Application of Wearable Electronics Sensors for Public Health Monitoring and Disease Prevention

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ABSTRACT

Each component of contemporary technology depends on sensors. Improved and more advanced sensors have the potential to advance technological advancements and ultimately contribute to a better quality of life for humans. Adopting more modern materials, designs, and sensing mechanism types is crucial to the development of sensors. Wearable sensors can be used to monitor several aspects of human gait by placing them on the hip, knee, wrist, and foot, among other parts of the body. Measurements of public health, including body temperature, heart rate, pulse oxygenation, respiration rate, blood pressure, blood glucose, ECG signal, and disease prevention, can be made with these sensors. Numerous recent studies have taken into consideration wearable sensor-based systems. With an emphasis on monitoring human physiological indicators, the research work aimed to demonstrate new sensor utilisation in the development of wearable devices for biomonitoring applications.

1. Introduction

With the population rising and technology advancing daily, the health sector needs to be given greater attention. Early disease diagnosis is essential for successful treatment. In certain circumstances, it is necessary to regularly assess a person's health in order to diagnose illnesses early or to keep an eye on patients who have received therapy [5]. Some people have dangerous jobs that require constant health monitoring, including being a soldier, firefighter, mine worker, deep-sea diver, or an elderly person at home who needs their health constantly watched while they go about their daily business. In order to perform better, athletes keep an eye on their health [1]. Because they are uncomfortable for the wearer and do not support extended duration monitoring, traditional physiological monitoring systems are not appropriate for continuous monitoring of the health condition of the individuals in the aforementioned category. Gel electrodes are used in conventional systems to collect physiological information. After extended use, the gel dries out. Long-term use also causes a rise in contact impedance, which lowers signal quality. Existing conventional monitoring devices are overly large and encircle the subject's body with numerous wires. As such, they are unsuitable for use in wearable technology [2]. Because they are uncomfortable for the wearer and do not support extended duration monitoring, traditional physiological monitoring systems are not appropriate for continuous monitoring of the health condition of the individuals in the aforementioned category [3]. Gel electrodes are used in conventional systems to collect physiological information. After extended use, the gel dries out. Long-term use also causes a rise in contact impedance, which lowers signal quality. Existing conventional monitoring devices are overly large and encircle the subject's body with numerous wires [15]. As such, they are unsuitable for use in wearable technology [2].

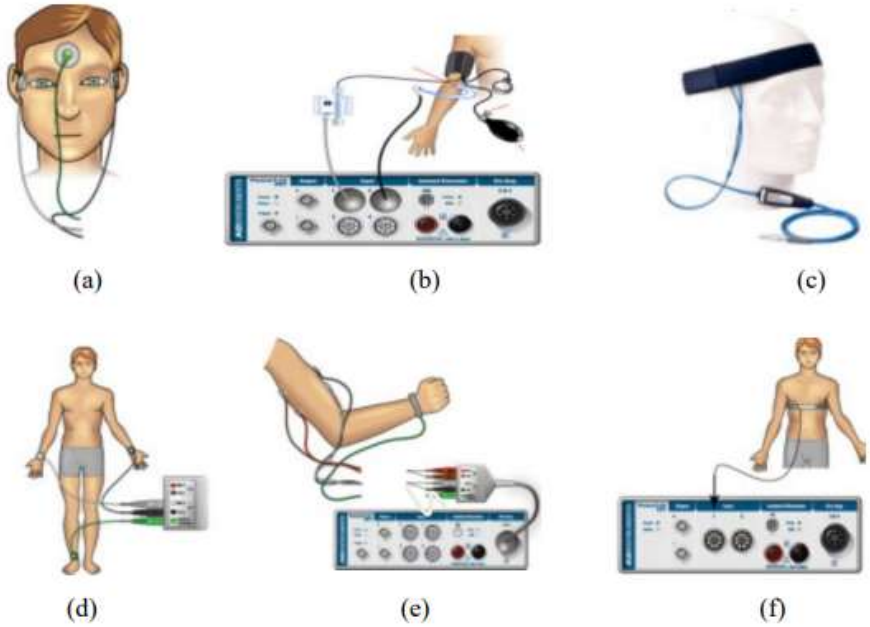

Fig. 1. Physiological bio signals (a) EoG (b)Blood pressure volume (c) Head blood volume pulse (d) ECG (e) EMG (f) Respiration

In this case, the introduction is examined in section 1 of the article while the overview of wearable sensor is discussed in section 2. Section 3 explains the application of the work, Section 4 shows the discussion of the work, and Section 5 concludes up the project.

Wearable Electronics Sensors

Interest in wearable technology has grown dramatically as a result of recent advancements in small devices used in medical applications. Since several decades ago, wearable electronics have been used in medical devices such as pacemakers and hearing aids. Wearable electronics have become more popular due to consumer demand and the ageing population. They can be used for a wide range of purposes, such as infotainment, activity tracking, health monitoring, etc. Additionally, wearable technology offers a way to record, monitor, and transmit physiological information, making it easier to employ hospital space for more responsive and emergency care. Electrocardiograms (ECGs), Electroencephalograms (EEGs), Electrooculography (EoG), Electromyogram (EMG), blood pressure, body temperature, and everyday activities are examples of physiological bioelectric signals. Fitness bands, smart glasses, smart clothes, and other medical equipment are among the wearable solutions available [16]. Figure 2 depicts wearable clothing with integrated sensors for arm position and movement detection in neurorehabilitation [12]. There are numerous difficulties with these designs. Textile electronics need to be flexible, machine-washable, cosy to wear, and user-unobtrusive.

Figure 2. Smart garments embedded with sensors used in neurorehabilitation

Since they hurt the wearer when worn for extended periods of time, the standard sensors and medical equipment found in hospitals and clinics cannot be employed as wearable technology. Long-term usage of the gel electrodes dries it out and makes it irritable [4]. As a result, the electrode's and skin's contact impedance changes with time, lowering the signal acquisition quality. In addition, the system is overly large and has an excessive number of hindering wires. Customised sensors for wearable technology must be developed; they must be thin, simple to incorporate into clothing, less uncomfortable for the wearer, and capable of reliably recording physiological information.

Application of Wearable Sensor in Health Care Industry

The healthcare sector is one of the key industries using WSNs. The rapid advancement of wireless technology through wearable medical sensors has given rise to a specialised field for continuous on-body health monitoring called the Body Area Network (BAN) [13]. WBANs are made up of a focal unit that collects data from the sensors via wireless association and a wearable sensor that is small, always ON, and uses less power to monitor the subject's physiological indications [6]. Customised gadgets, like a wearable computer, smart watch, smart phone, etc., are frequently utilised for the wireless association to a central controller [7]. In the event of an emergency, these centralised controllers notify the wearer and make a request to the hospital and physicians. They also continuously monitor the wearer's health data. Patients will receive an early diagnosis and therapy well within the "golden hour" if aberrant data from the individual is discovered early [14]. Over time, a large number of wearables for physiological monitoring have been produced. A wearable computer with firmware and many customised sensors embedded in the fabric are used by the washable shirt wearable physiological monitoring system to track each person's physiological and physical data and provide a health report. Wearable sensors, wearable hardware with firmware, wireless connection, and a remote monitoring station are some of the parts of wearable physiological monitoring systems. Wearable sensors are integrated into clothing, arm bands, watches, spectacles, and sensor patches, which are fastened to the body in different place.

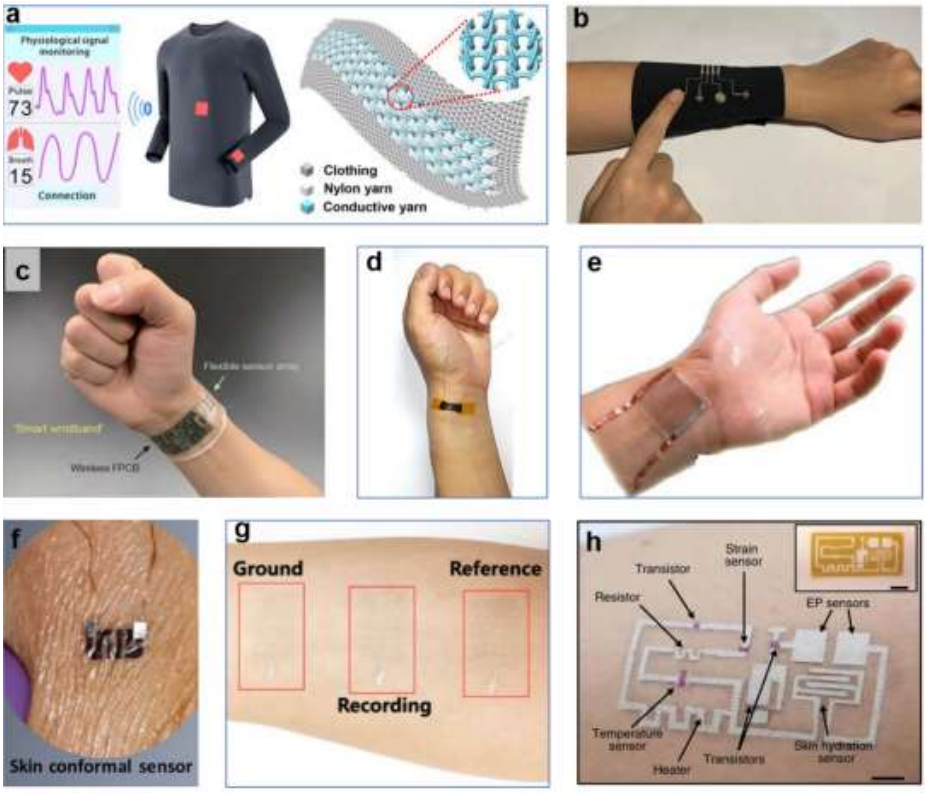

Figure 3: wearable sensors

Wearable physiological monitoring systems are being utilized for various applications as mentioned below:

- Senior citizens and those with ongoing medical issues might have their health monitored at

home for easy access by medical professionals and paramedics.

- Identification of stroke, heart attack, and epileptic seizure onset in individuals, with automatic alarm message production for medical professionals and family members. to research the efficiency of drugs, the development of prescribed drugs, and the advancement of medical care.
- keeping an eye on the health of people who take risks and carry out hazardous occupations. These people include law enforcement officers, firefighters, astronauts, deep sea divers, coal miners, and soldiers. It is imperative to consistently examine the health of these individuals due to their fragility. Wearable technology can be used to continuously check one's health.

Numerous sensors often referred to as electrodes are employed in the detection and measurement of bioelectric signals produced by induced pressure awakened by blood vessel rush and muscle contraction. Traditionally, a layer of conducting gel is applied to the skin in between wet electrode placements. Nevertheless, there are a number of intrinsic disadvantages to wet electrode electronics, including as discomfort, lengthy setup times, skin irritation, and a lack of long-term stability [8]. Sometimes utilising wet electrodes requires skin preparation, which can be problematic, especially for newborns.

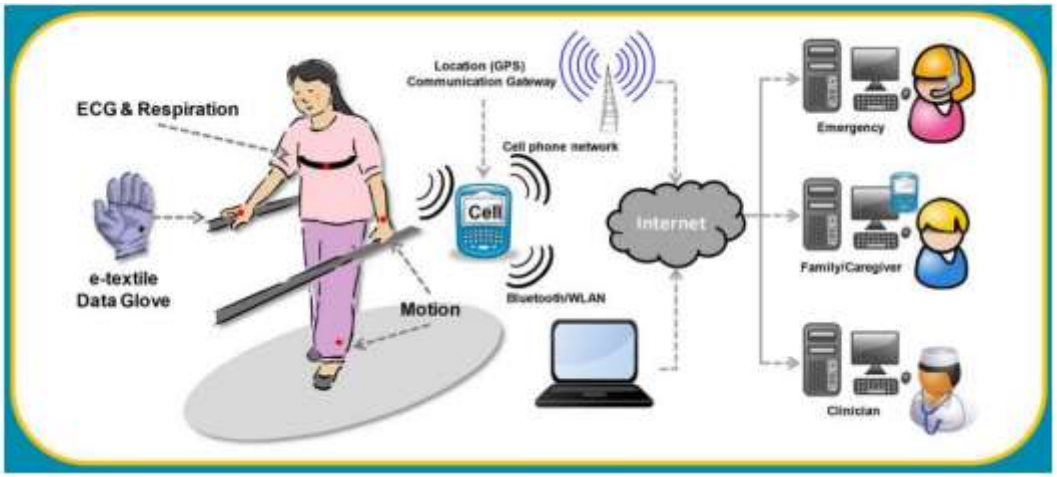

Figure 4. High demanding challenging technologies in wearable device

The construction of a sensor system with a suitable interface for the skin and the conformal, softer human body presented numerous challenges to an efficient Human-Machine Interface (HMI) [9]. Since the 1990s, wearable electronics have attracted a lot of attention because to developments in smaller, more powerful sensors, low power, cheap cost, wireless connectivity, and possibly even self-powered systems. This has been made possible in particular by the advancement of big area and flexible electronics. This includes new materials and even growth techniques that make it possible to deal with elastic, soft, and pliable substrates in conformal shapes on which the devices could be grown or mounted directly. Additionally, these materials and devices must have greater mechanical qualities, be softer, work with HMIs, and be comfortable for users. As of 2024, more than 350 million gadgets are in use. This figure is only anticipated to rise. Wearable electronics sensor-based systems are being used for a wide range of applications, such as continuous monitoring of patients in critical care, monitoring of young children, monitoring of elderly people, monitoring athletes or workers, monitoring for personal safety, monitoring for general integrated health, and more [10-11]. Wearable sensor design has many intricate design considerations. The first step in doing this is to have a reliable sensor that can accurately record and collect the important information. Subsequently, they must be communicated consistently, protecting the individual's confidentiality and privacy, providing comfort to the user, and operating in an unobtrusive manner. In theory, wearable sensors could be contact or non-contact,

invasive or non-invasive.

2. Conclusion and future scope

The current studies explore the rapidly developing and significant field of wearable biomedical devices, which heavily rely on sensors. Effective disease treatment depends heavily on early disease diagnosis and identification. Wearable health monitoring solutions have emerged as a result of advancements in smart materials, sensors, microelectronics, signal processing, and wireless communications. A variety of sensors are positioned thoughtfully on the body's surface or even implanted beneath the skin's surface in wireless body area networks. The sensors are incorporated into garments, wrist bands, chest belts, and other items. This is the upcoming technology for applications involving wearable physiological monitoring. With tiny input/output devices that can function as separate systems to gather physiological data from the body and send it wirelessly, it has completely changed computer communication. Wearable sensors have the advantage of being comfortable to wear and having the ability to monitor vital signs for extended periods of time in individuals with health conditions.

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