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Development of Wearable Device and their Application in Medical IoT

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Abstract - Health is one of the most important aspects of life. Still, people still could not get proper health services. It's caused by limitation to the used technology in hospitals and limitations to get to the hospital. Internet-of-Things (IoT) as one of the utmost trending motifs presently, formerly giving so many results in many ways, for example, in healthcare. Wearable devices are currently at the heart of just about every discussion related to the Internet of Things. The requirement for self-health monitoring and preventive medicine is increasing due to the projected dramatic increase in the number of elderly people until 2020.Developed technologies are truly able to reduce the overall costs for prevention and monitoring. This is possible by constantly monitoring health indicators in various areas and in particular, wearable devices are considered to carry this task out. These wearable devices and mobile apps now have been integrated with telemedicine and telehealth efficiently, to structure the medical Internet of Things. This paper reviews wearable health care devices both in scientific papers and commercial efforts.

Key Words: Delivering of health care, Information Storage and Retrieval, Internet, Mobile Application, Smartphones, Telemedicine

1.INTRODUCTION

The Internet of Things (IoT) is a new conception, furnishing the possibility of healthcare monitoring using wearable devices. The IoT is defined as the network of physical objects which are supported by bedded technology for data communication and detectors to interact with both internal and external objects countries and the terrain. In the last decade, wearable bias has attracted important attention from the academic community and assiduity and has lately come veritably popular. The most applicable description of wearable electronics is the following devices that can be worn or slept with mortal skin to cover an existent's conditioning continuously and nearly, without interposing or limiting the stoner's movements". Moment, the range of wearable systems, including micro-sensors seamlessly integrated into fabrics, consumer electronics bedded in fashionable clothes, motorized watches, belt- worn computers (PCs) with a head mounted display, spectacles, which are worn on colorful corridor of the body are designed for broadband operation. The field of wearable health monitoring systems is moving toward minimizing the size of wearable bias, measuring further vital signs, and transferring secure and dependable data through smartphone technology. Although there has been an interest in observing comprehensive memoir/non-bio medical data for the full monitoring of environmental, fitness, and medical data lately, but one egregious operation of wearable systems is the monitoring of physiological parameters in the mobile terrain. The maturity of commercially available wearable bias is one- lead operations to cover vital signs. Still, utmost of similar recreational bias is not suitable for the medical monitoring of high threat cases. Those devices that have been qualified for medical use are generally simple. The ideal of this paper is to review wearable health care bias both in scientific papers and marketable sweats. Our end is to address the most important wearable bias, which measure effective parameters in health status directly. Compendiums can gain comprehensive and useful information on the most dependable presently available devices and specialized generalities in this area. Conclusion is eventually epitomized with suggestions for unborn workshop.

Figure 1 different types of wearable technology

2. LITERATURE REVIEW:

The Internet of Things (IoT) is a new concept, providing the possibility of healthcare monitoring using wearable devices. The IoT is defined as the network of physical objects which are supported by embedded technology for data communication and sensors to interact with both internal and external objects states and the environment. In the last decade, wearable devices have attracted much attention from the academic community and industry and have recently become very popular. The most relevant definition of wearable electronics is the following: "devices that can be worn or mated with human skin to continuously and closely monitor an individual's activities, without interrupting or limiting the user's motions". To provides more transparent information on the importance of wearable devices and the IoT market.

Today, the range of wearable systems, including micro-sensors seamlessly integrated into textiles, consumer electronics embedded in fashionable clothes, computerized watches, belt-worn personal computers (PCs) with a head mounted display, glasses, which are worn on various parts of the body are designed for broadband operation. The field of wearable health monitoring systems is moving toward minimizing the size of wearable devices, measuring more vital signs, and sending secure and reliable data through smartphone technology. Although there has been an interest in observing comprehensive bio/non-bio medical data for the full monitoring of environmental, fitness, and medical data recently, but one obvious application of wearable systems is the monitoring of physiological parameters in the mobile environment. Most commercially available wearable devices are one-lead applications to monitor vital signs. However, most of such recreational devices are not suitable for the medical monitoring of high-risk patients. Those devices that have been qualified for medical use are usually simple.

3. OVERVIEW

In today's world, where time is precious, people, the working classes especially, spend most of the day shuttling between various tasks and tend to ignore their health and fitness. Even a simple appointment with a doctor in a clinic can require several tests set for diagnosis, prescription, and finally treatment, which can take a lot of time. Therefore, many patients only go to a clinic when they are suffering from a serious illness. Hence, many people are seeking for an alternative, such as a device that can be worn on the body, which would not only continuously monitor the user's health in real time but also provide timely insights on various health parameters to the user as well as his or her physician.

3.1. Motion Trackers

The dimension of human movement (motion tracker) has several useful operations in sports, medical, and other branches of studies. Similar operations include fall threat assessment, quantifying sports exercise, studying people habits, and covering the senior. Wearable trackers are getting decreasingly popular for two main reasons. They can motivate the stoner during the diurnal drill to perform further exercise, while furnishing exertion dimension information through a smartphone without homemade computation. Also, they enable the wearer to come apprehensive of the diurnal distance walked, which is veritably useful to ensure that the stoner maintains sufficient exertion in the diurnal routine to maintain a healthy life. To directly observe stir of the mortal body, 3- axis accelerometers, magnetometers, and gyroscopes detectors gain data, each for a specific purpose. These detectors can be used for mortal exertion recognition in the ubiquitous computing sphere as well. Gyroscopes and magnetometers are supplementary detectors that can be independently being combined with accelerometers to compensate the lack of delicacy in attained data for stir shadowing. In utmost cases, the combination of these three detectors leads to 9DoF.

Figure 2 Motion Tracker

(A-D) Four popular motion tracker wearable devices. (E) Four popular motion tracker wearable devices wrist- worn.

Device	Feature	Communication mode
Fitbit	Step counting and quality of steps, small size, wrist. worn	Wireless connection to mobile application only
Movella wearables	Wrist worn, Step counting, distance traveling, recording sleep time Measuring heart rate and percentage of the optimal sleep hours	Wireless connection to mobile application only
Apple Smart watch	Step counting, distance measurement and daily calories. burnt, measuring heart rate and sleep tracker monitoring and hours of light as well as deep sleep	Wireless connection to mobile application only

Table 1

3.1.1 Motion Measurement in Body Tracking

A new design was presented by Bertolotti etal. to ap- bias for objective measures of box or branch movements for the assessment of mortal body balance and control capacities. This system is grounded on a 72 MHz, 32- bit CPU (STM32F303VC; STMicroelectronics, Geneva, Switzerland) bedding a high-performance ARM CortexM4, 32- bit RISC core, with the eventuality of supporting several detectors externally with high performance in both SPI and I2C mode. In this exploration, the detector factors (STMicroelectronics detectors) have a direct range and a perceptivity that allow mount-er dimension of body movements. Online processing, in the sense of data accession from different detectors, altering, and data generation are performed at a high frequency of over to 72 MHz Body movements are measured using 9DoF detectors three inertial detectors, an accelerometer, a magnetometer, and a gyroscope. The full-scale values of the detectors can be modified by means of specific commands transferred by the microcontroller.

3.2. Vital Signs Measurement

Numerous wearable devices have been enforced to measure critical rudiments in healthcare monitoring. The maturity of these devices is in one lead similar as electrocardiogram (ECG) and electroencephalogram (EEG) dimension, skin temperature, etc. There have been recent sweats in wearable bias to give multi-task vital signs dimension. Then, we present the most creative and recent papers in this area. Numerous biases, structures, designs, and results for remote wearable ECG monitoring, which plays a vital part in health monitoring have been proposed in the literature and assiduity. Generally, these results are hard to apply and aren't effective enough in power

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consumption or performance. Some of them are remarkable but don't have the possibility of incorporating with other out signals from different system.

3.2.1 Body-Worn Smart Clothing

To gain health care status's signals from colorful physiological pointers due to forming a source data center for comprehensive health monitoring, a 'smart apparel' design was presented in. To make smart apparel systems intelligent, a structure incorporating smartphones, mobile operations, pall computing, and big data logical is needed to communicate in the structured design. Although several exploration approaches in the field of health monitoring have been proposed and enforced, the being results in different aspects have failed for long term health monitoring. Traditional health monitoring, which frequently collects one or a veritably limited number of physiological signals, isn't veritably useful for habitual conditions in a full-range health monitoring system. Detector deployment on the body is the main difference between old wearable bias and smart apparel. In smart apparel, all detectors which are used to measure the vital signs are integrated into cloth apparel. Detector placement is a critical point that must be performed duly. To give effectiveness and a well- formed design, the quality of the used detectors, proper positioning, layout of flexible electricity string, weak signal accession outfit, low-power wireless dispatches, and stoner comfort are pivotal factors. The fabric of the smart apparel to be worn, must be comfortable. In this design, it has been tried to measure only vital and necessary parameters. Now the used sensors and the location they are placed on the body are described below.

Sensor	Spot on body	Sensor's task
Pulse	Wrist	Photoelectric volume pulse wave signals measurement
Body tempera ture	Under arm seam	Body temperature
ECG	Chest and ribs	Vital sign
Myocar dial	Left chest	Complement for the ECG, measure the body's myocardial signal
Blood oxygen	Triceps muscle of left or right arm	Measures the volume of oxygen in blood
EEG	Left or right forehead and left or right back side of head	Detect abnormalities related to electrical activity of the brain

Table 2

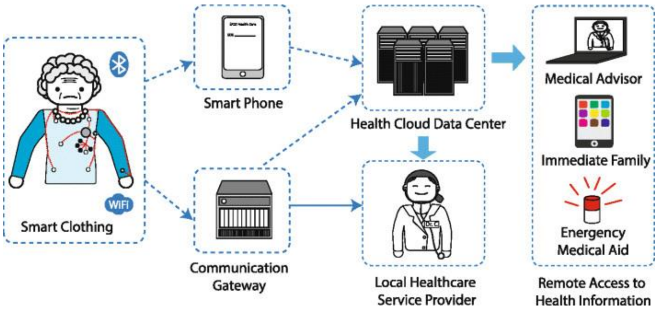

Figure 3 Smart Clothing

4. OBJECTIVES

The development of wearable sensors in the health care market has been relatively slow, despite wearable devices having emerged as a major part of lifestyle and fitness markets. However, the advancement of wearable sensor technology provides enormous opportunities for deployment in health care, especially in connected health care and precision medicine, in which wearable devices can achieve high-quality, real-time measurement of personal health. Although previous reviews have discussed consumer trends in wearable electronics and the application of wearable technology in recreational and sporting activities, data on broad clinical usefulness are lacking. This study reviews the current application of wearable devices in health care. In addition to daily health and safety monitoring, the focus of our work is mainly on the use of wearable devices in clinical practice. We also emphasize their current shortcomings and suggest directions for further research.

5. METHODOLOGY

5.1 Wire-Based Wearable Devices:

Limited Physiological and Environmental Parameters Measurement In this, a new approach to medical monitoring was introduced by Sanfilippo and Pettersen. The methodology is line grounded and numerous vital signs are measured. This wearable intertwined health-monitoring system is grounded on the e-Health Sensor Platform V2.0, which is the first biometric guard for Arduino and Raspberry Pi Still this device isn't certified for medical health monitoring. The system allows experimenters to measure and probe health through body monitoring by using 10 detectors to observe vital signs and perform stir shadowing. EEG, ECG, and body temperature dimension are carried out by these detectors, which are connected to the platform. A drive button is considered for exigency cases. Collected data are used in two scripts. In the first, the stoner is covered in real time, and in the alternate, sensitive data is transmitted to be anatomized for medical opinion. In this paper, a wearable health detector monitoring system grounded on a multi-sensor emulsion approach is outlined. The enforced device consists of a casket-worn device that embeds a regulator board, an ECG detector, a temperature detector, an accelerometer, a vibration motor, a color- changing light- emitting diode (LED), and a drive-button. The bedded vibration motor makes it possible to actuate distinctive haptic feedback patterns according to the wearer's health state. Haptic feedback informs the wearer about his or her health status in three different countries. When it does not joggle, it indicates a normal state; through low- frequency and high- frequency vibration, abnormal data observation and implicit threat are indicated, independently. To address sequestration enterprises, data is translated before transmission. Data collected for endless storehouse are transferred to pall storehouse, while data to be imaged in real- time, are transferred directly to a laptop or smart phone. The structural frame is grounded on a multi-sensor emulsion approach. In particular, a customer garcon pattern is espoused. A casket-worn device, comprising an Arduino Uno board Grounded on the ATmega328micro-controller, an Arduino Wi-Fi Shield-Health Sensor Shield, a wobbling motor, and push button, operates as a customer and ever communicates with a garcon. The garcon is enforced in three Situations of sense and communication. The device structure is enforced in three layers (Figure 3.1). The bottom and introductory sub caste is Arduino ATmega328. To enable communication capabilities to this proposed wearable device, an Arduino Wi-Fi Shield is piled on top of the espoused regulator board, which forms the alternate sub caste. In detail, the Arduino Wi-Fi Shield allows the customer to communicate with the garcon by using the802.11 wireless specification (Wi-Fi). The communication between the Arduino Wi-Fi Shield and the Arduino Uno board uses long wire wrap heads that extend through the guard. The third and top sub caste is enforced when the wearer’s biometric data are gathered, and an-Health Sensor Shield is piled on top of the espoused communication module.

5.2 Review

In this section, the literature review method is discussed. The review is started by deciding the keyword that will be used when searching for the references. The literature related to one of these topics: IoT, wearable device, healthcare, sensor, and disease. All the decided keywords are “wearable device in healthcare”, “wearable device for Parkinson”, “wearable device for blood pressure”, and “wearable device for breathing”. All the literature used in this review was searched from online search engines such as Google, Google Scholar, and IEEE Xplore. We prioritize literature from reliable publishers to be used in this review, such as IEEE, Elsevier, and Springer. The problem is that many journals were published more than five years ago. It means the journal is not suitable as references for this review. After filtering the references based on the relevance and published year (last five years), we find results: literature published in 2018 (5 paper), published in 2019 (7 paper). published in 2020 (10 paper), published in 2021 (8 paper), published in 2022 (11 paper), published in 2023 (15 paper).

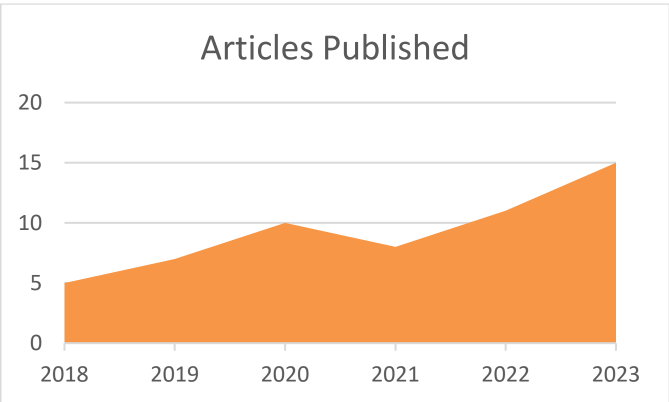

Figure 4 Number of related papers published.

5.3 General Architecture

In this, not all papers use the same type of armature but utmost use armature like this Fig. 2 shows the complete general armature of wearable-IoT for healthcare. The armature consists of the wearable detector, mobile device, mobile network, and the medical pall platform. The data attained from the detector is transmitted to a mobile device via Bluetooth or Wi- Fi. Mobile device acts as an edge device that pre-process the detector's data before transmitted to the medical pall platform via a mobile network. In the medical pall platform, data analytics and data storehouse are conducted. The sapience from data analytics will be transferred to the mobile operation to give druggies sapience into their health. In this, not all papers use the same type of armature, but utmost use armature shows the complete general armature of wearable-IoT for healthcare. The armature consists of the wearable detector, mobile device, mobile network, and the medical pall platform. The data attained from the detector is transmitted to a mobile device via Bluetooth or Wi- Fi. Mobile device acts as an edge device that pre-process the detector's data before transmitted to the medical pall platform via a mobile network. In the medical pall platform, data analytics and data storehouse are conducted. The sapience from data analytics will be transferred to the mobile operation to give druggies sapience into their health.

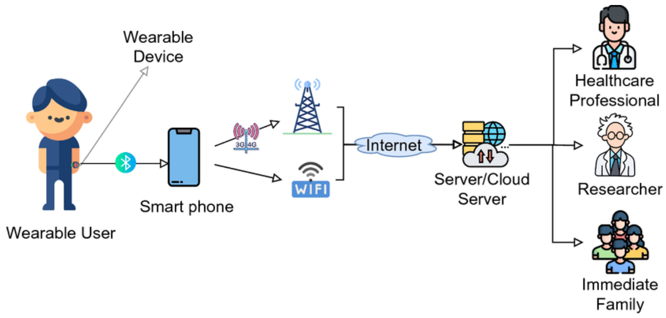

Figure 5 Architecture of Wearable devices

6. ADVANTAGES

Wearable technology provides us with the ability to monitor our fitness levels, track our location with GPS, and view text messages more quickly. Best of all, most of the devices that allow we to do this are hands free and portable, eliminating the need to take our devices out of our pockets. Before wearables, it was possible to obtain a lot of the information listed above, but it was sometimes a hassle and required devices that weren't always convenient. Wearables are connected to our smart devices, transmitting this Our project focuses on developing a backend system in the form of a REST API for electronic health record management. By providing a standardized interface, the API enables seamless communication between different applications and allows frontend developers to create user-friendly interfaces. information to them and allowing us to view it at later times, as well as in the moment. This can help you with setting goals and tracking your progress toward them.

7. DISADVANTAGES

Wearables tend to have a short battery life. Some devices, like the simpler Fitbit trackers, can last for several days. But some of the more advanced wearables, like the Apple Watch, will only last for a day or so. For some, it can be a hassle to remember to regularly remove your wearable to charge it. Because of this, a number of developers are looking into the possibility of wireless charging options that would eliminate the need to remove the device. Some wearables have been reported to measure data inaccurately on occasion. This can be especially dangerous when measuring data like heart rates. For individuals with heart conditions, this false reading could lead to overexertion and further health issues. Ultimately,

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it's up to you to decide whether a wearable device is something from which you would benefit. With their increase in popularity, it's important to weigh the pros and cons before committing to one.

8. FUTURE SCOPE

Future challenge defines more room for improvements like the sensor's improvement to get the best data in any conditions. In other aspects of how the data is processed to get the best information from the sensor or, in other words, the algorithm that is needed for pre-processing. Another aspect of IoT research in healthcare after the sensor and algorithm is compact IoT devices. The device needs to be compact when it is used by the user not to disturb the user. Then so the room for improvements is always required for the future of IoT. In this review, we conclude that future challenges are developing some unobtrusive device that doesn't distract the user in their daily life and can help the user monitor some aspect to warn or take actions to the hospital.
Smart Homes that Monitor Breathing and Heart rate have tested to accuracy in various scenarios like accuracy versus orientation, wall accuracy, and multi-user accuracy. The accuracy of this system is high enough, at 90%. Another implementation that can be developed for a contactless sensor is a sleep apnea sensor attached to the bed for detecting sleep apnea or anything else that contactless to the user". It can be some stretchable and flexible in a contact device that is small enough to not disturb the user". In network and data aspects there are some severe issues about mass monitoring if a system monitors many people in real-time and gives information to the user. This aspect needs to be managed appropriately and maintain for mass users. How to maintain the server to receive the mass request in real time to counteract the example of the conditions when someone with a heart attack can know where to go to deliver first aid to the patient. To provide such a fast counteract to the patients, it needs effective and efficient in sending the request from a region that far away from the signal tower or in a mall that some areas didn't have sufficient signal to send it fast to the server. Besides the network, the data aspect is important enough to accommodate the fast response first aid kit to the patient in the nearest hospital. The scalability aspect is how the system is managed in increasing user while the system is still capable of processing all the user's request that is growing daily and the requirements for a continuous health monitoring32. Suppose the IoT in healthcare is very needed to counteract the severe disease so it can be prevented. The system needs to be very efficient and effective in delivering first aid kit nearest to the patient. In network, the city needs a sufficient network technology in implementing the system, in the data aspect needs to be fast processed and delivered to the user and the hospital.

9. CONCLUSION

Wearable devices are getting popular in colorful fields from sport and fitness to health monitoring. Due to the adding senior population throughout the world, wearable devices are getting important for long term health monitoring. The main end of this work was to give a comprehensive overview of this area of exploration and to report the full range of tools in area of wearable health monitoring bias. In this review paper, we've reported both exploration workshop and marketable bias to study and probe the presently available technology. In preparing this paper, we studied the literature from colorful points of view. Grounded on discussion with expert scientists in environmental engineering and drug, we believe that, stir trackers, gas sensors, and vital signs are the most important rudiments in health monitoring; thus, to achieve the full range of health monitoring, all these parameters were studied. In each field, a variety of methodologies are employed, but not all are effective and effective. The most important criteria in this study were the possibility of using the device in the real world, performance, effectiveness, and power consumption. In addition, we considered the price of each device. Among all enforced workshop so far, no effective result has been proposed for comprehensive monitoring in gas discovery, stir shadowing, and vital sign monitoring to integrate all these into a single device. It might be possible to realize this in unborn work by creating a system with following characteristics -#MULTIPLE detectors on ONE detector knot, -#MULTIPLE bumps on ONE existent, -#MULTIPLE individualities on ONE pall system. Monitoring of an individual with number of parameters in his working/ living terrain is possible. Also, computational models and software development for data encryption and data contraction must be delved for further effectiveness. In the first script over, which seems to be the stylish approach, there are serious restrictions in available detectors. To realize this wearable possibility, applicable factors must be located duly and must serve well. In the alternate script, tasks can be devoted to each knot. For case, stir shadowing detectors can be enforced on one detector knot, and vital sign monitoring can be enforced on another. The third script is incorporating of the first and alternate methodology, which could widen the range of druggies and the range of practical operation.

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