



ORIGINAL RESEARCH PAPER

Medicine

MEDICAL APPLICATIONS FOR SMARTWATCHES TECHNOLOGIES

KEY WORDS: Health Care, Smartwatch Technologies, Samsung, Apple, Electronics, Wearables

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ABSTRACT

The background devices (WDs) can be useful in the early detection and management of medical conditions. Advanced wearable devices aid physicians and surgeons in knowing the physiological parameters of patients and assisting their patients in real-time, based on transmitted data. Studies have shown that elderly populations are more prone to benefits from using WDs. These WDs can measure the vital signs of patients and health conditions such as body and skin temperature, arterial blood pressure, heart rate, respiration rate, electrocardiogram (ECG), etc., as well as monitor physical movement. All these WDs are available with various technological capabilities, benefits, and costs. The patients should have the skills to use this technology. Patients with chronic conditions should be offered restorative treatment when they fall ill. Any delays in receiving full treatment could worsen the patient's health condition, so the WDs can reduce the health deterioration rate as they collect accurate and real-time data.

INTRODUCTION

Search: By teleconsultation we mean the sharing of medical images and other data of the patient between the doctor who examines him and one or more specialists, who are located in other areas. The following figure shows such an example. In this case, the first diagnosis is made by the local doctor, while the specialists help him to come up with a more accurate diagnosis. Many times in order to make the final diagnosis of a patient's condition, it is necessary to work with doctors of different specialties located in different locations. It goes without saying that in severe cases the diagnosis must be made quickly and accurately. Collaborative diagnosis, as an application of Telemedicine, provides the solution in this case. Collaborating physicians use telemedicine technology to exchange information, such as patient images and laboratory data, and present their views. Next, they come to a common decision, not only about the disease but also about the treatment plan they should follow. Two or more doctors of different specialties may be involved in this procedure. The means of communication do not preclude the traditional simple telephone consultation or its use e-mail, but extend to video conferencing, where multimedia capabilities (audio, video, and video) coexist. Home care is a field of telemedicine, where the user of a service is the patient at home and the provider is a machine located in the patient's home but controlled by a human being remotely. These kinds of services are telephony. Some examples of telephony are as follows: Security systems (Remote or simple alarm systems, fire safety and other warning devices). Support of daily activities with degradation systems and remote control | advice systems^[1-21].

elderly with a relative or neighbor nearby, so that in case of alarm at the same time with the center to be notified immediately and someone who is close to the patient.

Study Inclusion and Exclusion Criteria

The first telecardiology applications appeared 70 years ago, using the telephone network for the "tele-listening" of heart sounds and respiratory auditory findings using sensitive microphones connected to the telephone network. Telecardiology began to develop further in the 1970s when FAX was used to transmit cardiographic and encephalo-graphic prints over a telephone network. Today, tele-cardiology is mainly used to transmit cardiograms taken by portable and non-portable cardiographs with 12 nozzles (suction cups) from which the signal is received. Stations can then record this signal and send it over a wired or wireless network. The field of telecardiology is also aimed at sending echocardiograms, heartbeats, audio messages and images^[1-21].

Study Quality Assessment

Wearable technology, also known as "wearable's," is a category of electronic devices that can be worn as accessories, embedded in clothing, implanted in the user's body, or even tattooed on the skin. The devices are hands-free gadgets with practical uses, powered by microprocessors and enhanced with the ability to send and receive data via the Internet. The Internet of Things (IoT) is a name for the aggregate collection of network-enabled devices, excluding traditional computers like laptops and servers. Types of network connections can include Wi-Fi connections, Bluetooth connections, and near-field communication (NFC). The IoT includes devices such as "smart" appliances, like refrigerators and thermostats; home security systems; computer peripherals, like webcams and printers; wearable technology, such as Apple Watches and Fitbits, routers, and smart speaker devices, like Amazon Echo and Google Home. Wearable technology can be said to have existed since eyeglasses were first developed in the 13th century. Timepieces small enough to be worn have been around since about 1500. But modern wearable technology is defined as incorporating a microprocessor and an internet connection.

Data Extraction Strategy

The growth of mobile networks enabled the development of wearable technology. Fitness activity trackers were the first big wave of wearable technology to catch on with consumers. Then, the wristwatch became a screen and more robust mobile applications were added.

- Remote management and control of appliances in the home by health professionals (remote control of ventilation systems). This telemedicine application can be better understood in the case of an alarm and surveillance system of an elderly person. The alarm system is triggered either by the elderly or automatically. Automatic stimulation occurs when the patient loses consciousness or is unable to press the alarm button or when he can not easily move to the device. This system consists of:
 - An alarm trigger device.
 - The central monitoring station that controls the patient's monitoring device.
 - A means of communication that can be even a simple telephone line.
 - Possibly a wider network that can connect the home of the

Data Synthesis and Presentation

Bluetooth headsets, smartwatches, and web-enabled glasses all allow people to receive data from Wi-Fi networks. The gaming industry adds more wearables, with virtual reality and augmented reality headsets^[3].

MATERIALS AND METHODS

Healthcare providers can deliver the best care when they have powerful, intuitive tools. Our technology helps them work effectively within hospitals, connect remotely with patients, and conduct groundbreaking medical research. The result is care that becomes more efficient, more personalized, and ultimately more human^[24]. Samsung believes in putting the very best mobile experiences into the hands of as many people as possible, which includes our commitment to providing continuous software support for previous Galaxy Watch models^[23]. Apple products transform the way doctors and nurses work with their patients. Apps on iPhone and iPad allow hospitals to work more efficiently. Clinicians to access health records and data right when they need them. Nurses to ensure better patient safety while administering medication. And patients to stay informed and engaged in their own care by communicating with their medical teams during hospital stays^[24]. At home, iOS and iPadOS apps enable patients to stay connected to their care teams between office visits. Healthcare organizations can use off-the-shelf apps or use CareKit to create apps that empower patients to manage their health. iPhone, Apple Watch, the Health app, and HealthKit-enabled apps and medical devices make it easy for patients to record their health data and share it with their care teams^[24]. Medical researchers can take their studies into the real world by building apps with ResearchKit. The open source framework streamlines the process, making it easier for researchers to enroll participants, capture informed consent, and gather medical information more frequently, rather than only during periodic visits^[24]. The Health app makes it easier than ever for users to be engaged in their health with ways to visualize, securely store, and share their health data. You can now view certain data that patients have chosen to share, from within your EHR (Electronic Hart Rate) workflow^[24].

Group Challenge enables you to work out with friends no matter how far apart you are – helping you stay motivated and connected by working out together. With the new update, you can now add your friends or family members to a Challenge, battling it out to see who can go the furthest or the fastest, either working as a team or competing against each other individually. Keep track of your own place in the competition or see how you're performing as a team – all from your wrist^[23].

Optical sensors on wearable devices can detect irregular pulses. The ability of a smartwatch application (app) to identify atrial fibrillation during typical use is unknown. Fall Detection is designed to identify hard falls when the wearer is moving, such as when they are doing physical activities, like running. Coming to Galaxy Watch Active 2 and Galaxy Watch 3, the new update gives you the option to select a higher sensitivity for Fall Detection – you can even choose to detect a fall when you are standing still^[23]. Once a fall is detected, your watch will send an SOS notification to pre-selected contacts, helping ensure that the wearer can receive the assistance they need as soon as possible. When a hard fall is detected with Apple Watch Series 4 or later, an alert appears and allows the user to easily call emergency services or dismiss the alert. If the user is unresponsive for about a minute, an emergency call will be placed automatically and a message will be sent to the user's emergency contacts. All falls detected are recorded in the Health app. This feature is automatically enabled for users 55 years and older and can be turned on for anyone in the Apple Watch app on iPhone^[25].

The Galaxy Watch series has introduced a vast suite of advanced health features – from heart rate tracking and blood oxygen measurement to sleep and stress management. Plus,

with ground-breaking Blood Pressure (BP) and Electrocardiogram (ECG) monitoring in select markets, Galaxy Watch users can benefit from accurate health monitoring and gain deeper insights into their overall health through the Samsung Health Monitor app. These features are intended for general wellness and fitness purposes only. Not intended for use in detection, diagnosis, or treatment of any medical condition or disease. Availability of these features may vary by market or device. The Blood Pressure feature is only available in select markets. To ensure accuracy, users should calibrate their device every four weeks with a traditional blood pressure cuff. The BP app cannot diagnose hypertension, other conditions, or check for signs of a heart attack. This app can only be used for measuring in ages 22 and over. It is not meant to replace traditional methods of diagnosis or treatment by a qualified healthcare professional^[23]. The irregular rhythm notification occasionally checks for signs of irregular rhythms that may be suggestive of atrial fibrillation (AFib). This feature won't detect all instances of AFib but may catch something that can provide your patients with an early indication that further evaluation may be warranted. Irregular rhythm notifications use the optical heart sensor to detect the pulse wave at the wrist and look for variability in beat-to-beat intervals when the user is at rest. If the algorithm repeatedly detects an irregular rhythm suggestive of AFib, your patient will receive a notification and the date, time, and beat-to-beat heart rate will be recorded in the Health app. The irregular notification feature has been granted De Novo classification by the FDA for users 22 years and older in the U.S. with no prior history of AFib^[22].

The ECG feature is only available in select markets. The ECG app is not intended to replace traditional methods of diagnosis or treatment. The ECG app is not intended for users with known arrhythmias other than atrial fibrillation or users under 22 years old. Users should not interpret or take clinical action based on the device output without consultation of a qualified healthcare professional^[23]. Participants without atrial fibrillation (as reported by the participants themselves) used a smartphone (Apple iPhone) app to consent to monitoring. If a smartwatch-based irregular pulse notification algorithm identified possible atrial fibrillation, a telemedicine visit was initiated and an electrocardiography (ECG) patch was mailed to the participant, to be worn for up to 7 days. Surveys were administered 90 days after notification of the irregular pulse and at the end of the study. The main objectives were to estimate the proportion of notified participants with atrial fibrillation shown on an ECG patch and the positive predictive value of irregular pulse intervals with a targeted confidence interval width of 0.10^[25]. We recruited 419,297 participants over 8 months. Over a median of 117 days of monitoring, 2161 participants (0.52%) received notifications of irregular pulse. Among the 450 participants who returned ECG patches containing data that could be analyzed – which had been applied, on average, 13 days after notification – atrial fibrillation was present in 34% (97.5% confidence interval [CI], 29 to 39) overall and in 35% (97.5% CI, 27 to 43) of participants 65 years of age or older. Among participants who were notified of an irregular pulse, the positive predictive value was 0.84 (95% CI, 0.76 to 0.92) for observing atrial fibrillation on the ECG simultaneously with a subsequent irregular pulse notification and 0.71 (97.5% CI, 0.69 to 0.74) for observing atrial fibrillation on the ECG simultaneously with a subsequent irregular tachogram. Of 1376 notified participants who returned a 90-day survey, 57% contacted health care providers outside the study. There were no reports of serious app-related adverse events^[25]. The Apple Heart Study app is an application that analyzes heart rate (HR) and beat-to-beat data captured by the Apple Watch photoplethysmogram (PPG) sensor.

The Apple Heart Study app uses this data to identify irregular heart rhythms consistent with atrial fibrillation and other arrhythmias. Analysis is initiated when the Apple

Heart Study app successfully retrieves approximately one minute of beat-to-beat intervals, defined as a tachogram, derived from the Apple Watch PPG HR sensor through HealthKit, a data repository on a user's iPhone. In practice, tachograms are collected and stored at selected times throughout the day when a user appears to be still enough for a successful reading to be taken. If, and when, the Apple Heart Study app retrieves a tachogram and subsequently classifies it as "irregular", it shifts into a "confirmation mode" and begins requesting, and analyzing, tachograms on a more frequent basis until it is able to confirm sustained irregularities or the confirmation cycle is otherwise ended. Upon completion of a positive confirmation cycle within a 48-hour period, the Apple Heart Study app provides a notification to the user on their Apple Watch and subsequently on their iPhone app. While the app is able to identify irregular heart rhythms consistent with atrial fibrillation and other arrhythmias, the app is not intended to diagnose atrial fibrillation, and any irregular readings or subsequent notifications displayed by the app should be confirmed by ECG and/or by a clinician. The app is not intended to be used on an on-demand basis and should not be used to guide medical therapy decisions. The Apple Heart Study app is not intended as an implant but rather is stand-alone software that runs on general purpose platforms (the Apple iPhone and Apple Watch). The Apple Heart Study app is also not claimed or otherwise represented to be for a use in supporting or sustaining human life. The Apple Heart Study app is further not intended for use in diagnosing, curing, mitigating or treating disease, as the app is not an atrial fibrillation diagnostic device and should not be used to guide medical therapy decisions. About monitoring during the monitoring period, upon the detection of a series of irregular tachograms, and based on the IPNA, the Apple Heart Study app will notify the participant that an irregular rhythm was identified. When notified of a pulse irregularity, participants will be asked to contact the telemedicine technology services company, American Well Corporation (together with Online Care Group, the "Study Telehealth Provider") administered within the app that will manage the participant's study follow-up throughout study participation^[26]. Following the first notification, the participant will be reminded daily to contact the Study Telehealth Provider via the app^[26]. Wearable devices with optical sensors, such as smartwatches, are commonly used to measure wearers' pulse rates. Algorithms that use pulse wave data to detect atrial fibrillation and atrial flutter have been developed. An Apple Watch application (app) can use intermittent, passively detected pulse rate data in an algorithm that identifies episodes suggestive of atrial fibrillation. Apple Watch checks for unusually high or low heart rates in the background, which could be signs of a serious underlying condition. This could help you and your patients identify situations which may warrant further evaluation. If a patient's heart rate is above 120 bpm or below 40 bpm while they appear to have been inactive for 10 minutes, the user will receive a notification. Patients can adjust the threshold bpm or turn these notifications on or off. All heart rate notifications — along with date, time, and heart rate — can be viewed in the Health app on iPhone^[26].

The Galaxy Watch series has introduced a vast suite of advanced health features – from heart rate tracking and blood oxygen measurement to sleep and stress management. Plus, with ground-breaking Blood Pressure (BP) and Electrocardiogram (ECG) monitoring in select markets, Galaxy Watch users can benefit from accurate health monitoring and gain deeper insights into their overall health through the Samsung Health Monitor app^[23].

Your oxygen level expresses the percentage of oxygen that red blood cells carry from the lungs to the rest of your body. Knowing how well your blood performs this vital function can help you better understand your overall well-being. Most

people have a 95-100% oxygenation level. However, some people live a normal life with oxygen levels below 95%. Slightly lower values during sleep are expected and some users may experience values below 95%. Even under ideal conditions, the Apple Watch may not be able to receive reliable oxygen measurements every time. For a small percentage of users, various factors may make it impossible to perform any oxygenation measurements. Sweating of the skin (ie how much blood flows into your skin) can affect the measurements. Skin perspiration varies greatly from person to person and can also be affected by the environment. If you are outside in the cold, for example, the perspiration of the skin on your wrist may be too low for the sensor to work with the Oxygenation app to perform the measurement. Permanent or temporary changes to your skin, such as some tattoos, can also affect performance. The ink, pattern, and saturation of some tattoos can block light on the sensor, making it difficult to measure by the Oxygenation app. Motion is another factor that can affect the ability to take successful measurements in the background or on demand. Some postures, such as with the hands hanging on the sides or the fingers in the fist position, will also result in unsuccessful measurements. If your heart rate is too high (above 150 rpm) at rest, you will not be able to get a successful oxygenation test. In the Apple Watch Series 6 and Series 7, the optical heart rate sensor has been redesigned to add possibilities for measuring blood oxygen. During an oxygenation measurement, the rear crystal emits red and green LEDs and infrared light on your wrist. The LEDs then measure the amount of light reflected^[26].

Complex algorithms use this data to calculate the color of your blood. Color determines the level of oxygenation: bright red blood has more oxygen, while dark red blood has less oxygen^[26].

Finally about battery performance the Galaxy Watch has 270 mAhs-472 mAhs duration charge WPC based wireless charging^[27] additionally the iWatch 7 charge about 45 minutes to 80% & for 75 mins to 100% using the included Apple Watch Magnetic Fast Charging USB-C Cable^[28]. For water resistance durability Galaxy Watch gives 5 ATM + IP68 / MIL-STD-810G ISO standard 22810:2010^[29] on the other hand the iWatch 7 gives us rating of 50 meters under ISO standard 22810:2010^[27]. This means that they may be used for shallow-water activities like swimming in a pool or ocean. However, they should not be used for scuba diving, waterskiing, or other activities involving high-velocity water or submersion below shallow depth. Series 7 is also rated IP6x dust resistant And about environmental Apple take responsibility for the environmental footprint of our products throughout their life cycle. We're committed to one day sourcing 100% recycled and renewable materials across all of our products and packaging. Apple Watch is designed with a list of features to reduce environmental impact^[30].

RESULTS AND DISCUSSION

Review Statistics: These devices use Internet protocol (IP), the same protocol that identifies computers over the world wide web and allows them to communicate with one another. The goal behind the Internet of things is to have devices that self report in real-time, improving efficiency and bringing important information to the surface more quickly than a system depending on human intervention. The Internet of Things promises to transform a wide range of fields. In medicine, for example, connected devices can help medical professionals monitor patients inside and outside of a hospital setting. Computers can then evaluate the data to help practitioners adjust treatments and improve patient outcomes^[3].

- The Internet of Things (IoT) is a name for the aggregate collection of network-enabled devices, excluding traditional computers like laptops and servers.
- Types of network connections can include Wi-Fi

connections, Bluetooth connections, and near-field communication (NFC).

- IoT includes devices such as "smart" appliances, home security systems, computer peripherals, wearable technology, routers, and smart speaker devices.
- The Internet of Things is transforming a wide range of fields, from medicine to urban planning to consumer data collection.

Another field that's also experiencing a transformation is urban planning. When sensors that have an IP address are placed under a busy street, for instance, city officials can alert drivers about upcoming delays or accidents. Meanwhile, intelligent trash cans are able to notify the city when they become full, thus optimizing waste collection routes^[5].

Study Quality Assessment

As first reported, wearable devices (WDs) started off as purely mechanical systems. However, with the creation of electrical and electronic components, WDs are now mostly known as purely electronic devices. Current WDs are composed of a set of sensors for acquiring and measuring body information and signals for health monitoring and diagnosis [Motti, 2020]^[4,20]. There are also many WDs that are composed of both actuators and sensors for augmenting human capacities, rehabilitation, providing assistance, and replacing body limbs lost due to amputation or congenital diseases. These are referred as mechatronic and robotic WDs [Pons, 2008; Resnik et al., 2012]^[5,20]. Examples include robotic exoskeletons that a user wears. As first reported, wearable devices (WDs) started off as purely mechanical systems. However, with the creation of electrical and electronic components, WDs are now mostly known as purely electronic devices. Current WDs are composed of a set of sensors for acquiring and measuring body information and signals for health monitoring and diagnosis [Motti, 2020]^[4]. There are also many WDs that are composed of both actuators and sensors for augmenting human capacities, rehabilitation, providing assistance, and replacing body limbs lost due to amputation or congenital diseases. These are referred as mechatronic and robotic WDs [Pons, 2008; Resnik et al., 2012]^[5,20]. Examples include robotic exoskeletons that a user wears for augmenting strength to lift heavy objects or enhance gait or running (also known as extenders) [Maciejasz et al., 2014; Jarrasse et al., 2014; Shen and Rosen, 2020]^[6,20].

Quantitative synthesis/Meta-analysis

Despite these efforts, WDs are not yet widely used, as there are still many challenges to overcome [Armstrong et al., 2019; Kristjansdottir et al., 2019]^[7,20]. WD users would like a cost-friendly device that is similar in shape and function to their lost limb; low-cost WDs are still very limited [Biddiss and Chau, 2007]^[8,20]. Another big challenge is that amputees do not feel as though the WD is a part of their body due to the lack of bilateral communication and sensory feedback between the device and the amputee [Kuiken, 2006; Marasco et al., 2018]^[9,20].

Every WD is in physical contact with the human skin, and communicates different sensations to the human user through sensory feedback. This human sensory feedback generally includes hearing, sight, taste, smell, and sense of touch. Sense of touch is described by the term "haptics," which is the science that studies the sense of touch on human skin.

Before the development of externally powered prostheses, devices were commanded solely by buttons or switches in an open-loop control manner. However, it was not until the myoelectric prosthesis appeared that this approach changed. Myoelectric prostheses belong to the electrical-powered active prostheses spectrum with capability of reading the electromyographic (EMG) activity from the voluntary movements of muscles [Popov, 1965]^[10,20].

Tactile feedback such as pressure, stretch, vibration, and combined stimuli is recorded by the human body through sensory organs called mechanoreceptors, which are located in our whole skin, being in greater density on the fingers and palm of our hands [Johnson, 2001]^[11,20]. These mechanoreceptors are the Meissner's corpuscles, Merkel's disks, Ruffini endings and Pacinian corpuscles (PCs), which are connected to the peripheral nervous system by peripheral nerve bundles along with the human dermis. Mechanoreceptors have temporal and spatial resolution ranges. Hence they are categorized by types and adaptation due to a stimulus. Mechanoreceptors type I have small receptive fields, while those of type II have large receptive fields. In addition, mechanoreceptors can be PC rapid adaptors (RAs), whose response ranges cannot register static stimuli signals, or they can be slow adaptors (SAs), which can register transient stimuli. The two types of SAs are type I and type II.

Evidence of Effectiveness

Kinesthetic feedback is characterized by the sense of movement and strength in our limbs. The receiving organs that allow this sensation are the muscular spindles and Golgi tendon organs [Proske and Gandevia, 2012]^[12,20]. When these are stimulated, the individual can perceive an illusion of movement [Culbertson et al., 2018]^[13,20].

In the last few decades, technology has evolved such that WD systems now include on-body sensors for detecting physiological signals without discomfort, and are able to capture and continuously record data in real time [Bonfiglio and De Rossi, 2011]^[14,20]. In this sense, WDs have the potential to help in both diagnosis and ongoing treatment of a vast number of individuals with neurological, cardiovascular, and pulmonary diseases [Patel et al., 2012]^[15,20]. Since the development of transistors, WDs have become much smaller, and with the advent of the Internet of Things (IoT) WDs are becoming smart, portable, multi-functional, and able to connect to the Internet and run on batteries [Hung et al., 2004]^[16,20]. These devices have been used for many applications, including communication, sports, optics, Virtual Reality (VR), and Artificial Intelligence (AI). In the field of mechatronics, WDs are proposed as wearable mechatronic devices or wearable robots to be worn by humans either to augment the function of a limb or to replace it completely [Pons, 2008]^[17,20]. WDs are used externally to the body, either attached as an accessory or embedded in clothes [Raskovic et al., 2004; Yang and Sahabi, 2016; Motti, 2020]^[18,20]. To physically assist weakened and/or disabled individuals with impaired upper limb function, extensive research has been carried out in many branches of robotics, particularly wearable robots (e.g., exoskeletons, powered orthotic devices, etc.) and end-effector-based robotic devices (i.e., devices that do not actively support or hold the subject's arm, but rather connect with the subject's hand or forearm) [Rahman et al., 2014]^[19,20].

The use of smart devices will also likely mean a competitive advantage for businesses that use them strategically. For instance, by tracking data about energy use and inventory levels, a firm can significantly reduce its overall costs. Connectivity may also help companies market to consumers more effectively. By tracking a consumer's behavior inside a store, a retailer could theoretically make tailored product recommendations that increase the overall size of the sale. Once a product is in a consumer's home, that product can be used to alert the owner of upcoming service schedules and even prompt the owner to book the appointment. As with all questions of personal data, there are many privacy concerns that have yet to be addressed when it comes to the Internet of Things. The technology has advanced much faster than the regulatory environment, so there are potential regulatory risks facing companies that are continuing to expand the range of Internet-connected devices^[21].

Apple Watch has powerful apps that make it the ultimate

device for a healthy life. Now with new notifications and the ECG app, it can provide you and your patients with important information concerning their heart health^[22].

Upgraded Health and Personalization Features Come to Galaxy Watch, Galaxy Watch Active, Galaxy Watch Active 2 and Galaxy Watch 3^[23].

CONCLUSIONS

Wearable devices and smartphones allow for truly ubiquitous and continuous tracking of physical behaviors. Here we introduced established and emerging modeling methods for mobile sensing data and discussed the impact that the application of Artificial Intelligent (AI) will have in the field. These methods will facilitate the collection of large-scale data with unprecedented granularity which, in turn, will have important implications for industrial and academic purposes. Given the nature of the data collected, it is paramount that these practices meet appropriate privacy controls and that they are regulated accordingly. As the technology continues to develop, this will require adequate management of the availability of data for researchers to conduct studies in the public interest, while protecting personal privacy and preventing the misuse of sensitive data.

For the future we must stay centered and move ahead. Taking a moment throughout the day to pause and breathe can reduce stress. The new Reflect feature in the Mindfulness app helps you set an intention and center yourself with a beautiful animation. And new audio and video guided meditations in Apple Fitness+ focus on improving your overall wellbeing with specific themes such as calm, gratitude, or kindness.

Also Light-emitting diodes (LEDs) are semiconductor devices that produce incoherent, narrow-spectrum light when forward voltage is applied. LEDs range in wavelength from the UVC band to infrared (IR) and are available in packages ranging from milliwatts to more than 10W. The first LED was an IR-emitting device and was patented in 1961. In 1962, the first practical visible spectrum LED was developed. The first high-power (1-W) LEDs were developed in the late 1990s.

LEDs create light through a semiconductor process rather than with a superheated element, ionized gas, or an arc discharge as in traditional light sources. The wavelength of the light emitted is determined by the materials used to form the semiconductor junction. LEDs produce more light per electrical watt than incandescent lamps with the latest devices rivaling fluorescent tubes in energy efficiency. They are solid-state devices, which are much more robust than any glass-envelope lamp and contain no hazardous materials like fluorescent lamps. LEDs also have a much longer lifetime than incandescent, fluorescent, and high-density discharge lamps (U.S. Dept. of Energy). Although LEDs possess many advantages over traditional light sources, a total system approach must be considered when designing an LED-based lighting system. LEDs do not radiate heat directly, but do produce heat that must be removed to ensure maximum performance and lifetime. LEDs require a constant-current DC power source rather than a standard AC line voltage. Finally, because LEDs are directional light sources, external optics may be necessary to produce the desired light distribution. A properly designed LED light system is capable of providing performance and a lifetime well beyond any traditional lighting source.

Our technology helps them work effectively within hospitals, connect remotely with patients, and conduct groundbreaking medical research. The result is care that becomes more efficient, more personalized, and ultimately more human^[31]. But of course the limitations are few such as the battery life and the different applications that exist for the same parameters.

Declarations

All authors have seen and agree with the contents of the manuscript and there is no financial interest to repost. We certify that the submission is original work and is not under review at any other publication.

We would like to thank Samsung Electronics, Samsung Corporation, and Apple for all these products. No conflicting interests between the companies hinder this specific comparative scientific article.

I believe that finding could be of interest to the readers of Health & Research Journal because they bring new and strong evidence for the innovation and the technology especially for vital human functions. The author have seen and agree with the contents of the manuscript and there is no financial interest to repost.

No funding during our scientific job for this scientific article (self-financing). We have all the appropriate guarantees from the Apple and Samsung companies because we buy cash for their products in the list below as you can show:

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- Samsung Galaxy Watch 47 mm
- Two (2) Samsung Galaxy fit e R375

This repost take place from both authors during last year. Contact details: vlachosi@upatras.gr and panayiot@upatras.gr

Acknowledgment

First of all, we are very glad that we have finished our scientific assignment with the title Medical Applications for Smartwatches Technologies. We are thankful to the universities of Patras Rion and the University of West Attica Athens. The Department of Medicine is from Patra Rion, and the Department of Biomedical Engineers is from Attica Athens.

Finally, we are thankful for all the above products (in the 5th paragraph) and the manufacturers like Apple and Samsung for their products.

REFERENCES

1. Study tools Telematics services simulations (- ealth). Professor Chaikalis Konstantinos. Higher Technological Educational Institution of Thessaly 2002.
2. Principles of Telemedicine and its Applications in Modern Medical Science. Papakosta Aleksandrou. Higher Technological Educational Institution of Crete Higher Technological Educational Institution of Crete. Chania 2010.
3. Wearable Technology <https://www.investopedia.com/terms/w/wearable-technology.asp> (last access 2024)
4. Michelangelo Hand, 2019. Available from: <https://accessprosthesis.com/wp-content/uploads/2017/06/michelangelo-technology.pdf> (last access 2024)
5. Schulz, S., Fylatiuk, C., Bretthauer, G., 2001. A new ultralight anthropomorphic hand. In: 2001 IEEE Conference on Robotics and Automation (ICRA). IEEE, pp. 2437-2441.
6. Markovic, M., Schweisfurth, M.A., Engels, L.F., Bentz, T., Wüstefeld, D., Farina, D., Dosen, S., 2018. The clinical relevance of advanced artificial feedback in the control of a multi-functional myoelectric prosthesis. J. Neuroeng. Rehabil. 15 (1), 28.
7. Armstrong, T.W., Williamson, M.L., Elliott, T.R., Jackson, W.T., Kearns, N.T., Ryan, T., 2019. Psychological distress among persons with upper extremity limb loss. Br. J. Health Psychol. 24, 746-763.
8. Bottomley, A., Kinnier Wilson, A.B., Nightingale, A., 1963. Muscle substitutes and myoelectric control. Radio Electron. Eng. 26 (6), 439-448
9. Massa, B., Roccella, S., Carrozza, M.C., Dario, P., 2002. Design and development of an underactuated prosthetic hand. In: 2002 IEEE International Conference on Robotics and Automation (ICRA). IEEE, vol. 4. pp. 3374-3379
10. Scott, R.N., 1992. Myoelectric control of prostheses, a brief history. In: 1992 Myoelectric Controls/Powered Prosthetics Symposium, Fredericton, Canada.
11. Johnson, K.O., 2001. The roles and functions of cutaneous mechanoreceptors. Curr. Opin. Neurobiol. 11 (4), 455-461.
12. Proske, U., Gandevia, S.C., 2012. The proprioceptive senses: their roles in signaling body shape, body position and movement, and muscle force.

- Physiol. Rev. 92 (4), 1651–1697. Proske, U., Gandevia, S.C., 2012. The proprioceptive senses: their roles in signaling body shape, body position and movement, and muscle force. *Physiol. Rev.* 92 (4), 1651–1697.
13. Culbertson, H., Schorr, S.B., Okamura, A.M., 2018. Haptics: the present and future of artificial touch sensation. *Annu. Rev. Control Robot. Auton. Syst.* 1, 385–409.
 14. Bonfiglio, A., De Rossi, D. (Eds.), 2011. *Wearable Monitoring Systems*. Springer, New York, pp. 3–4. Bonfiglio, A., De Rossi, D. (Eds.), 2011. *Wearable Monitoring Systems*. Springer, New York, pp. 3–4.
 15. Patel, S., Park, H., Bonato, P., Chan, L., Rodgers, M., 2012. A review of wearable sensors and systems with application in rehabilitation. *J. Neuroeng. Rehabil.* 9, 21.
 16. Hung, K., Zhang, Y.T., Tai, B., 2004. Wearable medical devices for tele-home healthcare. In: *Proceedings of the 26th Annual International Conference of the IEEE EMBS*, vol. 7, pp. 5384–5387.
 17. Pons, J.L., 2008. *Wearable Robots: Biomechatronic Exoskeletons*. John Wiley & Sons.
 18. Raskovic, D., Martin, T., Jovanov, E., 2004. Medical monitoring applications for wearable computing. *Comput. J.* 47(4).
 19. Rahman, M.H., Ochoa-Luna, C., Rahman, J., Saad, M., Archambault, P., 2014. Forceposition control of a robotic exoskeleton to provide upper extremity movement assistance. *Int. J. Model. Identif. Control.* 21 (4), 390–400.
 20. Wearable mechatronic devices for upper-limb amputees. Juan J. Huaroto^{a,b}, Etsel Suárez^{a,b}, Emir A. Vela^c (From Peru)
 21. The Internet of Things (IoT) <https://www.investopedia.com/terms/i/internet-things.asp> (last access 2024)
 22. <https://www.apple.com/healthcare/apple-watch/> (last access 2024)
 23. <https://news.samsung.com/in/upgraded-health-and-personalization-features-come-to-galaxy-watch-galaxy-watch-active-galaxy-watch-active2-and-galaxy-watch3> (last access 2024)
 24. <https://www.apple.com/healthcare/> (last access 2024)
 25. Large-Scale Assessment of a Smartwatch to Identify Atrial Fibrillation <https://www.nejm.org/doi/full/10.1056/NEJMoa1901183> (last access 2024)
 26. <https://support.apple.com/en-us/HT211027> (last access 2024)
 27. <https://www.samsung.com/global/galaxy/galaxy-watch/specs/> (last access 2024)
 28. <https://www.apple.com/apple-watch-series-7/> (last access 2024)
 29. <https://www.apple.com/environment/> (last access 2024)
 30. A Survey of Smartwatches in Remote Health Monitoring. Survey Paper Published: 18 December 2017. Volume 2, pages 1–24, (2018)