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REVIEW

The scoping review and prospects on wearable health technology

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One of the most fascinating areas of technology is wearable medical devices. These wearables provide a constant stream of health care data for disease diagnosis and treatment, in addition to helping users live healthier lifestyles by continuously monitoring physiological signals and analyzing metabolic state. This article seeks to cover all the various facets of wearable technology, such as its historical evolution and certain essential characteristics.

Keywords: wearable, technology, miniaturization, machine learning, deep learning, artificial intelligence, wearable health technology

Introduction

The concept of wearable technology was first proposed in the 1960s by Edward O. Thorp, a math professor at the Massachusetts Institute of Technology in the United States. Since then, wearable technology has received a lot of interest from academics worldwide (1). Wearable technology, or simply wearables, refers to electronic devices that are worn on clothing, as tattoos, or as implants, or are in close proximity to the skin. They have been most widely used for health monitoring, offering real-time information on things like heart rate and daily step count. They may now, however, also be used to make phone calls, send and receive emails, and set alarms. In actuality, they offer an increasing number of functions (2). Wearable sensor data can be processed by machine learning (ML) and artificial intelligence (AI) algorithms to provide information about a person's health state. This allows for the early identification of health problems and the delivery of individualized treatment (3). These gadgets frequently have wireless connectivity, data processing power, and sensors, allowing for ongoing user data monitoring and analysis. Their capacity to provide proactive, continuous, and tailored monitoring outside of typical clinical settings is what makes them significant in changing healthcare (4, 5). The term "wearable's" refers to electronic devices that are worn on the body and serve a practical purpose for the user or a caregiver, such as smart watches or adhesive patches with sensors. Wearable technology is being used more effectively in the medical industry to enhance patient care and has the potential to revolutionize healthcare by enabling proactive, continuous, and customized monitoring outside of traditional healthcare settings (6). These days, wearable technology is all the rage, from the constantly changing and much-awaited Google Glass to Fitbit gadgets and the Apple Watch. However, wearable electronics were conceptualized and developed long before smartphones or even desktop computers (7).

Five key characteristics of wearable technology are (8)

a. wireless mobility
b. interactivity and intelligence
c. sustainability and durability
d. easy operation and downsizing
e. wearability and portability as a routine health care intervention.

From the standpoint of contemporary medicine, wearable technology is applied in the medical area in accordance with the 4P medical paradigm, which stands for participatory, personalized, predictive, and preventive medicine (1).

In the medical industry, wearable technology is being utilized increasingly successfully to enhance patient care and quality of life. The current state of wearable technology is characterized by a vast array of gadgets that are imperceptibly integrated into our everyday lives and provide features that go beyond standard health monitoring. These gadgets have developed into fitness trackers, smart glasses, wearable cameras, smart jewelery, smart clothes, and even implanted health monitoring tablets (6).

There are three types of wearable devices based on their use in the human body: head, limb, and torso wearables. These devices are intended to be used on all areas of the human body. Glasses, helmets, headbands, hearing aids, earbuds, earrings, and patches are examples of head-wearable technology. Wearable on the arms, legs, and feet are the primary types of limb wearables. Smartwatches, wristbands, and other accessories that may be used to track physiological indicators, including body temperature, heart rate, Ultraviolet Radiation (UV) exposure levels, and daily activities, make up the majority of devices worn on the upper limbs. The primary categories of torso wearables include undergarments, belts, and suits (8).

There are three types of wearables based on sensors for monitoring human health: chemical sensors, biosensors for assessing chemical signals, and physical sensors for measuring physiological and physical signals (3).

History

The first wearable was designed with malicious purpose by Edward Thorp and Claude Shannon, who wanted to use it to assist them in cheating at roulette. The two had a 44% advantage in play because the gadget functioned. When Keith Taft created "George," a wearable computer he put in his shoe and used his big toes to control, in 1972, it was with a similar purpose in mind: to aid in counting cards when playing blackjack. When the casinos eventually realized how daring these moves were, computer use at the tables was prohibited (7). With the release of the Hamilton Pulsar in 1972, the world witnessed the introduction of the first digital watch and the beginning of the fusion of fashion and technology (9). August 19–21, 1996, Boeing conducted a minor symposium on wearable computers. Administrators and researchers from independent laboratories, industry, and academia were present. There were also a number of businesses offering complete wearable computers, voice recognition software, and displays. For the event, 204 individuals had registered (10). Industry leaders convened for the first "Wearable in 2005" event, hosted by the Defense Advanced Research Project Agency (DARPA), in July 1996. The purpose of the session was to present research, new hardware, and technologies, as well as to explore the future direction of wearables. Body-mounted cameras and computerized apparel were the major topics of discussion at this session (7, 11). The 2015 release of the Apple Watch completely changed the wristwatch industry by synchronizing with iPhones and offering a wide range of features, including health tracking and mobile payments. It was an instantly attractive item due to its vast variety of features and excellent design (9). 2017 saw a significant change in the healthcare sector with the release of wearable glucose monitors and Apple Watches equipped with electrocardiogram (ECG) capabilities. With the help of these devices, people were able to monitor their health more closely, gaining valuable knowledge and taking early action. The line between style and function blurred in 2021 with the release of stylish smart spectacles like Amazon Echo Frames and Facebook's Ray-Ban Stories. These wearable devices, which included features like voice-assisted AI, calls, and video capabilities, increasingly integrated technology into everyday life (7).

Miniaturization

Innovative products like the G6 continuous glucose monitoring (CGM) system from Dexcom and the Micra pacemaker from Medtronic—which is regarded as the smallest pacemaker in the world—show how miniaturization has a substantial influence on healthcare. These gadgets provide patients individualized, effective answers. Implementing design approaches focused on sensor accuracy and reliability is necessary to provide high-quality data collecting (12).

To maximize sensor performance and increase wearable technology's overall efficacy, amplification, signal conditioning, power supply, multipoint calibration, and other components are essential. The potential for remote patient monitoring is increased by the seamless collection, analysis, and quick response of data made possible by the combination of wearables and smart phones. Bridging the gap between traditional health and smart phone sensors and Internet of Things (IoT) connections. The consumer electronics and healthcare sectors have seen significant transformations as a result of the wearable technology paradigm of mobility and shrinking (12).

Wearable devices in health care

Wearable technology may promote health in a number of ways, such as by offering a more precise and dependable way to track one's health and activities and by acting as a tangible support for changing one's habits. Effective health improvement interventions include assisting individuals in

managing their behaviors and exercise levels as well as understanding their underlying health (13).

Wearable technology adoption has enormous potential to move healthcare toward a proactive, individualized approach, which will eventually improve patient outcomes and reduce costs. Personalized health tracking, remote patient management, and early diagnosis of cardiovascular issues have been made possible by the development of remote monitoring technologies, the integration of AI, and the shrinking of sensors. Monitoring and digital medicine, provide patients and healthcare providers with affordable options for remote monitoring, tailored health insights, and improved illness treatment (14).

The industry for powered sensor devices that track physiological indicators like temperature, blood pressure, and pulse rate that can be placed next to, affixed to, or implanted within the body is still expanding. These smart devices monitor lifestyle, fitness, health, behavior, and surroundings. Blood sugars, ECGs, vital signs, sleep, emotions, stress, respiration, activity, exertion, posture, gait, body shape, lesions, and cognitive function are some of the biological markers that are tracked (8).

Artificial intelligence algorithms increase the precision and efficacy of identifying diseases like hypertension, directing treatment plans to enhance patient outcomes. These gadgets make it easier to continuously monitor vital indicators like blood pressure, heart rate, and activity level. This gives medical practitioners crucial information that they may use to customize treatments and make treatment decisions. In situ sweat analysis is crucial for the non-intrusive tracking of physiologic well-being status (such as physical stress or dehydration) as well as the diagnosis and management of illness. Wearable sweat collection devices and monitoring devices for sweat cortisol, alcohol, and ammonia monitoring are among the innovative microfluidic techniques for sweat collection and biomarker identification that have been discovered in several investigations (13). Originally developed in 2007 for CGM, wearable tear biosensors have been utilized for lactate detection since 2012. Additionally, the quantity of glucose in tears was measured utilizing optical sensors by means of a photonic microstructure on the hydrogel sensor networks and contact lens surfaces.

Wearable saliva biosensors come in a variety of designs, including wireless mouthguard biosensors. Wearable saliva biosensors are beneficial for precise measurements because of their large analyte volume, constant flow, efficient collection speed, and relatively clean samples; nevertheless, they are not very practical or pleasant to use in everyday scenarios (13).

Conclusion

The market for smart wearables has grown rapidly in recent years due to a number of factors, including the growing acceptance of personalized health ideas, the development of mobile medicine, and the introduction of innovative technologies like smart sensing. Among them, wearable medical technology has emerged as one of the most intriguing fields. These wearables not only assist users in living healthier lives by continually monitoring physiological signals and measuring metabolic condition, but they also give a continuous flow of health care data for illness diagnosis and treatment. Wearable medical technology therefore has the potential to play a significant role in the future of the mobile medical industry. It is expected that wearable technology will become more ubiquitous in the healthcare industry and more easily incorporated into people's daily lives as science and technology advance and customized health concepts gain acceptance. Applications of wearable technology in the medical area need to be further investigated.

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Conflict of interest

I hereby declare that the work was conducted in the absence of any commercial or financial interest that could be construed as a potential conflict of interest.

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