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A Real-Time Health Monitoring System Using Wearable Technology and IoT Integration

Maruti Maurya, Ishan Khan, Hera Fatima, Maaz Ahmad, Faraz Husain
Dept of Computer Science Engineering,
Integral University, Lucknow, India
marutimaurya14@gmail.com, ishankh@student.iul.ac.in, heraftima@student.iul.ac.in, maazahma@student.iul.ac.in, Fhmeraj@student.iul.ac.in

Abstract: This project presents a Health Monitoring System using a wearable device designed to continuously track vital physiological parameters such as heart rate, body temperature, blood pressure, blood oxygen saturation (SpO_2), and physical activity. The system employs a smart wearable band integrated with biomedical sensors and a Bluetooth- enabled microcontroller to collect real-time health data. The data is transmitted to a mobile application via Bluetooth Low Energy (BLE), where it is processed, analyzed, and displayed in a user-friendly interface. Abnormal readings trigger instant alerts, which can be communicated to healthcare providers or caregivers through SMS or email. Additionally, the system supports cloud integration for remote monitoring and historical data storage, allowing physicians to access patient data at any time. Designed with a focus on elderly and chronically ill individuals, this solution offers a cost-effective, non- invasive, and portable approach to personal health monitoring, ultimately enhancing preventive care and enabling timely medical intervention.

Keywords: BLE, SpO_2, IoT, Health monitor

1. Introduction

Both the scientific research and the industry have taken advantage of the wearable devices. Wearable devices with physiological information measurement functions are widely studied and produced given the low cost and convenience related advantages of the devices. Such gadgets can now measure various kinds of physiological information regarding the body such as movement, temperature, heart rate, blood pressure, and blood glucose, among others. This project will develop a wearable device that continuously monitors and records physiological data from the body. The recorded data can be reviewed later for health analysis, and the details of health data are transferred to the cloud storage to get real-time health advisory services. Besides, the proposed system is equipped with an automatic designation function to make a phone call, send an SMS, or an email in case of emergency health symptoms [1].

The feasibility of the wearable device is illustrated to measure the body temperature continuously. Nowadays, with a more advanced technology booming, it provides new productivity systems known as the Internet of Things (IoT). This innovation includes an all-weather wonder that lets people use their gadgets and multitask wherever they are both at home or on the go. The system health monitor actually quantifies the physiological biomarkers of an individual by the medium of a gadget and then utilizes a particular algorithm. The algorithm is part of the software that provides the crucial feedback depending on the input values [2].

2. Related Work

Health monitoring is crucial for understanding current wellness and fitness levels and evaluating progress toward health goals. Wearable devices have become prominent in the healthcare sector due to their wearability, accessibility, and integration with the Medical Internet of Things (IoT). These devices, such as wristbands, smartwatches, and even wearable massage chairs, allow users to conveniently track health indicators. In developing healthcare-oriented wearables, several design metrics must be considered, including system architecture, clinical utility, user comfort, data security, long-term monitoring, signal accuracy, resilience to data disturbances, reliable communication, power efficiency, and system lifespan. A seven-week study in South Korea evaluated the accuracy and usability of four commercial wristband-style wearables, providing valuable insight into user expectations and the development status of these technologies.

Mobile healthcare systems extend functionality by collecting real-world physiological and contextual data through sensors. The types of data include life events (e.g., loss, job changes), symptoms, mood states, general health conditions (e.g., blood pressure, shortness of breath), and performance metrics like attention and memory. In a study involving 142 undergraduate students, a feature design survey combined with machine learning models—including regression trees, bagging, and neural networks—was used to analyze health data and interpret consumer preferences. The research also emphasized the importance of proper device form factors and placement, such as wristbands or belts, in enhancing comfort and performance. Accurate data collection, cleaning, and processing were key components in developing effective wearable healthcare systems.

2.1. Existing Technologies

Ghosh et al. proposed a real-time, energy-efficient health monitoring system aimed at assisting both healthcare providers and patients, particularly in acute care situations, by delivering immediate feedback. This system is entirely mobile phone-based and lacks the intelligence of more advanced healthcare applications. It employs a fit-band and a custom-designed mobile app to monitor and transmit health data. Although the fit-band operates for approximately 18 hours—equating to two days of usage—details regarding SMS-related costs are absent. The system's intelligent data analyzer processes the streamed data at the server end and delivers voice-based feedback via SMS to users and healthcare professionals in real time [1].

Similarly, a healthcare application developed by Wu et al. is capable of connecting with four LinDing wearable devices simultaneously to monitor physiological signals such as photoplethysmography (PPG), electrocardiogram (ECG), human implication pressure (HIP), body temperature, and blood oxygen saturation (SpO2) [2]. However, the necessity of wearing multiple devices can lead to user discomfort. Moreover, limitations arise due to the lack of Bluetooth 4.0 support in mobile phones, requiring a third-party USB-to-Bluetooth bridge. Still, real-time visual monitoring and data logging are possible through a dedicated Android app. In a related effort, Huifeng et al. proposed a continuous health monitoring system tailored for athletes, integrating a chest strap with ECG sensors, a heart rate monitor watch, and a foot pod for step tracking. A more user-friendly alternative involves a wristband-based solution utilizing optical sensors for heart rate monitoring. While some bands with optical displays and long battery life exist, they have limited durability. Their popularity also contributes to frequent disposal or resale, raising concerns about sustainability and e-waste [2].

2.2. Recent Advances in Wearable Devices

In the era of Internet of Things (IoT), lightweight wearable devices are utilized to monitor the condition of the human body to avoid any failure of the vital organs. Furthermore, they are additionally employed in the sports field and to observe the fitness level. With the fast development of Biosensors and the advancement in information electronics, the integration of wearable device and wireless technology gives birth to personal health monitoring systems extensively agreed by industry.

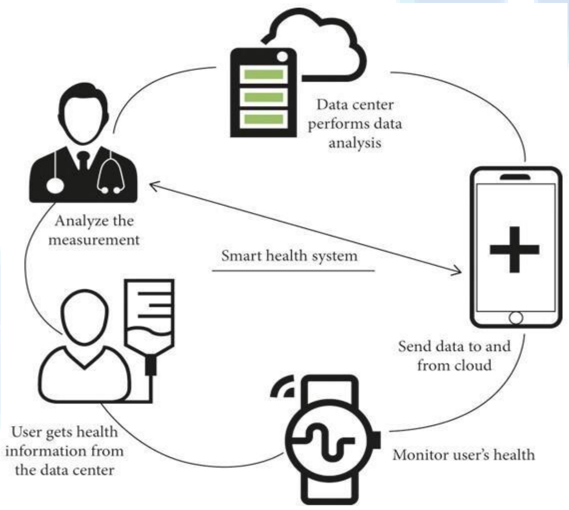
In recent years, wearable devices have obtained substantial interest as a reliable tool for long-term health monitoring systems. A wide range of health monitoring indicators can be monitored by means of wearable devices. Generally, these wearable devices are applied in watching vital signs and fitness, watchkeeping, and initiative response in a smart home environment or hospital in a considerable safety measure. The potential market for these devices is growing because of the technological advancement in low-cost personal healthcare systems and betterment in the quality of lifestyle. The majority of wearable devices can take long battery life for powering them because implantable and wearable devices always have sizes that are reduced, which limited battery capabilities and consume considerably more energy [2].

There are numerous different products in the wearable device market. Most wearable devices are still smart watches, and the Fitbit's flex represents. In addition to this kind of device, there are head-mounted displays like Google glasses, which can be employed in individual environmental perception project, and recognition is possible through face and text. Major companies such as Google and Samsung have already released their wearable technologies and have invested heavily in the wellness field with their products. Google has lately released a watch, glasses, and health tracker that can be linked to the cloud. In contrast, Samsung has already released a watch that can measure bio-signals. On the other hand, biosensor is a device, which transforms a person's physiological significance into electricity. These biosensors are very fragile and should be attached to the body securely. For instance, unfix biosensor can lessen the heart rate's electrical signal quality, so the tiny holes on the biosensors to make them air premetallized.

2.3. Applications in Health Monitoring

Wearable human interaction devices, which can interact more conveniently beyond smartphones and portable computers, have emerged as devices that can monitor and control the conditions of users of devices or environmental signals around devices. Monitoring and control applications through wearable electronic devices are expected to be actively used. Healthcare monitoring, one of the application areas, is referred to as the monitoring and control applications for health conditions. Examples include diseases diagnosed early or monitored by health conditions, treatment effects monitored in real time or controlled, continuously monitored on the health conditions of ordinary people, and situations controlled.

Wearable electronic devices that can monitor healthcare include, for example, heart rate, wrist pulse, motion, and internet-related health or conditions such as blood pressure, body temperature, ECG, respire function, sweat composition, bioelectrical information, blood glucose, cholesterol, intraocular pressure, heart rate variation, SpO2, and mental health. Attention is being paid to the increase in the number of people who can attach without discomfort by realizing the various types of wireless systems, especially capabilities of transmitting and receiving data from such devices and systems, and the means to attach to the user or other object among smart sensors. In general, skin arrays or headware were used in health monitoring.



Human health monitoring is attracting substantial interest and increasingly becomes the focus for next-generation wearable smart sensor systems. Smart sensor systems for the health monitoring of heart rate, body motion, bioelectrical signals,

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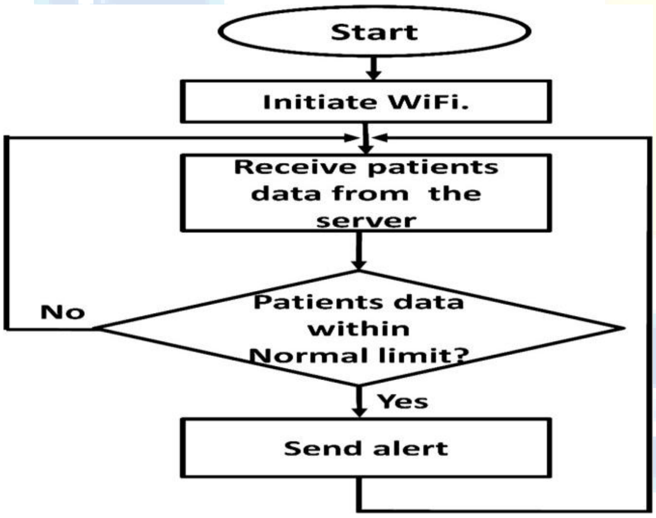
and skin temperature are reviewed as the representative health status parameters of the human physiological conditions [3]. Digital devices that allow the real-time and continuous health monitoring of various health status parameters in daily life can be invaluable to the improvement of the length and quality of human life.

3. Methodology:
The methodology for developing the Health Monitoring System using a wearable device is divided into multiple phases, covering hardware selection, system design, data acquisition, processing, transmission, and user interface development.
Initially, appropriate physiological parameters such as heart rate, body temperature, blood pressure, SpO_2 (oxygen saturation), and step count are identified as primary indicators of a user's health status. A wearable device, typically in the form of a smart band, is chosen with embedded sensors like a heart rate sensor (e.g., PPG sensor), temperature sensor, accelerometer, and blood oxygen sensor. These sensors are integrated onto a microcontroller platform, such as Arduino or ESP32, with wireless communication capabilities using Bluetooth Low Energy (BLE).
The system collects real-time physiological data and transmits it via BLE to a paired smartphone. A dedicated mobile application processes this data using basic threshold-based algorithms or machine learning techniques for anomaly detection. When abnormal readings are detected, the system triggers alerts to notify the user or a healthcare provider via SMS, email, or push notification.
Simultaneously, the processed data is stored in a cloud database through the mobile gateway. The cloud backend enables remote access to historical health data for healthcare professionals. To ensure reliability and user privacy, the system incorporates secure data transmission protocols and user authentication mechanisms.



The mobile interface is designed for simplicity and accessibility, especially for elderly users. It displays real-time data, health status summaries, and notifications. The system also supports emergency protocols, such as automatic message dispatch with location details in case of critical health events.
This end-to-end methodology ensures that the health monitoring system is continuous, non-invasive, user-friendly, and capable of real-time health assessment and response.

4. System Architecture:
Health is defined as a state of complete physical, mental, and social well-being, not merely the absence of disease or infirmity. As public health conditions improve, life expectancy rises, contributing to a higher standard of living. With the rapid evolution of electronic technologies, healthcare products have extended beyond traditional treatment-focused tools to more diversified solutions that emphasize continuous monitoring and prevention. Verifying an individual's physical health level scientifically remains a challenge, especially in the context of early detection of infectious diseases, such as those spread through public transportation.
Hence, the development of digital health-monitoring systems plays a vital role in enhancing public health awareness. One such innovation is the Wearable Health-Monitoring System, which integrates the e-Health Sensor Platform V1.0. This platform allows for accurate and real-time tracking of personal health indicators using a smart bracelet that records motion data and computes multiple health metrics. The system architecture is strategically divided into three functional modules to improve operational clarity and efficiency. The widespread popularity of wearable devices is largely attributed to their ability to track a broad spectrum of physiological and environmental parameters, including heart rate, step count, sleep patterns, skin temperature, blood oxygen levels, calorie expenditure, and exposure to light or UV radiation [2][4]. These devices not only simplify health monitoring but also enable timely detection of abnormal conditions.

4.1. Overview of the System
A person's health condition is reflected through various parameters such as pulse rate, heart rate, body temperature, blood pressure, oxygen saturation, respiration rate, and blood glucose level. Regular monitoring of these indicators is crucial for early detection and prevention of complications. In the digital age, many of these parameters can be automatically tracked using wearable devices. While numerous health-monitoring applications exist in the market for tracking physical activity and health metrics, a truly comprehensive solution, particularly for elderly patients, is still lacking. The proposed project, a Wearable Health Monitoring System using a Fit-Band, introduces key improvements tailored to the needs of elderly individuals. Unlike conventional systems, it incorporates specific features such as real-time monitoring, ease of use, and advanced alert mechanisms [1]. One such innovation is the SHUBHCHINTAK system, designed to support elderly individuals living alone. This system uses a Fit-Band to monitor heart rate, step count, and basal metabolic rate, transmitting data to a mobile phone via Bluetooth Low Energy (BLE). The mobile device processes the data, extracts contextual information, and forwards it to a remote server. There, machine learning algorithms assess the patient's health status and generate alerts only when necessary. The system

sends notifications through mobile apps, SMS, or email, and communicates basic medical advice via a digital display. It can also vibrate the Fit-Band to alert the user. Moreover, due to its offline compatibility, any updates made in the centralized system are automatically reflected in both mobile and desktop clients, making it a robust and intelligent remote health-monitoring solution [5].

4.2. Components of the Wearable Device

Wearable devices is a general concept for portable devices that can be worn on the body. With the development of science and technology, types, functions, and styles of wearable devices have gradually diversified and have been widely utilized in all aspects of people's lives. Wearable devices have usually been applied to data monitoring and collection related to body/health, sports, and sleeping, mostly for fitness tracking. They can also have other applications such as telephone-saving reminders, navigation, alarms, and social networking. In the realization of health monitoring by wearable devices, products from a large number of manufacturers have rendered people's lives more convenient, efficient, and smart [2].
These wire-based wearable devices are similar to an appliance, and their function has been just limited to measuring physiological and environmental parameters. Monitoring only static physiological and one environmental parameter is generally passive heath monitoring. With the development of Internet of Things (IoT) wearable devices have been applied to diversified smart services, in which the same type of wearable devices mostly communicates to the same brand smart phone, and the brand's smart phone synchronizes monitoring data to a cloud server. Integrated solutions implemented by companies are in the form of bracelets, rings, watches, and the like; people were expected to carry these bands by their selves. With the Liquid Date System (LaDS) a new garment is introduced that leverages Bluetooth networked conductive threads to enable the wearer to inspect the state data of the wireless network node that is associated with the garment itself.

4.3. Data Transmission Mechanisms

In an embodiment, a centralized sensor device is in communication with the first and second biologically-based sensors, and the user may wear the centralized sensor device. The centralized sensor device is connected to a wireless communication device that wirelessly transmits the signal information to a remote computational device. In an embodiment, energy expenditure information of the user is determined and the user is provided with feedback of the energy expenditure information. The mobile computational device comprises a storage system that receives and saves the signal information and a processor that determines the energy expenditure information. In another aspect, a system is having a mobile, facemountable communication and processing device that is connected to an external skin surface contact sensor.
A health monitoring system includes a headband including a forehead band on which a dual-axial accelerometer having two accelerometers that measure movement of a user on a respective lateral axis is mounted. The measurements are transmitted by cables to a remote computer processor, where the pre-processed signals are fed to a machine-learning model that determines the energy expenditure. The system transmits the feedback on the energy expenditure of the user to a phone or in real-time. In another aspect, the dual-axial accelerometers have a maximum weight less than 1 as the headband, and the dual-axial accelerometer is in a sealed water-proof case to be waterproof. The communication device comprises a cellular phone attached to the headband, and the processor receives the signal information on the cellular phone.

5. Sensor Technologies:

Wearable human interaction devices have become increasingly essential in modern healthcare, contributing significantly to comfort, convenience, security, and continuous health monitoring. These devices are crucial for early disease diagnosis, treatment monitoring, and overall health assessments. By enabling real-time data collection on key physiological signals such as heart rate, ECG, wrist pulse, and motion, wearable health systems provide continuous monitoring of various body functions [1][2]. This paper explores the integration of smart sensors and wireless systems used to monitor biological signals and human movements in the wearable healthcare ecosystem. Specifically, it examines wearable bio-sensors, including electrodes, ECG strips, and health patches, placed in close proximity to the skin, supported by experimental results. Furthermore, the paper delves into the role of body area networks (BANs), which form the backbone of the wearable healthcare ecosystem.

The growing adoption of smart wearables is revolutionizing healthcare by enabling individuals to monitor their health on a continuous basis, improving both life quality and potentially extending lifespan. Wearable technology has experienced remarkable growth, especially in healthcare applications, initially focusing on fitness monitoring and the measurement of physiological parameters such as heart rate and body temperature [3]. Today, these devices are expanding into more sophisticated medical applications, with commercial development anticipated to increase significantly in the near future. While many existing wearables can track vital signals like heart rate and body activity metrics, such as those found in smartwatches and wearable shoes [4], most commercially available health monitoring devices still lack the professional-grade sensors and algorithms necessary for precise healthcare measurements. While research-focused devices are used in hospitals or clinics, consumer-grade wearables often provide basic health data without the advanced diagnostic capabilities required for more in-depth healthcare applications [5].
However, ongoing advancements in bio-signals, including EEG and motion-based monitoring techniques, hold great promise for the development of more comprehensive wearable health systems, including those capable of analyzing video-based bio-signal data [6].

5.1. Types of Sensors Used in Wearable Health Monitoring

Wearable health monitoring systems rely on three main types of sensors: bio-sensors, environmental sensors, and motion sensors. Each sensor type plays a unique role in providing comprehensive health data.

1. Bio-sensors
Bio-sensors are designed to monitor physiological conditions of the body. These sensors are integrated into wearable devices and are placed in direct contact with the skin for continuous health monitoring.

Sensor Type	Function
ECG Sensor	Measures the electrical activity of the heart, detecting arrhythmias and other heart-related issues.
Blood Oxygen Sensor	Monitors blood oxygen levels (SpO2), critical for detecting respiratory issues.
Bio-impedance Sensor	Measures the impedance of body tissues, offering insights into body composition and hydration.
Temperature Sensor	Monitors body temperature to detect fever or hypothermia.
Microphone Sensor	Captures respiratory sounds to analyze breathing patterns and detect conditions like sleep apnea.
Galvanic Skin Response (GSR) Sensor	Measures the skin's electrical conductance, which changes with moisture level, used for detecting stress or emotional responses.

2. Environmental Sensors
These sensors monitor the wearer's environment, contributing to the overall health assessment.

Sensor Type	Function
Humidity Sensor	Measures the moisture level in the environment, which can impact comfort and respiratory health.
Lighting Intensity Sensor	Detects light levels, useful for tracking circadian rhythms and managing sleep disorders.

3. Motion Sensors
Motion sensors track the wearer's physical activity and body movements, which are essential for fitness tracking and monitoring physical health.

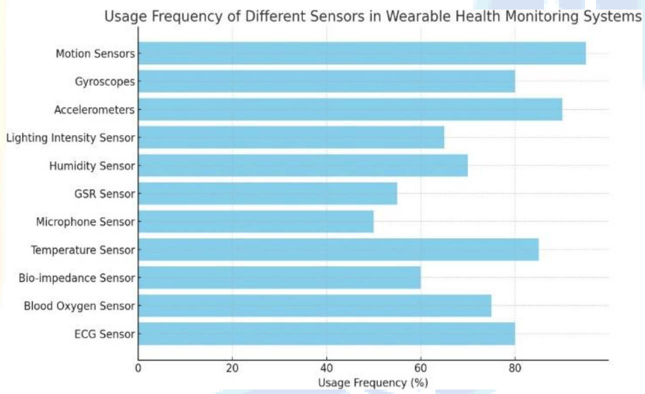
Sensor Type	Function
Accelerometers	Measure acceleration, helping to track physical activity and detect falls.
Gyroscopes	Measure angular velocity, aiding in posture analysis and motion detection.
Motion Sensors	Detect movement, helping to track specific actions such as walking or running.

These sensors work in conjunction with one another to form a sensor-node, enabling holistic monitoring by synchronizing data from multiple sources to provide accurate health assessments [1][2].

5.2. Sensor Accuracy and Reliability
While wearable health monitoring devices are becoming more sophisticated, ensuring the accuracy and reliability of the data they collect remains a significant challenge. Several factors can influence the quality of data, including:

• Environmental Interference: Magnetic fields, radio frequencies, and other environmental factors can disrupt sensor signals, leading to data inaccuracy.
• Signal Noise: Physiological signals, such as ECG or blood pressure, can be contaminated by noise, making it difficult to distinguish relevant data.
• Sensor Calibration: Accurate readings require proper calibration, which can be affected by the physical movement of the wearer or changes in environmental conditions.

To overcome these challenges, advancements in sensor technology focus on improving signal quality by reducing electromagnetic interference and enhancing sensor sensitivity. Additionally, wearable devices are being equipped with algorithms to automatically correct or filter out noise from the data [3][4].



6. Data Collection and Processing in Wearable Health Monitoring Systems
In recent years, wearable health monitoring systems have gained prominence as effective tools for healthcare intervention, extending beyond traditional hospital settings. These systems, which integrate sensors for continuous physiological monitoring and feedback systems for intervention, hold great promise for personalized healthcare, especially for remote monitoring and chronic disease management.

6.1 Data Acquisition Techniques
Wearable devices, such as fitness bands, smartwatches, and sensor-enabled clothing, have become integral in collecting

vital health data. These devices typically include sensors for monitoring physiological parameters like heart rate, ECG, blood oxygen levels (SpO2), and body temperature. The data acquired by these sensors is valuable for continuous health monitoring, particularly for patients with chronic conditions such as diabetes, hypertension, or cardiovascular diseases [8]. Moreover, these devices can be used in point-of-care (POC) applications, allowing for health data collection in remote or underserved locations where access to healthcare is limited.

The integration of multiple sensors into a single wearable device allows for the monitoring of various health metrics in real-time. For example, some devices are equipped with accelerometers to monitor physical activity, while others track ECG or even more complex parameters like respiratory rate [9]. These diverse sensor data are transmitted to a central hub or cloud service for processing and analysis. One of the challenges faced in such systems is the complexity and heterogeneity of the data, which must be managed efficiently to ensure accurate monitoring and alerts for medical conditions [9].

6.2 Data Processing Algorithms

The vast amount of data generated by wearable sensors presents challenges in terms of processing and analysis. Most of this data is continuous and often unlabeled, making it difficult to extract meaningful insights using traditional methods. In addition, due to the continuous nature of the data, it is typically broken down into smaller time frames for more manageable analysis [10].

Advanced data processing algorithms, including machine learning and deep learning techniques, are employed to handle this influx of data. For instance, in the case of the EchoWear system, which aids in speech and voice treatment for Parkinson's disease patients, multi-modal data (voice and motion signals) collected from the smartwatch is processed using deep learning frameworks. These algorithms are capable of extracting hidden features from raw data, enabling real-time feedback on the patient's progress [1]. Additionally, unsupervised learning techniques are being explored to analyze sensor data without requiring labeled training datasets.

6.3 Data Storage Solutions

As the volume of data collected from wearable sensors increases, efficient data storage and management become critical. Cloud-based solutions are widely used to store the vast amounts of data generated by wearable devices, enabling easy access by healthcare providers, researchers, or patients themselves. These systems allow for secure data transmission and storage, ensuring patient privacy while providing the flexibility of remote access for monitoring and diagnostics [9].

In the context of energy-efficient health monitoring, solutions have been proposed that utilize low-power wearable devices designed for long-term use. For example, wearable devices with low-energy consumption, such as the proposed fit-band with PPG sensors, are designed to work for extended periods without requiring frequent recharging. These devices can be integrated into health monitoring systems to continuously collect data on vital health parameters, with minimal disruption to the user's daily life [1].

7. Privacy and Security Concerns

With the new wave of technology that tracks personal health data, privacy concerns have also risen. Cops used murdered woman's Fitbit to charge her husband with her death. There were plenty of candidates for the 2017 word of the year, including "blockchain," "gig economy," and even the meme-inspired term "fidget spinner." All of these point to a fast moving and constantly evolving (culturally and technologically) world. The goal is to take a closer look at privacy concerns within the context of the industry, the user perspective on health data privacy, taking into consideration the technicalities of the technology, and open up the conversation around how these can align better. A co-design workshop with the Wearable Technology Research Group and the Northern Design Centre raised some interesting perspectives that on health data privacy within the wearable devices industry, including the observation that "good design doesn't mean the Boring Bit can't be included." The survey found a chance in perception amongst 18-24 year olds that may reflect a growing up with social media and user data scandals, and found general comfort accepting privacy in exchange for perceived health benefits was the bottom line of consumer consent [12].

Privacy concerns rise. The notion of privacy has existed for as long as human societies have formed behind closed doors, but the concept of privacy as it pertains to the protection of personal information from intrinsically interconnected with the data collection and communication capacities of emerging communication and sensing technologies were only first documented in the 19th century through an essay by Samuel Warren and Louis Brandeis entitled "The Right to Privacy" [13].

With the rapid development and falling cost of technology we have seen a rapid rise in the capabilities of commercially available consumer goods, including an increase in the processing capabilities of everyday devices, and growing market for wearables, and the increasing pervasiveness and ubiquity of the Internet of Things and connected devices. It is within this context, -the generation, collection and expansion of personal information through networked objects and services, from fitness trackers, surveillance cameras, smartwatches and China's "Social Credit System," and the storage of this data in the remote datacentres of multi-national

8. Future Trends in Wearable Health Technology

Technology and society are developing rapidly, and the field of health applications must respond to these developments. The recent trend is the use of wearable devices that can help to improve lifestyle, health and fitness. Today, wearable health devices are becoming increasingly popular and fashionable to use. Such devices are used in many branches of healthcare. They not only monitor basic parameters, such as heart rate, pressure, or temperature, but are also potential lifesavers. [2].

Wearing them for 24 hours a day brings in new features of medical monitoring of the patient which were previously unavailable under the ordinary visit of a doctor. It can also help to save lives by monitoring chronic diseases if they require immediate medical intervention. The purpose of the paper is to present the basic characteristics of a new health care monitoring system with the use of a wearable device that allows heart health parameters to be measured accurately and precisely in real time.

The accuracy of fitness tracking is one of the key factors of device selection. This has led to a lot of work in developing interoperable fitness tracking models that can be worn in free-living conditions. The performance of fitness trackers is the focus of a recent survey, which shows that some fitness tracking devices perform better than others. Experiments use four wearable devices to measure heart rate, energy burn, steps, and activity type. These devices provide information on objects, data, and sampling rates. One important parameter is data resolution, often called "epochs," which means converting raw data into information that a given device uses to create some measures. There are many studies of wearable device practice, both academic and from the industry. Most of them evaluate devices' feasibility to support specific applications. The effectiveness of wearable heart rate (WHR) equipment was examined. A survey after examining the literature confirmed the beliefs of challenging WHR measurement design, indicating a poor performance. Subsequent evaluation underscores another important aspect of the problem: users themselves. It is also necessary to consider their variant physical characteristics since they directly affect the quality of data obtained. In the explanatory section, recommendations were made on what should be taken into account in further research to improve WHR measurement. On average, each device has a 95% confidence interval for heart rate measurements between 12-40 beats per minute (BPM). This paper also proposes and evaluates a generalized methodology of collecting and processing data that can help in designing sensor-based experiments generally.

8.1. Emerging Technologies

Nowadays, numerous smart wearable devices like a fitness tracker, fall detector and heart rate monitor are popular. This trend is expected to continue in the future.

Some emerging technologies related to this trend are presented. Wearable devices will increase work efficiency and safety. Smart glasses, for example, enable a worker to see a work manual or receive consultations with an expert in real time. One of the applications of the UWB technology is for the location information of personnel in a construction site. UWB technology can be used to obtain precise location information, including the Z-axis. The cost of UWB technology is relatively cheap, it is expected to be used more and more in the future for this application. Many countries have already proposed regulations for a novel industry like drones. Radio Frequency Identification (RFID) is expected to be used to identify a worker or manage a safety pass. Some of the construction companies have already begun to try this system. It is expected that such implementation will result in greater use [3]. By 2025, a new small digital economy, including wearable technology in Asia, will generate 4.5 trillion to 5.5 trillion USD economic profit. In Korea, the commercial market for smart wearable devices has steadily increased. The health care system to monitor the health condition and location of the elderly living alone is emerging. In addition, a smart wearable detector will appear in a hazardous workplace. Many wearable sensors can be attached to a human body, enabling the real-time monitoring of several biological variables. By integrating the bio-physiological characteristics of a person, a tiny body sensor with radio frequency (RF) technology can be printed on flexible substrates [2]. Wireless data transmission allows the possibility to monitor body temperature, respiration rate, and heart and pulse rate. Due to polymer thickness and attachment to an adhesive bandage, the device is hardly noticeable and doesn't impede the user. The UWB technology may be useful in some healthcare applications including drug administration, and patient monitoring both inside and outside hospital environments. Specifically, it can be exploited in a hospital environment as a means to reduce inadvertently declining notification recipient locations. It can also be used for patient monitoring enabling health care providers and physicians to keep track.

8.2. Potential Impact on Healthcare

The rapid advancement of the world's economy has brought a variety of facilities in the life of humans. But, on the other hand, the advancement in the world's economy also leads a hectic lifestyle which makes considerable stress, blood pressure, and cardiac attacks, etc. Therefore, health monitoring comes first so that health precautions can be taken [1]. The health monitoring system is a type of disease detection device. Different types of health monitoring systems are found for different types of facilities like wearable health monitoring devices, and others. It has some wearable sensors that collect health status of a human and pass these data to an Android Smartphone using Bluetooth. These data are displayed on an Android mobile screen and analyzed health status is tracked accurately. The system is used to check the Continues Bluetooth packet Transfer, the increase or decrease human body temperature, and the pulse rate of the heart [15]. In that case, a bandage is equipped with a temperature sensor. The Bluetooth receiver is connected with an android Smartphone to receive the health status data of the human body. That data is displayed on the mobile screen. The health status of each session is stored in the database. Using this system the health status is analyzed by the doctor anywhere in the world. The system is observed that soil moisture monitoring accuracy is 83.4%, light intensity monitoring accuracy is 79%, water-level monitoring accuracy is 78%, and heart rate monitoring accuracy is 85.2%. For that reliability of that health monitoring system, the power consumption is first checked. For this system, the consumed power is observed that it is only 0.7. It is noted that the working distance of the remote health monitoring system is up to 10m. The system is examined in different locations like on the rooftop, inside the room, in a field, a crowded place like a fair, and others at different times. The transmitted health parameter data is observed accurately according to the monitoring screen of the android mobile.

Continuously monitoring the health status of a human through this system suggests taking health precautions whenever needed.

9. Conclusion.

Monitoring healthcare and remaining healthy has developed into the highest challenge before humanity. This can generally be taken care of with scheduled meds and further regular appointments with the health care provider. Nevertheless, this older version of healthcare is neither efficient nor cost-effective. Welfare attire can rejuvenate the scenario by immediately monitoring and tracking continual oxygens status, pulse rate, body temperature, blood pressure, ECG, and many others.

However, this technology is still just an emerging field, so it is critical to get an appreciation of the modern technology that has been developed in the field of wellness gears in body sensor networks. Today, wellness gowns and personal health coverage offerings have become progressively renowned. In recent times, there has been enormous interest from the consumer whenever it is said about personal well- being coverage solutions. Thanks to these personal protective solutions, various valuable health warnings can be extracted routinely, which would not be feasible with traditional medical tools. The overview of state-of-the-art personal protective wellness wear and gadgets has been presented. The discussion also covers many current medical results, detailing the tasks, goals, technologies, and project progress in the area of BME wellness wears and wellness covers. The possibility of personal protective wellness clothing and BMS to significantly deteriorate the regular healthcare sector has been underlined.

A thorough understanding of the research and the publicly available items in this area have been obtained for the intended audience. In addition, the discussions are summed up with a focused research that shows where the investigative work is demanded now and is expected in the changing fields of wellness dressing and emergency health care. Although wellness garments and their BMS operations remain primarily principled in the biological research ranges, they are supported by a wealth of relevant data across various other subjects [2]. The objective of this report is to deliver a brief overview of wellness clothing in the state of art, to both experts and people from other parts of the investigation.

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