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SMART TEXTILE FOR AGING COMMUNITY

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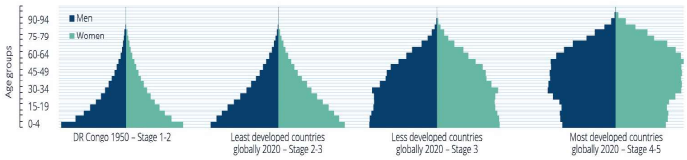
Home care is becom
people, but it comes
caregivers. However
wearable technology
the pressure on careg

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 physiologiÂ cal parameters and physical activity, enabling remote monÂ itoring and analysis of patients' health status, thereby reducing caregiver burden.

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.

Market Opportunities

OVERVIEW OF THE HOME CARE INDUSTRY AND ITS GROWTH

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).

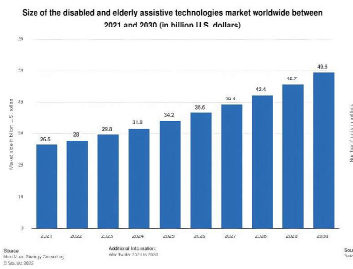


Figure 2.2

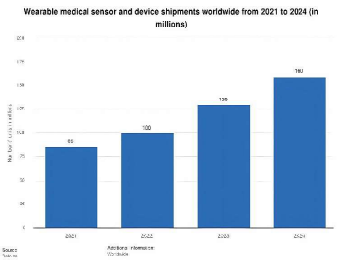


Figure 2.3

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.

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THE CHRONOLOGICA

Fitness tracking

Elderly care

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givers 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.

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).

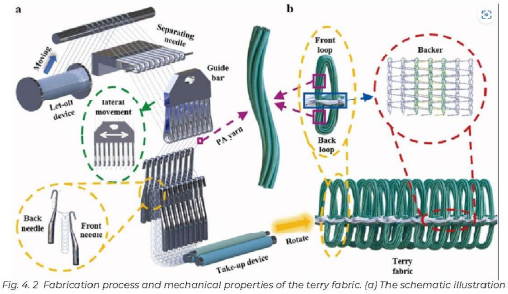


Fig. 4. 2 Fabrication process and mechanical properties of the terry fabric. (a) The schematic illustration of the fabrication process of the terry fabric using warp knitting technique. (b) Structural diagram of the terry fabric.

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)

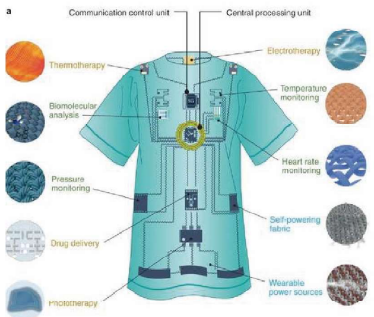
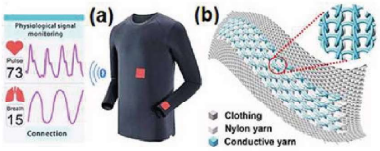


Fig. 4. 5 An autonomous textile body area network (ATBAN) on clothing (Meena et al., 2023)

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.

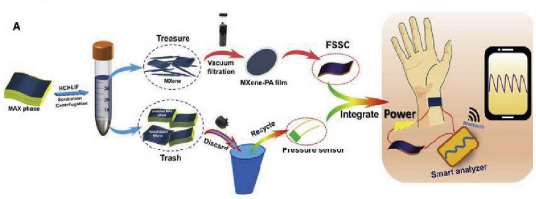
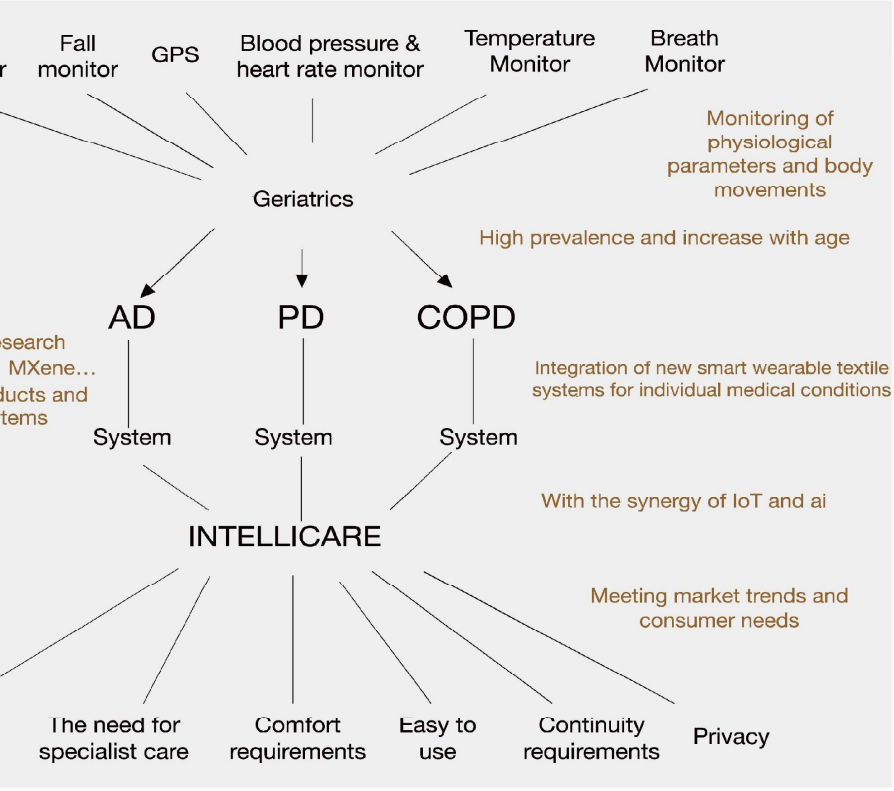
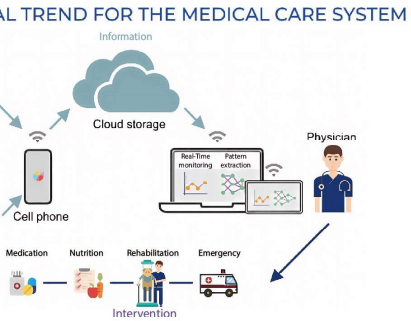


Fig. 4. 4 Schematic of acquisition and application of MX treasure and MX trash. (Ma et al., 2022)

RO TOPICS

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





being used to develop a wireless body area ystem that will be able to assess vital signs (e.g., ory rate, blood pressure) and physical activity and ofessionals and patients with continuous and ng (Alemdar and Ersoy, 2010).

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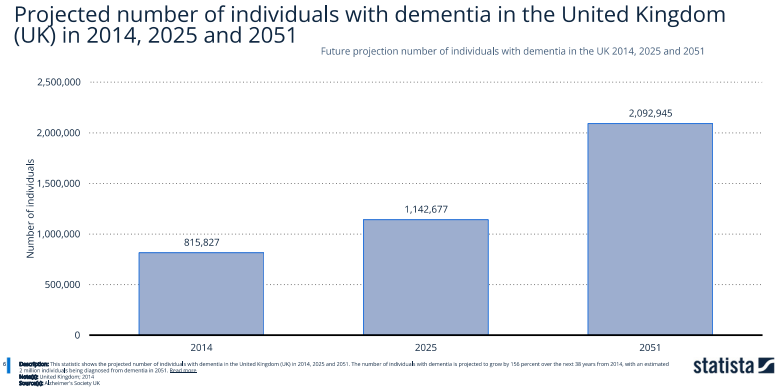
A smart insole that utilizes piezoelectric technology to generate power and alleviate stress for caregivers - Intellisole

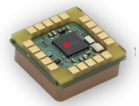
Chenxi Fu
10964095

Introduction

The global burden of healthcare and welfare systems has been amplified by the aging population. Although home care provides a cost-effective customized option, it often lacks the necessary professional knowledge and equipment, leading to a decrease in care quality and an increase in caregiver stress. Technological advancements have provided a solution to enhance care quality and **reduce caregiver stress**.



Recent studies indicate a growing number of elderly people in the UK suffer from **Alzheimer's** disease. A major concern is the risk of wandering, which can result in high search and rescue costs, injury, and even death. A device that tracks patient location and is not easily lost, while also ensuring long-term operation, will alleviate caregiver concerns.

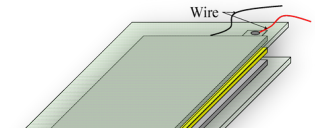


Ultra-low-power GNSS antenna module for location tracking

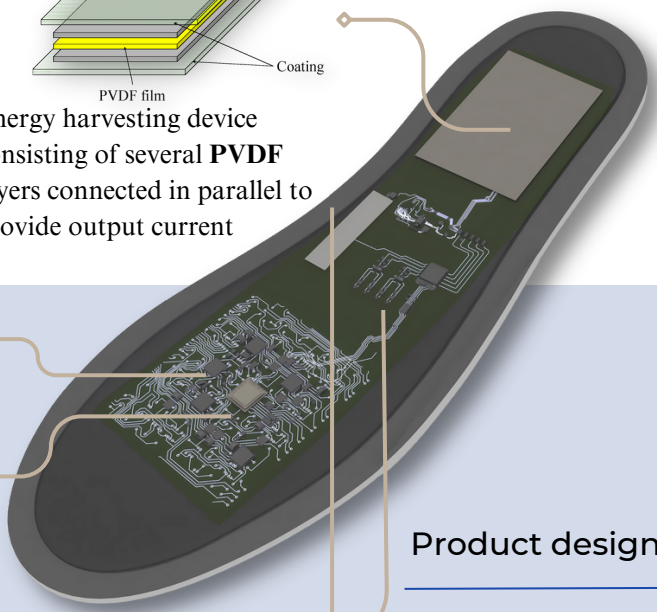
Feature-rich Bluetooth 5 low energy module

Buck converter board to provide stable energy output and rectifier to facilitate energy storage

Battery for energy storage and output



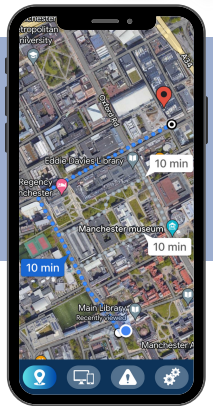
Energy harvesting device consisting of several **PVDF** layers connected in parallel to provide output current



Product design

This is a type of piezoelectric energy harvester embedded in a shoe sole, designed to capture energy from human motion. The DC power system, which comprises the harvester and power management circuitry, collects mechanical energy expended in the shoe and provides power to low-power functionalities such as GPS tracker and Bluetooth module.

Application



Caregivers can utilize the **Intellisole** application to track patients and optimize efficiency by providing various navigation routes. Whether installed pre or post shoe insole, caregivers can use **Bluetooth** technology to establish safe travel parameters for patients. If the patient exceeds the set parameters, an **alert** will be triggered, and the **GPS** location frequency will be increased to ensure the patient is located promptly.

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Wu, Y., Ma, Y., Zheng, H. & Ramakrishna, S. (2021). 'Piezoelectric materials for flexible and wearable electronics: A review' Materials & Design, 211 p. 110164. DOI: https://doi.org/10.1016/j.matdes.2021.110164

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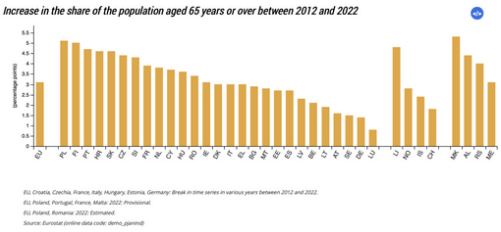
Individual Executive Summary Board

Micro topic: Homecare and health monitoring for COPD patients.

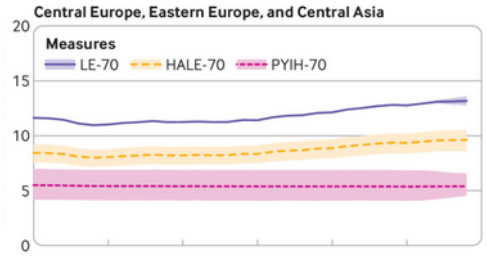
Shubei Li
10966006

Overview of the macro topic

The decline in birth rate and the increase in life expectancy have led to the acceleration of the global ageing process(Phillips & Siu, 2012). For elderly diseases caused by ageing, home care has greater advantages over hospital care because it reduces costs and infection rates, and improves patients' psychological conditions(Romagnoli, Handler and Hochheiser, 2013). This essay provides a new approach for home care providers by using smart textiles to monitor patients in their daily lives, which can increase the safety and professionalism of home care.



Global aging has been identified as one of the five major global risks in the coming decade caused by the decline in birth rate and the increase in life expectancy.



Global	Ischaemic heart disease 0.81	Stroke 0.97	COPD 1.86	Alzheimer's disease 1.010
Central Europe, Eastern Europe, and Central Asia	Ischaemic heart disease 2.11	Stroke 1.84	Alzheimer's disease 1.00	COPD 0.82

COPD has been designated as the third level cause of death for people over 70 years old globally, and the survey results show that elderly people with disabilities and deaths due to chronic obstructive pulmonary disease are almost twice as high as expected globally (observed expected ratio of 1.8). (BMJ，2022)

Outline of the micro solution

Micro topic: Home care and health monitoring for COPD patients.

This essay proposes a new smart pulmonary function monitoring wireless suit for COPD patients, which is improved by a traditional respiratory monitoring band. The key part of this solution is the overview of the suit's innovative features and analysis of the current status of technology and literature.

Evidence of the Investigation

Surveys show that the main clinical manifestations of COPD are shortness of breath, persistent wheezing, and frequent chest infections(Nussbaumer-Ochsner & Rabe, 2011). Therefore, the innovative feature of this suit is the use of respiratory rate textile sensors and temperature textile sensors to monitor respiratory conditions and lung inflammation. Currently, the application of respiratory rate in the assessment of respiratory dysfunction is limited, and it is mainly used for sleep monitoring(Esfahani, 2021). Therefore the product will have great market opportunities.

The working method of this suit is to determine the respiratory status by measuring the clothing strain caused by breathing and to alarm if an abnormality is detected. The data processing chip is placed inside the clothing button and connected to the sensor with metal wires. The clothing is powered by a wireless power source. with the main coil integrated into the mattress, allowing the patient to charge the battery while lying in bed.

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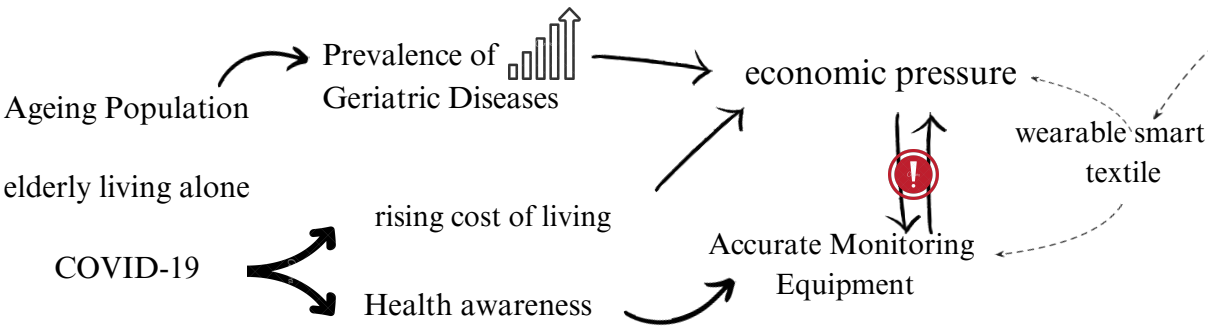
Exploring Current and Future Applications of Wearable Smart Textiles for Monitoring Motor Performance in Parkinson's Disease

Yue Zhang
10975305

1.Macro Issue

The increasing prevalence of geriatric diseases, combined with the impact of COVID-19, is creating a conflict between high healthcare costs and the need for long-term surveillance.



4. Market Opportunities

TENG improves comfort and enables mass manufacturing. Meet patient expectations for price and demand for product precision and comfort.

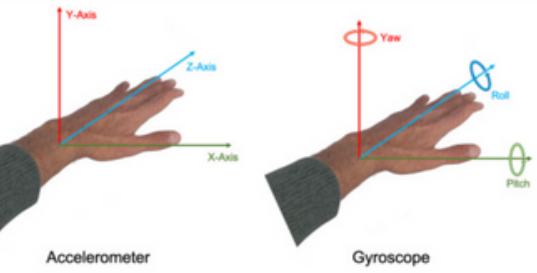
2.Micro Solution

Wearable textiles are the future of healthcare. Parkinson's disease, a common geriatric disease, is one of the main research objects.


E-Textile Planning


Smart Gloves

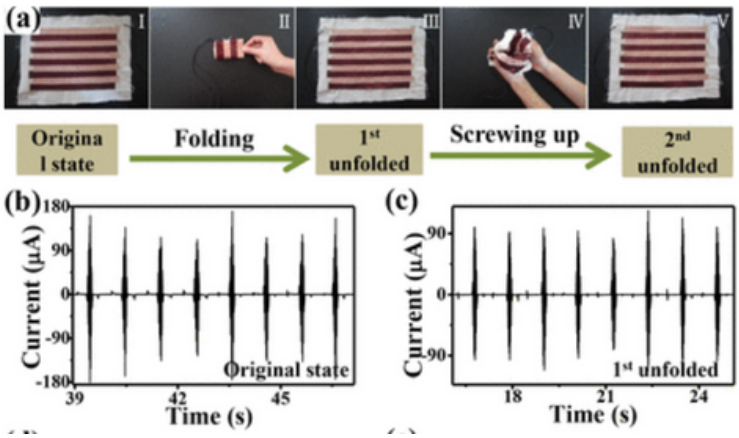
IMU, comprised of an accelerometer and a gyroscope, is commonly used for human motion sensing. Although IMU-based systems have shown promise, their power requirements have hindered their further development.



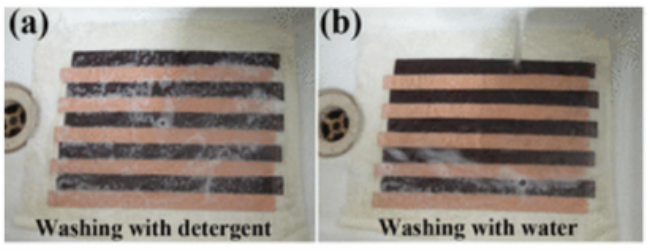
Measurement direction of accelerometer and gyroscope

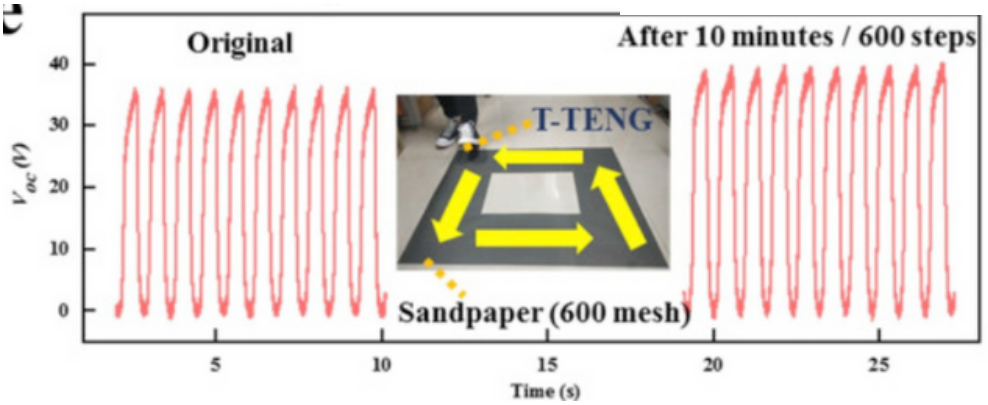
3.TENG

TENG's excellent wear resistance, foldability, and washability have made it an attractive option for supplying power to electronic components.



After wear and washing, the output of TENG remained stable.





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