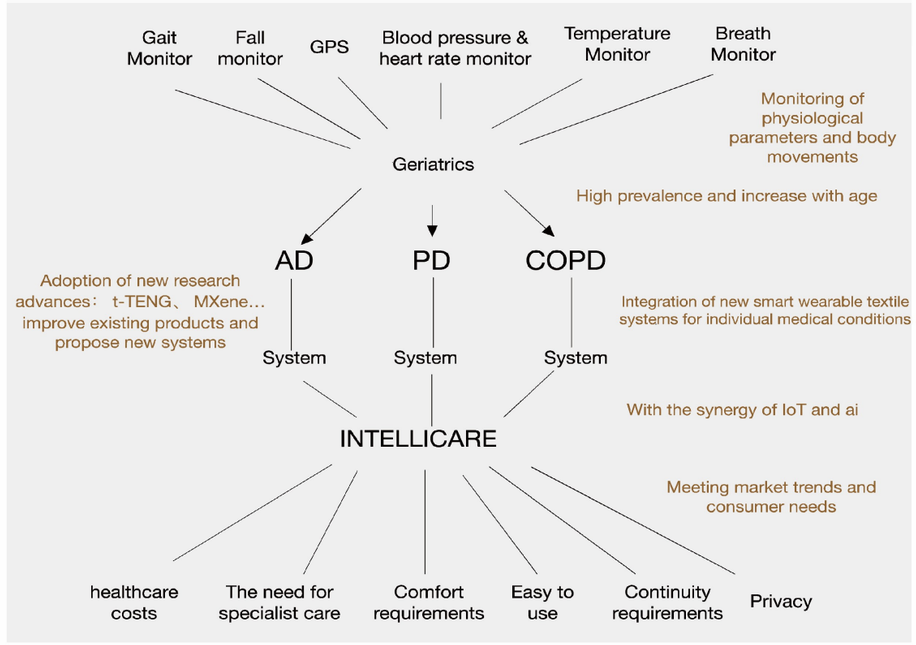
Smart insole in the market

03 Respiration Rate Monitoring

Respiratory rate is critical in the assessment of respiratory dysfunction, sleep monitoring and remote monitoring of some respiratory diseases. Respiratory strain sensors are used to ensure a valid estimation of inspiratory and expiratory activities and the data obtained can then be used for RR assessment(De Jockkheer, Jeanne, Grillet et al., 2007).
There are fewer respiratory monitoring clothing products on the market.

MICRO TOPICS

Personalized professional home care can be provided to the elderly with disease-specificsmart textiles. This research aims to design three systems, targeting Alzheimer's diseaseParkinson's disease, and chronic obstructive pulmonary disease, linked through the Internetof Things and AI.



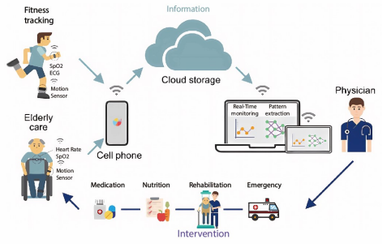
04 Fall monitoring

There are two widely used fall monitoring products in the market
One is the SSD-PM2 Floor Pressure Pad, another is bed or chair exit alarms are also used in the market. These products can alert and quickly provide assistance when a person falls.

SSD-PM2 Floor Pressure Pad

Tamper Proof Fall Alarm Kit

THE CHRONOLOGICAL TREND FOR THE MEDICAL CARE SYSTEM



Smart textiles are being used to develop a wireless body area network (WBAN) system that will be able to assess vital signs (e.g., heart rate, respiratory rate, blood pressure) and physical activity and help healthcare professionals and patients with continuous and real-time monitoring (Alemdar and Ersoy, 2010).

T-TENG

As wearable smart textiles continue to advance, flexible and sustainable power sources are increasingly needed. Triboelectric nanogenerators (TENGs) based on textiles have shown impressive output performance and wear resistance, making them promising for flexible wearable and micro-nano energy harvesting. TENGs are currently divided into two types: yarn-based and fabric-based. Among the fabric-based TENGs, warp knitting is good for commercial production, but more research is needed. Large-scale production can reduce costs and make e-textiles more accessible to consumers. (Guan et al. 2021; Wang et al. 2023).

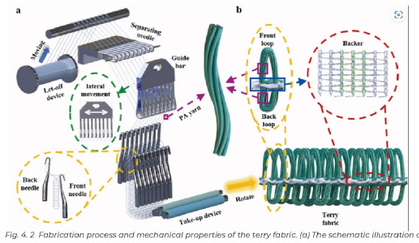


Fig. 4. 2 Fabrication process and mechanical properties of the terry fabric. (a) The schematic illustration of the fabrication process of the terry fabric using warp knitting technique. (b) Structural diagram of the terry fabric.

Wang et al. (2023) proposed a 3D warp knitted terry fabric TENG (WKTF-TENG)that could be mass-produced for motion monitoring and energy harvesting. This generator can be mass-produced using proven warp knitting technology. The device generates distinctive electrical signals at specific locations depending on the stimulation applied during various exercise states, enabling identification of human body movements The output of WKTF-TENG even increases with the duty cycle. This provides a promising direction for downy fabric-based TENGs.

SYSTEM

The development of the Internet of Things and AI deep learning networks has sparked interest in constructing smart textiles to provide better healthcare for the elderly. Currently, smart wearable textiles on the market primarily focus on vital sign detection, while the industry faces challenges in miniaturizing and integrating relevant components and expanding their use to specific diseases (Meena et al., 2023).

Singha (2019) suggested using the Autonomous Textile Area Network (ATBAN) to enable independent, autonomous, and smart management functions in textile embedding. By integrating smart textiles with IoT through continuous wireless external communication, ATBAN offers personalized healthcare solutions in a fully closed-loop system (Libanori et al., 2022). (Fig.4.5)

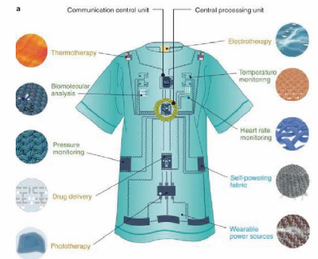


Fig. 4. 5 An autonomous textile body area network (ATBAN) on clothing (Meena et al., 2023)

Fan et al. (2020) proposed a flexible and durable smart e-textile sensing system called TATSA for health monitoring. It can assess cardiovascular disease and apnea disorders and seamlessly integrate into clothing with multiple sensors for high sensitivity monitoring.

MXene material

MXene, an emerging 2D material family, has gained significant attention for wearable smart textiles due to its outstanding electrical conductivity. MXene has been investigated for its potential in fabric modification, sensing, and energy storage. Xing et al. (2022) have developed an MXene/MWCNT fabric sensor that minimizes changes in humidity response under stretching, providing a feasible approach for real-time respiratory monitoring

MXenes have demonstrated great potential in supercapacitor applications. Ma et al. (2022) have proposed a self-powered health monitoring system by combining MXene nanosheets with MXene deposits, achieving efficient MXene utilization and demonstrating a promising approach for integrating smart wearable electronics in future practical applications.

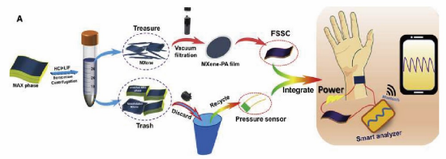


Fig. 4. 4 Schematic of acquisition and application of MX treasure and MX trash. (Ma et al., 2022)