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Real-Time Analysis of Wearable Sensor Data Using IoT and Machine Learning in Healthcare

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Abstract: Practitioners in the medical field are always on the hunt for new tools that can improve their workflow. There have been several developments in the operating room as a result of the digital age's impact on the clinical environment. The purpose of this study is to reduce the likelihood of burnout while providing better treatment to patients. The LM35 and pulse sensor in the system measure the user's core body temperature, heart rate, and breathing rate. The Arduino UNO controller board communicates with each of these sensors. The WiFi module's data transmissions are tracked by use of AR glasses. Adafruit, an Internet of Things platform, stores sensor data reserved by the ESP8266 WiFi module. In this way, the medical history of the patients may be accessed whenever necessary. When the data from the sensors is too high, an alarm is sent to the surgeon. As a result, the prototype facilitates the doctor's ongoing monitoring of patient data.The use of IoT(Internet of Things) with Machine Learning can help use to solve this issue

***Keywords**: -Patient monitoring system, controller, pulse rate sensor, temperature sensor, AR glasses, IoT*

1. Introduction

There is a growing trend among surgeons to embrace cutting-edge tools that improve their working conditions. Medical augmented reality was primarily motivated by the desire to see health records. By providing instantaneous access to data and patient information, AR technologies may improve physicians' and surgeons' diagnostic, therapeutic, and operative success rates. During manual surgery, it is essential for physicians to assess the patient's vital signs. And this could add another layer of difficulty for doctors to deal with. Therefore, the system must keep an eye on the vitals during the operation. In recent years, wireless technology has enabled higher precision, eliminated the need for manual processes, and provided Real-time access to data. Medical personnel may now keep a closer eye on their patients and make proactive contact with them thanks to the Internet of Things. In the conventional model, medical professionals play a pivotal role in maintaining health. The time needed for registration, appointment, and checkup is substantial. This cutting-edge method improves care for patients while decreasing wait times and the likelihood of mistakes. India's population is growing rapidly. A recent study found that India's population grows by over 15% per decade. Consequently, the number of patients is growing at the same clip. It will put more stress on healthcare providers. The burden on healthcare providers and facilities will lessen if patients can be tracked remotely.Some rural areas of India don't even have access to a single medical professional. When a patient's situation is really dire, they confront a formidable challenge. To address these issues The concept of a smart healthcare system is the focus of this study. IoT is used in the creation of the smart healthcare system.To put it simply, "IOT" refers to internet-enabled devices. The internet of things allows us to monitor and manage any physical asset from any location. Humans have sensors attached to them that collect information.A medical application makes use of the data. The program collects data from the patient's various devices, uploads them to a cloud database, and determines the severity of the patient's illness. If the patient's condition is deemed critical, the information is sent immediately to the physicians. Wireless Body Area Network (WBAN) is the result of recent developments in wireless communication technology. A wireless body area network consists of a collection of sensors put in various locations on or around the human body.

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These sensors may be found in a variety of wearable devices, like as wristbands, chest belts, etc. This cutting-edge hardware represents the future of wearable physiological monitoring. Small input/output devices that can function as a standalone system to capture physiological data from the body and wirelessly communicate it have changed computer communication. The benefit of wearable sensors is that they may be worn for extended periods of time to monitor crucial signals without causing discomfort. Dry electrodes are used to create three distinct wearable sensor types in this work: a) a textile electrode, b) a surface electrode, and c) a needle electrode.

Three sensor nodes and one sink node are used in the design of the wearable system in the proposed study. Electrocardiogram (ECG) and body temperature (thermo) signals are acquired by sensor node-1; electroencephalogram (EEG) signals are acquired by sensor node-2; and galvanic skin response (GSR) and photoplethysmography (PPG) data are acquired by sensor node-3. ZigBee communication is used to move data from the sensor node to the sink node, and the wireless body area network is set up in a star topology.

In this research, researchers use a variety of filtering strategies to rid ECG signals of powerline interference and baseline wandering noise. Various methods, including finite impulse filtering, notch filtering, and discrete wavelet transform, are used, and their relative merits are evaluated. Using a tenth-order Daubechies wavelet and a moving-average filter, a technique is employed to get rid of baseline wandering.

In addition, this research uses and compares a variety of machine learning regression algorithms for non-invasive blood pressure monitoring, including decision tree, ensemble tree method, linear regression, support vector machine, and AdaBoost method. These regression methods use the subject's age, height, weight, and pulse transit time as inputs in addition to other physiological variables. Systolic and diastolic blood pressure are determined using these parameters.

Finally, the electrocardiogram-derived heart rate variability is used to identify the driver tiredness level in this investigation. Methods of analysis include classification techniques from machine learning, such as decision trees, SVMs, KNNs, ensemble classifiers, discriminant analyses, and deep auto encoding. Time and frequency are used as inputs in these classifiers.

Hrv domain parameters. The aforementioned approaches of estimating levels of weariness are compared.

The following outcomes are derived from the aforementioned procedures. Three distinct dry electrodes were used to collect ECG data, and the results were compared to those obtained using a typical gel-based wet electrode. Correlation values ranged from 0.8842 to 0.8113, with the greatest value found for the MedTex 130 textile electrode.

The multiple machine learning methods were used in two phases of analysis for non-invasive blood pressure monitoring. AdaBoost's accuracy in predicting systolic and diastolic blood pressure was greatest throughout both phases. Only HR and PTT measurements were utilized in the first phase. The resulting R2 values for systolic and diastolic blood pressure are 0.8668 and 0.7223, respectively. In the second phase, we employed HR, PRT, and other physiological variables. Systolic blood pressure has an R2 of 0.9453, while diastolic blood pressure has an R2 of 0.9707. This demonstrates the need for physical factors for accurate pressure prediction.

2. Related Works

This related work provides an overview of recent researches made on the AR, Wireless technology, IoT in healthcare.

Virtual items exhibited in AR by Egui Zhu et al.[1] seem to share physical space with the actual world. Medical professionals use augmented reality (AR) because it allows for an interior view of patients without the need for intrusive treatments. It was unclear what kind of learning theory was employed to inform the development of AR for use in healthcare education. In this research, we provide a concrete plan for using augmented reality (AR) during surgical procedures by equipping surgeons with semi-transparent glass equipped with alerts for when certain parameters exceed certain limits. The augmented reality system for vehicles was created by Filip Malwski and colleagues [2].

This study inspired us to create a similar approach to aid medical professionals. Head-mounted displays (HMDs), smart glasses, and smart lenses are just some of the applications for augmented reality technologies. Large-scale financial investments in image-guided and robot-assisted surgical procedures. This motivates significant effort to develop augmented reality (AR) equipment that take into account the surgeon's inherent intuitive skills.

S. P. et al.[3] The suggested solution gives the user access to the item's attributes while also enabling them to control the object through virtual buttons. The system also includes a quiz where the user may evaluate his or her mastery of the three-dimensional ideas and interactive films to help in the learning process.

Reference: Proniewska, K., et al. [4] The system's basic concept is based on the use of holography and wireless technology to allow a doctor to keep tabs on a patient, gather data from the patient, and access that data at any time.

The low-power wide-area network (WAN) was described by Afef Mdhaffar et al.[5] for analyzing medical monitoring data. system of care. The IoT architecture has been laid out for a methodical approach to learning about the IoT. LoRaWAN has a maximum uplink and downlink data rate of 50 kbps.

In GPRS, the downlink speed is just 14% of the uplink speed. These findings provide proof of concept for an Internet of Things–based health monitoring system. Mohammad M. et al.[6] detailed how ECG signals were measured at varying intervals and in a variety of settings. They have taken into account issues with energy awareness, scarce computer resources, and service outages in the network. A mathematical model has been devised to tackle these problems by carrying out each job in turn. There are three potential methods for solving this problem. The first method is mobile-based monitoring; the second is data mining; and the third is machine learning.

The work of Ayush Bansal et al.[7] focuses on the creation of a system that can identify life-threatening cardiac episodes. In order to identify signs that lead to catastrophic cardiac episodes, a sophisticated remote monitoring system is utilized.

Hamid Al-Hamadi and colleagues [8] This study is grounded on a unique trust-based selection protocol that employs trust-based information sharing across health IoT devices to enable the development of a collective body of knowledge for the purpose of rating the surrounding environment at a given point in time and place.

3. Proposed System

We suggest a device that displays vital signs in real time on semi-transparent glass, allowing medical professionals to monitor a victim's condition in the event of an emergency.

This will provide a quantitative evaluation of the patient's vital physiological characteristics at crucial times. In this study, we propose a system in which sensors worn by patients continuously monitor their vital signs and send that information to a doctor's augmented reality glasses through wireless technology, who then receives an audible alarm if anything out of the ordinary happens.

The crucial data acquired by the Medical IoT devices utilized here is updated every 60 seconds and sent to doctors for Real-time monitoring. The suggested system's goals are to encourage positive interactions between patients and their caretakers and to boost patients' spirits. The system's overarching goal is to provide patients with high-quality treatment and alleviate their emergency circumstances via constant monitoring of their vital signs.

The temperature sensor, heart rate sensor, respiration sensor, Arduino UNO, WiFi module chip, LCD display, IoT and AR wearable glass, and buzzer are all required to carry out the aforementioned method. The Arduino board receives electricity from an external source.

Several features of the project, such as reading sensor data, are implemented by the Arduino code running on the device.

information, changing it into strings, and sending it on to the Internet of Things platform. After that, an Embedded C software is written to communicate with the heart rate sensor, respiration sensor, and temperature sensor through an Arduino UNO controller board.

The variations in blood volume in the finger over time can be detected by a heart beat sensor, allowing researchers to learn more about how the heart works. The LM35 integrated circuit is a precise temperature sensor whose output is directly proportional to the inside body temperature.

Around the zero point of respiratory flow, a respiratory sensor detects minute flow rate. These sensors measure the patient's vitals and send the data to an Arduino-connected LCD. Then, the Wireless transmitter and permissions send all sensor values to the IoT that is used to store patient data. The sensor readings of victims in their most vulnerable states are recorded by the IoT gateway, allowing for estimation of their conditions at certain times.

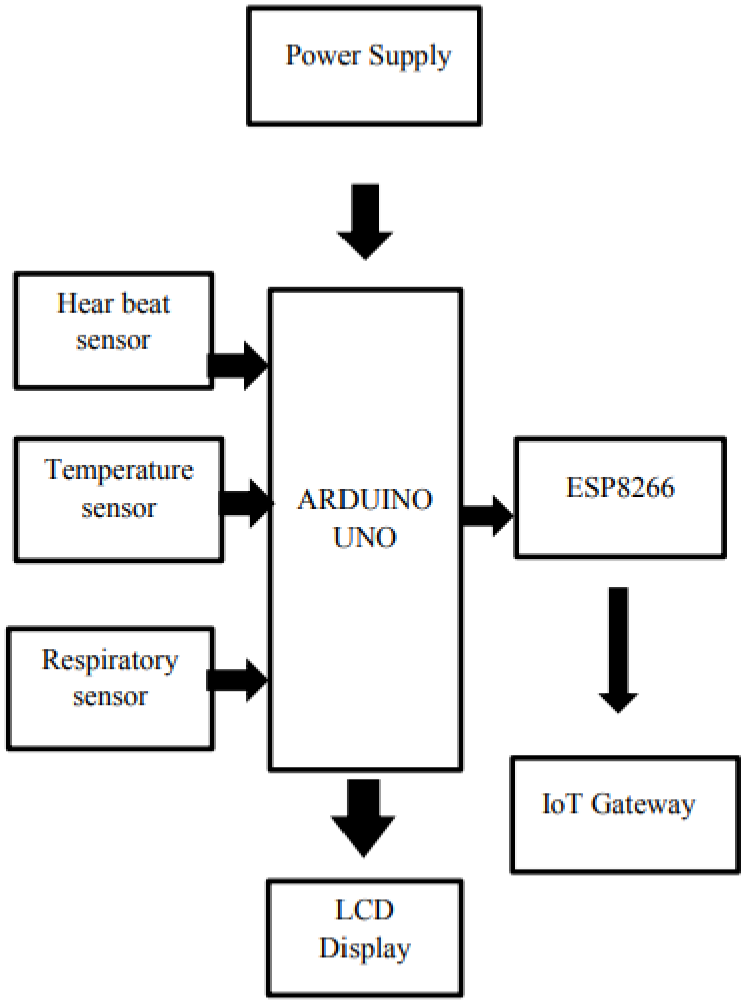

Fig 1 Overall system Configuration

4. Machine Learning Concept

Machine Learning: Machine learning is a subset of Artificial Intelligence (AI) which provides the machine to learn automatically from experience without being explicitly programed. Classification of Machine Learning:

i.Supervised Learning

ii.Unsupervised Learning

iii.Semi Supervised Learning

iv.Re-Inforcement

In supervised learning, computers study labeled data to improve their performance. What we mean here is instruction-based learning. Machines in this learning scenario acquire knowledge from input-output tagged data. In this kind of training, the machine is taught by observing its own inputs and outputs. In supervised learning, a computer is taught to predict the correct response to a given input. Learning Types that Benefit from Supervision: Discrimination and Prediction In supervised learning, classification is used to divide input data into their respective classes. When the value of the supervised learning output variable is a real or continuous value, the resulting issue is known as a regression. Linear regression is a basic method of analyzing data for patterns. The machine learning methodology is implemented in this project's system. The system employs a supervised learning methodology. In order for the system to function, it will need input from the sensors. Supervised learning will be used to teach the system how to produce the required output in response to a given input value. Supervised learning techniques are utilized for both classification and regression.

LOGISTIC REGRESSION ALGORITHM: A decision tree is a machine learning approach that uses a tree structure to make decisions. It may be used for both forecasting and sorting. In a tree-like structure, it instructs the machine on how to produce the desired result given a given input. As a supervised learning approach, decision trees may be used for both classification and regression. Each node in a decision tree represents an attribute test, each branch an attribute test result, and each leaf node a class. The decision tree approach is being employed in this project. Like a tree, it specifies at each node what the expected result of a given input is. Our blood sugar, pressure, and temperature are all tracked by the sensors. This decision tree instructs the system as to what to do based on the input it receives.

PROPOSED WORK ON THIS PROJECT ON MACHINE LEARNING

The doctor has determined a normal rate of heartbeat, blood sugar, blood pressure, and body temperature. X = Pulse normal range Y = a healthy blood sugar level Z=Normal blood pressure levels The pulse values are compared to if=x and if!=x in the decision tree. If your pulse is not equal to x, the system will prompt you to enter further symptoms. The patient's symptoms, together with their pulse, blood pressure, and blood sugar levels, are sent to the closest hospital. and a reminder was given to the patient to perform an electrocardiogram. Sensors for glucose and blood pressure use the same basic principle. The temperature threshold at which the decision tree stops processing data is the upper and lower limits of the usual temperature range. The decision tree will identify a fever if the measured temperature is higher than the threshold set by the medical professionals (98.4 degrees Fahrenheit).as shown in figure 2

Doctor detects a normal pulse, denoted by X

Y=Normal Doctor finds high blood sugar

Z=Normal Doctor detects blood pressure

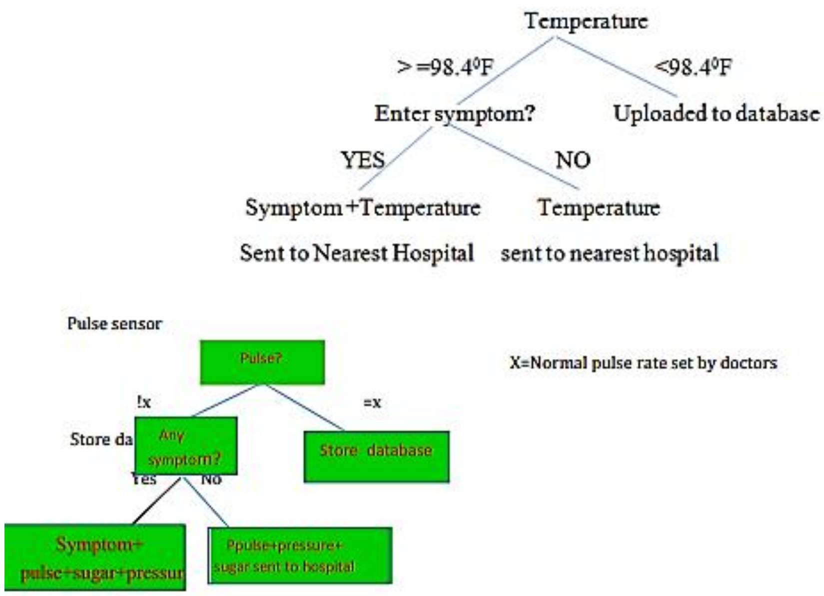

Fig 2. Shows the Decision tree Model

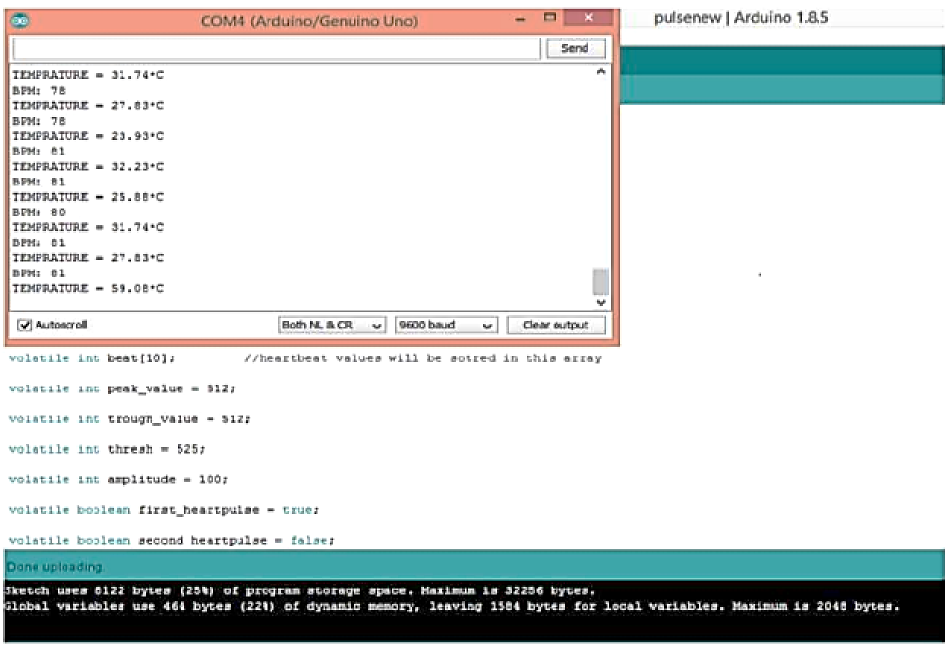

Fig 3. Simulation Results using Arduino IDE Enviornment

5. Conclusion

The rising prevalence of chronic illnesses among the elderly is a major cause for concern owing to the inadequacy of available resources and the prohibitive expense of treating these conditions. Timely

early detection and treatment may significantly lessen danger. Augmented reality has the potential to save lives and reduce medical mistakes by displaying imaging data and patient information. The Internet of Things (IoT) is being used in healthcare to assess risks and make health data more easily available. This article describes the remote monitoring system technology that allows for patient monitoring outside of clinical settings, hence expanding people's access to medical attention. The study show that using Wearable devices and Machine learning technique may help both patients and surgeons make more informed decisions about their health.

References

[1] Egui Zhu1, Italo Masiello, Arash Hadadgar, Nabil Zaru 2014 on the title "Augmented Reality in healthcare education:an integrative review" Department of Learning, Informatics, Management and Ethics (LIME) DOI:10.7717/peerj.469; Source: PubMed

[2] Filip Malawski, 2018 AGH University, "Driver Assistance System Using Augmented Reality Headset," IEEE Transactions on Electronics and Telecommunications, vol. 3, pp. 978-1-5386,

[3] Siddhant Patil,Chiquitha Prabhu, Omka rNeogi, AbhijitR. Joshi, Neha Katre 2016," E-learning system using Augmented Reality", IEEE.DOI:10.1109/ICCUBEA.2016.7860038

[4] Proniewska. K, Dołe¸ga-Dołe¸gowsk.D, and D. Dudek, 2018 ''A holographic doctors' assistant on the example of a wireless heart rate monitor,'' Bio-Algorithms MedSyst., vol. 14, no. 2, pp. 1–5.

[5] Afef Mdhaffar, Tarak Chaari , Kaouthar Larbi, Mohamed Jmaiel and Bernd Freisleben 2019 "IoT-based Health Monitoring via LoRaWAN", IEEE EUROCON.Vol 8,Issue 12

[6] Mohammad M. Masud, Mohamed Adel Serhani, and Alramzana Nujum Navaz 2015 "Resource-Aware Mobile Based Health Monitoring", 2168-2194 (c) IEEE.vol 2, Issue 2

[7] Ayush Bansal , Sunil Kumar, Anurag Bajpai, Vijay N.Tiwari, Mithun Nayak, Shankar Venkatesan, Rangavittal Narayanan,2016 "Remote health monitoring system for detecting cardiac disorders", IET Syst. Biol., Vol. 9, Issue 6, pp. 309–314.

[8] Hamid Al-Hamadi and Ing-Ray Chen, 2017 "TrustBased Decision Making for Health IoT Systems" DOI 10.1109 /JIOT.2018.2736446, IEEE Internet of Things Journal. Vol.4, Issue 5, pp (99):1-1

[9] Salman Al-Nuaimi, M. A. ., & Abdu Ibrahim, A. . (2023). Analyzing and Detecting the De-Authentication Attack by Creating an Automated Scanner using Scapy. International Journal on Recent and Innovation Trends in Computing and Communication, 11(2), 131–137. https://doi.org/10.17762/ijritcc.v11i2.6137

[10] S.Meivel, S.Charanyameenachi, D.supritha, S.G.Hamsaveni,2019 on title" E-Health Real-Time Monitoring System using IoT Sensor (ESKIN) Methodology International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Vol-8, Issue-3S,

[11] Bhagya Lakshmi, M1 Hariharan ,R2 Udaya Sri, C3 Nandhini Devi, P4 Sowmiya "Heart Beat Detector using Infrared Pulse Sensor" IJSRD - International Journal for Scientific Research & Development| Vol. 3, Issue 09.

[12] Dr.A.Sabanayagam, G.Anish Girija, 2017" DESIGN AND MODELING OF MOBILE HEALTH MONITORING SYSTEM", International Journal of Innovations in Scientific and Engineering Research (IJISER),vol.4,no 2,pp.63-65.

[13] Pallathadka, D. H. . (2021). Mining Restaurant Data to Assess Contributions and Margins Data . International Journal of New Practices in Management and Engineering, 10(03), 06–11. https://doi.org/10.17762/ijnpme.v10i03.128

[14] M. Prakash, U. Gowshika, T. Ravichandran, 2016 "A Smart Device Integrated with an Android for Alerting a Person's Health Condition: Internet of Things" Indian Journal of Science and Technology, Vol. 9 (6). [13]] S. Wang et al 2017., ''Augmented reality as a telemedicine platform for remote procedural training,'' Sensors, vol. 17, no. 10, p. 2294.