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Analysis of Wearable Sensor Electronics and Wireless Health Monitoring Systems

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Abstract: Due to the way we live today and problems with ageing, diseases are on the rise dramatically. Healthcare systems must adapt to the evolving needs of medical conditions. Current health monitoring systems must meet a number of criteria, including being portable, power-efficient, user-friendly, and others. Such systems and gadgets can now be created thanks to the quick development of technologies like wireless, embedded, nanotechnology, and others. In this work, we conducted a survey of several wireless protocols. Investigating how people and machines interact in mobile environments has been one of the most important scientific endeavours in recent years. In this project, we'll look at ways to make use of current technologies to create an eHealth system for people with heart disease. Patients should be able to communicate with their doctor through this method, eliminating the need for frequent clinic visits.

Keywords—*Health system, wireless, Patients, Wearable Electronics*

1. Introduction

Patients with heart conditions are required to regularly see their doctors for a checkup.They occasionally travel great distances and occasionally miss events due to medical appointments. Why do people always have to adhere to this dated custom when they might email the doctor all the information he requires to evaluate them? What kinds of data are required by health professionals to evaluate the health of their patients? When a patient is not present at the doctor's office, the doctor may still need to evaluate him or her based on physical activity and emotional state in specific circumstances, particularly when it comes to cardiac disorders [1].

2. Wearable Electronics

Fig 1 Creation of a Stretchable, Self-Powered Sensor for Wearable Electronics Over the past few decades, numerous sensors have been investigated and created, including those for robotics, healthcare monitoring, and body motion tracking[2-3]. The majority of reported sensors, however, are built in rigid, not stretchable, forms. In addition, the sensor needs to be powered in order to function. In this study, a stretchy sensor called an ionic polymer-metal composite (IPMC) is presented. To improve the sensor's co formality and sensitivity, a serpentine cut pattern has been carved on it. According to experimental results, the proposed IPMC sensor is two times more sensitive than the standard one. Through a change in output polarity, the suggested sensor can also distinguish between the directions of the applied force. These benefits demonstrate that the suggested IPMC sensor can be applied to the field of monitoring heath.

The development of soft sensors has been accelerated recently by advancements in microelectromechanical systems (MEMS) [4], particularly in the field of healthcare monitoring. Capacitive sensors have been investigated, among others with different transduction principles [5]. piezoresistive and piezoelectric sensing’s [6] are two examples. The variation in the area [10] or the distance [7] between two conducting electrodes is the basis for the capacitive sensing mechanism. On the other hand, piezoresistive sensing relies on changes in the material's resistivity to identify parameter changes [8]. However, to function, these sensing systems need an outside power source. Due to the unfavourable effects of frequent power source switching, this requirement prevents the use of sensors for wearable applications. Investigating piezoelectricity transduction is one approach that could be taken to resolve the aforementioned problem. Due to the

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inherent charge movement, the piezoelectric transduction generates an electrical output voltage at an applied pressure . Piezoelectric transduction, however, is unable to distinguish the direction of the applied force. To accomplish this goal, a sophisticated external circuitry is needed.

Due to its low actuation voltage, softness, and flexibility, ionic polymer-metal composite (IPMC), an electro active polymer, has recently attracted scientific interest. For biomedical applications, it has been widely employed as a soft actuator [9]. However, the non-flexibility attribute of IPMC limits its application as a stretchable sensor. In this study, an IPMC material is suggested for use in a stretchable sensor that is self-powered. By utilising a serpentine cut pattern, the material's mechanical properties are altered. The pattern of the serpentine cut is hypothesised to lower the IPMC structure's Young modulus The proposed sensor should be able to determine the direction of the mechanical movement based on the sensing theory of the IPMC material. Comparing the proposed sensor to a non-serpentine construction, its sensitivity is two times higher. This study demonstrates how well the IPMC material may be used as a self-powered sensor for wearable electronics.

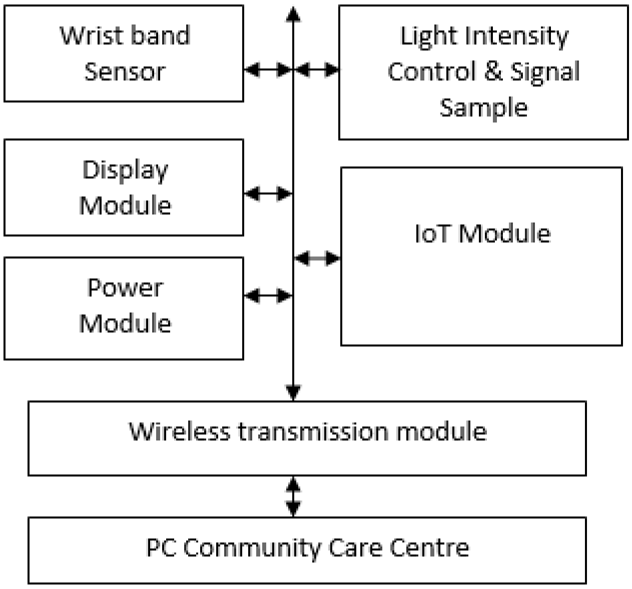

Fig. 1. Wearable Block diagram

3. Sensor

The IPMC material is used in this study to create a self-powered sensor utilising the electroless plating process. The soft self-powered sensor has a serpentine cut pattern carved into it to increase sensitivity. According to experimental data, the voltage produced by a serpentine cut IPMC sensor is two times that of a regular IPMC (non-serpentine cut IPMC) sensor. The rigidity of the traditional IPMC is also greatly diminished at the same time. The advantage of directional recognition is a feature of the proposed self-powered sensor. Two different bending directions can be determined using the IPMC sensor. Due to its benefit, the IPMC sensor can be used in a variety of industries, including robotics and body motion monitoring systems.

4. Health Monitoring

In recent years, health monitoring has gained relevance. It can be characterised as the periodic observation of changes that reveal information about a person's wellness. On-body sensors are shown to be quite helpful when factors like enabling a patient's movement and ease of wear are taken into account [10].Over the past ten years, wearable health monitoring technologies have attracted a lot of interest from both businesses and researchers.

Due to the sharp rise in healthcare costs and the ageing population, it has become necessary to keep track of a patient's health outside of the hospital setting. Wearable or implantable small sensors, power supply, processing units, actuators, and other components make up wearable health monitoring systems. The measurements received from the various biosensors can be sent to a medical facility or directly to a microcontroller board or Personal Digital Assistant (PDA).The biosensors are capable of sensing critical health indicators like blood pressure, body temperature, respiration, and heart rate. Wearable sensors have made it possible for patients with conditions including sleep apnea, heart attacks, Parkinson's, and other conditions to receive treatment at home instead of being hospitalised following an attack.[11]

In-depth research is currently being done to develop smart sensing devices that can detect falls in the homes of elderly persons [12].Falls can result in health concerns that require quick assistance in order to prevent complications. If this assistance is delayed, difficulties including hypothermia, dehydration, extreme pain, and other conditions may worsen.

The choice of network is crucial since it should be economical, allow for the addition of additional nodes, consume less power, offer flexible configuration options, etc. ZigBee (IEEE 802.15.4) and Bluetooth are the body area network standards that are most extensively used (IEEE 802.15.1).Typically, ZigBee is chosen for applications that need low data rates, long battery life, and networking security. ZigBee employs AES with a 128-key algorithm for encryption and other functions. Through the usage of a Personal Area Network (PAN), Bluetooth is frequently utilised to transmit data over short distances for mobile devices. Due of its ability to link numerous devices, Bluetooth can alleviate synchronisation issues.

The movements acceleration force measurement in three-dimensional spaces skin or chest electrodes Electrocardiogram (ECG) (ECG) waveform measurement demonstrating the heart cycle's contraction and relaxation piezoelectric or piezoresistive sensor breathing rate Breathing rate in breaths per minute Phonocardiograph sound of the heart Stethoscope use for heart sound measurement Chronic heart issues are likewise concerning and should be watched in such circumstances. Cardiovascular disorders can be identified using electrocardiogram sensors[13]. The signals collected from ECG sensors provide details about the regularity and pace of heartbeat, which aid in the analysis of cardiovascular illness. The information about a few biosensors and the bio signals they produce .

5. Applications for Wireless Standard Range Data Bandwidth Consumption 100-Meter Range, 1-3 Mbps

2.14 GHz 2.5-100 mw Monitoring, control, and short-range ZigBee 10-100m, 250 Kbps, 868 GHz, 915 GHz, and 2.4 GHz, 30 mw applications with lower power requirements and data rates WiMAX 75 Mbps at 15 kilometres2.3GHz, 2.5GHz, and 3.5 GHz - Offers mobile devices internet access. 5 km/450 Mbps Wi-Fi 2.4 and 2.5 GHz - Data acquisition from PC, internet service IrDA 1 m 115 kbps, 1 Mbps, and more. For wireless health monitoring, ineffectiveMICS25 w, 402-405 MHz, 2 m, 500 kbps Low data rates are often not recommended.

The monitoring systems' essential component, sensors, aid in meeting the aforementioned standards. There are various sensor types available for monitoring human activity. Microelectronics, along with other related technologies, have made significant strides in the realm of micromechanics, enabling the creation of acute sensors that measure data more quickly and effectively while using less power. One of the vital markers used to evaluate a patient's health is body temperature.When there is an infection, inflammation, heart attack, shock, etc., the body temperature can fluctuate.

Thermometers were previously used to measure body temperatures, but they are currently being replaced by temperature sensors and other electrical and electronic techniques that are similar [14].Accelerometers are utilised for human activity monitoring when it is necessary to record .They primarily function in health monitoring to detect falls. There are various types of accelerometers based on piezoelectric capacitance, transconductance, piezoresistive, etc.The heart rate is another crucial physiological indicator. The heat rate varies as a result of ailments, accidents, exercise; etc. Identification of health-related disorders can be aided by heart rate monitoring.

6. Mechanisms

A portable gadget called the "FlexPock" uses two sensors to measure the pulse and respiration using the principles of reflecting photoplythography (rrp) and magnetic induction (MI), respectively.

They have used a heart rate monitor in place of the more conventional multichannel electrocardiograph in the gadget they have proposed [15].Numerous techniques, including photoplethysmography technology, colour changes in the region of interest, variations in the patient. Instead of the more conventional multichannel electrocardiograph, they used a heart rate monitor in the device they presented [16-17].For monitoring heart rate, a variety of techniques are suggested, including photoplethysmography technology, changes in the colour of the patient's face, and variations in the brightness of that patient's skin tone.

An alarming system is provided that can recognise faces in a certain region, collect information on motion speed, and then sound an alarm in the event of a fall .An algorithm that uses the signal produced by the mobile device's accelerometer to detect falls and automatically adjust rescuers. They forced you to use a cell phone with an accelerometer sensor. When the phone is in a pocket, the algorithm they utilise generates misleading alerts .

Utilizing water flow sensors and monitoring water usage behaviours, a health monitoring system for senior citizens has been considered. Household chores including cooking, urinating, and cleaning up after oneself. Since these activities regularise water use, regularity is utilised to assess health .

This study Fig 2 and 3 has analysed a few wearable sensors, appropriate wireless standards, and advancements in health monitoring systems. Research in the flamboyant field of health monitoring is predicted to advance more in the future. The rise of health monitoring devices is being hampered by issues including high gadget costs and power consumption, which need to be taken into consideration more seriously.

A new area that is on the verge of becoming a common technology is sleeping wearable's. Numerous technologies are developing to help individuals day and night, from tracking basic sleep habits to alerting you when you could be having a heart attack. These tools might range from basic, stylish wristbands to complex, pocket-mounted ambulatory medical gadgets that doctors use to track patients' health. No matter how big or little these gadgets are, they must nevertheless conform to a number of safety requirements and go through extensive testing by professionals in their respective industries before they can be put on the market. The best knowledge from several areas is gathered for the creation of such gadgets.

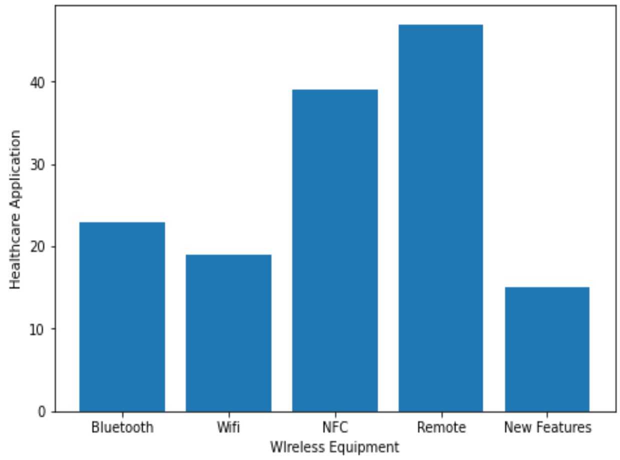

Fig. 2. Wearable Sensor Electronics

Device developers should pay attention to a number of unique ideas from cutting-edge sleep research that have not yet been incorporated into sleep wearables.We anticipate that this chapter will draw more interest to the worlds of wearable technology and sleep, allowing for the expansion of functionality in already-available products.

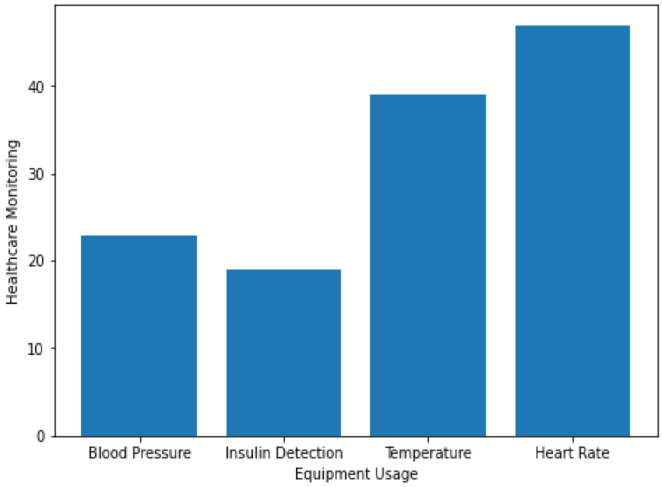

Fig. 3. Wireless Health Monitoring Systems

7. Future Researchers

These sensors are frequently found in wearables like smart watches and smartphones.This chapter focuses on smartphone-based programmes that may identify and monitor a person's activities.We also examine neural network-based approaches to automatically identify workout routines and track repetitions using wearable sensors.The photoplethysmograph (PPG) sensor is an example of a physiological sensor in the section that follows.The PPG functions fundamentally as an optical transceiver that sends out a known-amplitude, known-wavelength electromagnetic signal (usually infrared) and detects the signal that is reflected.

8. Conclusion

Health Monitoring System for Workers in Industries Using Wearable Sensor Network.The safety and health of employees have recently received increased attention from many companies.The healthcare system is undergoing a transition that makes it possible to continuously monitor patients.Innovative solutions utilising cutting-edge technologies are in demand.The suggested system is an IOT-based remedy.By tracking physiological and environmental characteristics, wearable sensor networks can spot unusual and unforeseen events.Different wearable sensors can communicate with one another and send data to a gateway.When environmental and human health factors exceed the acceptable limit, they issue warnings.

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