ENHANCING HEALTH AND WELLNESS MONITORING: CLOUD-BASED REAL-TIME HUMAN ACTIVITY TRACKING SYSTEM USING WEARABLE SENSORS

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I. ABSTRACT

The design and development of wearable sensor systems for health monitoring have garnered substantial attention and interest in recent years, both within the scientific community and the industry. These systems hold the potential to revolutionize the future of healthcare by enabling proactive personal health management and widespread monitoring of patients' health conditions. The driving force behind the development of these systems is the increasing healthcare costs and the need for more efficient healthcare solutions. Our project involves the creation of a wearable device equipped with an accelerometer, temperature sensor, pulse sensor, and Wi-Fi module. This device enables the collection of human movement data, which is then transmitted to the cloud for further analysis. Additionally, we incorporate a GPS module to track the individual's location and utilize a GSM module to receive location information via SMS. This proposed system proves invaluable in monitoring human movement patterns and has the potential to aid in the identification of different health-related factors.

Keywords: Wearable Sensor, Accelerometer Sensor, GSM module, GPS module, Cloud.

II. INTRODUCTION

In recent times, the utilization of wearable sensors in healthcare research and applications has witnessed a significant increase. These sensors, now available in smaller and more affordable forms, have found application in various areas such as tracking, human-computer interaction, rehabilitation, and monitoring geriatric patients to enable ambient living. Leveraging the Internet of Things (IoT) technology, wearable sensors offer substantial advancements without compromising personal safety. While consumer-grade wearable trackers have gained media attention for monitoring calories, weight, and daily activity, it is crucial to understand the distinction between medical-grade tracking information and information that is merely sufficient. A promising development in this field is the introduction of IoT-enabled wellness applications such as the health app, which can collect health data and integrate it with other health-related applications through tools like the health development kit.

These advancements in health sensing technology provide valuable resources for application developers, enabling them to leverage data from connected and wireless tools and sensors. The users of such applications can securely share this information with healthcare professionals, physicians, clinics, and family members, thanks to encrypted health record storage in the cloud.

The convergence of advancements in communication technology, microelectronics, sensor production, and data analytics has opened up new possibilities for leveraging wearable technology and digital health platforms to achieve various healthcare outcomes. Previously, the size constraints of sensors made it challenging to incorporate electronics and sensors into portable wearable devices. However, certain critical situations may still require the use of a wireless medical system to promptly alert individuals about life-threatening conditions, necessitating a higher level of assurance. Two significant trends, namely the aging population and the increase in obesity rates, pose risks of various disorders that may require costly medical care, leading to higher healthcare expenditures. Governments worldwide are recognizing this challenge and exploring more efficient approaches to healthcare delivery, including telemedicine and personal health networks.

Wearable sensors are widely used in systems designed to track and identify human activities. Various forms of sensors are available, each accompanied by constantly evolving software. They possess the capability to detect a wide range of human activities, including both simple and complex motions. Simple actions encompass basic movements, while complex actions involve daily activities such as reading, using a computer, or engaging in sports. While simple human action recognition has received significant attention, complex human action recognition has been relatively less explored. Motion sensors, integrated into wearable devices like bracelets, clothing, or smartphones, are strategically placed on different parts of the body to track and identify human activities. Common locations for sensor placement include the wrist, lower back, and waist. The accuracy of gesture recognition improves when the sensors are positioned closer to the body's center of mass, enabling a more precise representation of the movements.

III. LITERATURE SURVEY

In March 2018, I. Khokhlov, L. Reznik, J. Cappos, and R. Bhaskar [1] published a study focusing on the design of wearable activity detection systems. Their research aimed to explore the various aspects related to sensor selection, the physical placement of sensors on the human body, the types of activities monitored, and the devices used. The primary goal of the study was to assess the accuracy of human activity detection achieved through wearable sensors.

The implementation of a system for recognizing body activity in motion by K. Kunze and P. Lukowicz [2] involved addressing the issue of sensor displacement which is published in 2008. In this, they took only certain parts of the body (like the lower arm) and recognized the different motions of that body part. It generally helps in recognizing the different activities of humans.

M. Al-Khafajiy, T. Baker, C. Chalmers, M. Asim, H. Kolivand, M. Fahim, et al. [3], proposed Remote health monitoring of the elderly through wearable sensors which was published in the year 2019. The main emphasis of this is the capacity to monitor a person's physiological data over time to identify particular illnesses that can help with early intervention practices. By effectively processing and analyzing the collected sensory data, the system identifies any signs of illness and promptly communicates them to the appropriate caregiver.

V. Vippalapalli and S. Ananthula[4], describe a system for smart health care based on the Internet of Things (IoT). It was published in 2016. It is feasible to collect, record, and analyze data thanks to the devices' seamless information gathering, sharing, and storing. As a result, users can benefit from high-quality services as the system aids medical staff by collecting real-time data, eliminating the need for manual data collection, and facilitating efficient monitoring of a large number of patients.

Y. J. Fan, Y. H. Yin, L. Da Xu, Y. Zeng, and F. Wu[5], proposed a IoT-based smart rehabilitation system. This article introduces an automation design methodology (ADM) based on ontologies for IoT smart rehabilitation systems. Ontology helps computers better grasp the symptoms and medical resources, which makes it easier to swiftly and automatically develop a rehabilitation strategy and reorganize medical resources to meet patients' unique needs. Additionally, the Internet of Things (IoT) offers a powerful platform for connecting all the resources and enabling real-time information exchange. It was published in 2014.

In their work, D. Naranjo-Hernández, L. M. Roa, J. Reina-Tosina, and M. A. Estudillo-Valderrama[6] developed a smart sensor known as SoM (Sensor-on-Module) that serves the purpose of monitoring human activity and assisting in promoting healthy aging which was published in 2012. To encourage seniors to have healthy lives to help them age actively, independently, and healthily and help discover psychomotor irregularities early. In this study, they introduced a cost-effective, wearable, and non-invasive intelligent accelerometer sensor designed and implemented for the purpose of monitoring human physical activity

In 2019, S. T. U. Shah, F. Badshah, F. Dad, N. Amin, and M. A. Jan [7] introduced a smart respiratory monitoring system for asthma patients, utilizing Cloud-assisted Internet of Things (IoT) technology. The proposed solution aimed to provide specialized asthma management by capturing respiratory rates through advanced sensors and securely transmitting the data to the cloud. The collected patient data could then be analyzed by healthcare professionals to determine the appropriate medication and administer it accordingly.

Published in 2020, M. M. Islam, A. Rahaman, and M. R. Islam [8] presented a smart healthcare system designed for the Internet of Things (IoT). The system enables real-time tracking of a patient's vital signs and the environmental conditions of their room. To achieve this, the system employs five sensors: a heartbeat sensor, body temperature sensor, room temperature sensor, CO sensor, and CO2 sensor. These sensors work together to collect data regarding the patient's health and the hospital environment, offering valuable insights for healthcare professionals.

IV. PROPOSED SYSTEM

The proposed system utilizes a diverse range of sensors to monitor various aspects of an individual's well-being, including position, movements, temperature, and heart rate. The sensors extract human parameters and store them in a cloud platform for further analysis by a computer subsystem. By integrating the Global System for Mobile Communications (GSM) and Internet of Things (IoT) subsystems, the measured values are swiftly communicated to both the caregiver and physician for immediate notification. In the event of any changes in the sensor-extracted parameters, the person's location is immediately traced using Global Positioning System (GPS), and the caregiver is alerted.

The primary objective of this project is to assist in alerting caregivers when an individual experiences a sudden fall. Additionally, this system enables real-time data acquisition and monitoring of day-to-day activities for individuals undergoing rehabilitation. Its implementation helps prevent potentially hazardous accidents for individuals who require assistance, such as the elderly or mentally challenged individuals under someone's care. In the realm of embedded systems and IoT, the connection lies in the utilization of sensors that operate through electronic data signals. These sensors, detectors, monitors, and microcontrollers are interconnected to ensure synchronization. The sensors and detectors capture analog signals, which are subsequently converted into digital form. The microcontroller facilitates internal analog-to-digital conversion to ensure the data is obtained in a suitable digital format. Following data conversion, storage is carried out before transmitting the data to a server or cloud platform.

Using local Wi-Fi, the sensed parameters are received and stored in the cloud platform for the doctors to further diagnostics in improving the health of the human.

In the event of a fall or sudden changes in temperature or pulse, the location of the individual is immediately transmitted to the caregiver via SMS.

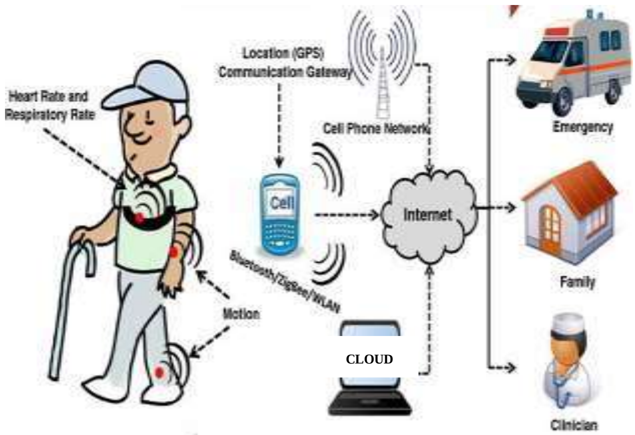

Fig: Cloud Based human Health monitoring system

The whole workflow consumes of three important steps: Data Capturing, Data Storing, and Data Displaying. The most crucial stage is data capturing because it is exclusively responsible for measuring the parameters through sensors. In the second step, the captured data is stored in the cloud platform through the Wi-Fi module which is used for further diagnostics. In the end, however, all the captured parameters are shown on the display to check at every moment.

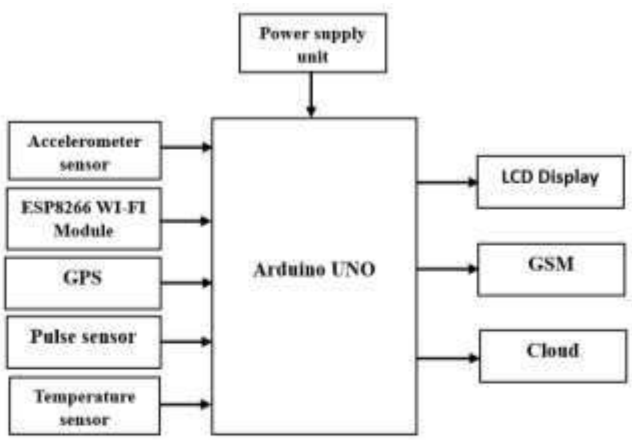

Fig: Block Diagram of Wearable sensor

The proposed wearable system incorporates various sensors, including an Accelerometer sensor, Pulse sensor, Temperature sensor, and the Arduino UNO microcontroller. To enable location tracking, a Global Positioning System (GPS) module is utilized, while a Wi-Fi module is employed for storing the sensed data in a cloud platform. The choice of Arduino UNO as the microcontroller is primarily due to its three analog inputs, which interface with the Accelerometer sensor. The IoT system plays a crucial role in notifying doctors or physicians about any deviations in the patient's health based on predefined standard values.

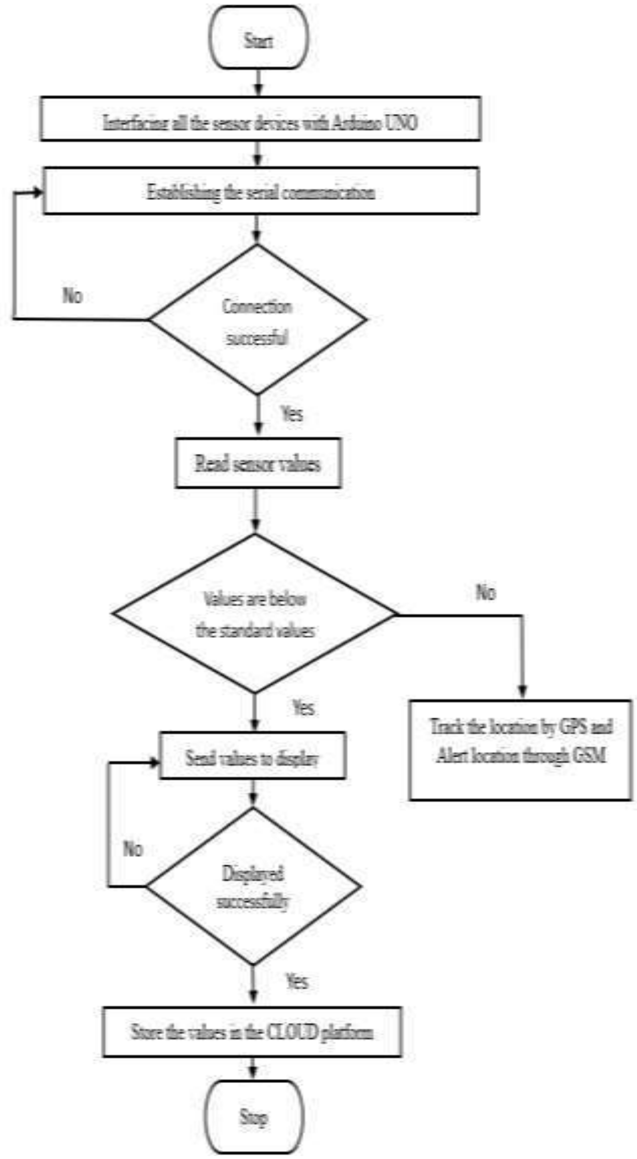

Fig: Flow Chart of the Wearable System

The project initiates with the activation of power to the wearable device, triggering the functionality of the sensor devices. The microcontroller establishes communication with all the sensor components. Once a successful connection is established, the sensors start sensing and capturing values. The sensed values are displayed on the device's screen if they fall below the standard range. Conversely, if the sensed values exceed the standard range, the system tracks the individual's location and sends an SMS alert to the caregiver's mobile phone. Furthermore, if the values are displayed on the device's screen, they are also stored in the cloud platform. This allows the doctor to analyze the data for further diagnostic purposes. By monitoring health in this manner, the system helps prevent dangerous or sudden accidents for elderly and disabled individuals. It aids in promptly detecting falls by providing information on the impact direction, whether it was frontal, rear, left, or right. This crucial information is also communicated through alerting messages to the caregiver.

V. RESULTS

The system stores the data in the cloud, updating it every 15 seconds. Whenever there is a change in the parameters sensed by the sensors, an alert message is promptly sent.

Fig: Data stored in the cloud

We get the accelerated data in the x, y, and z format i.e., three-direction format. This helps in motion movement. The data stored in the cloud can be accessed by the doctor to monitor the actions of the patient for further diagnostics and further medication of the patient. We can also view the data in the graph way in the cloud platform.

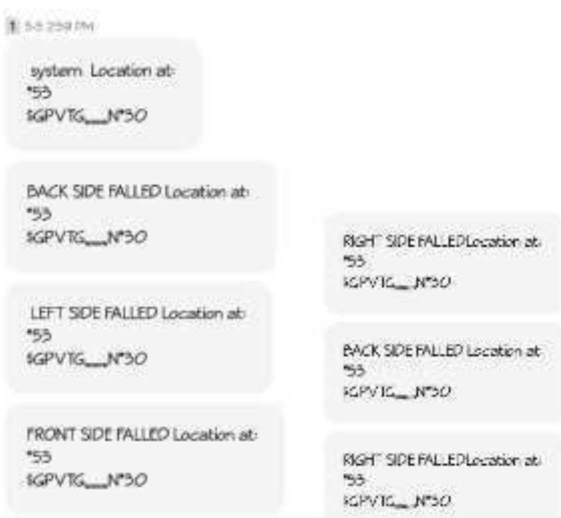

Fig: Message alerts along with the location

The alert message has the location details which consist of the longitude and latitude values of the place. This helps in direct locating of the human at the time of the abnormal changes in the parameter values of the sensed values.

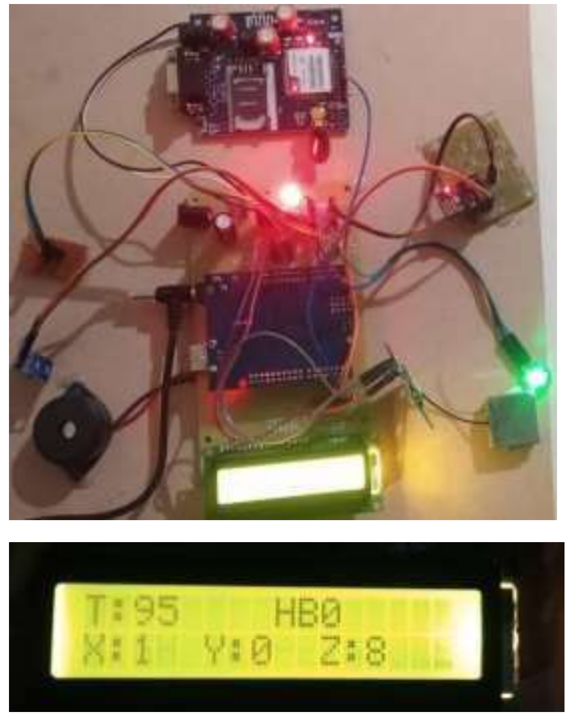

Fig: Hardware Wearable System

The hardware representation of the wearable system has different sensors interfacing with the microcontroller. It consists of a temperature sensor, pulse sensor, accelerometer sensor, GPS module, GSM module, and buzzer. Correct interfacing helps in sensing the values and the figure shown is taken under working conditions. If there is any change in the values then the message alert along with the changed value of the sensed data.

VI. CONCLUSION

The proposed wearable system, integrated with a cloud-based platform, enables monitoring of human activities, as well as sensing temperature and pulse. An accelerometer sensor is utilized to track various activities, providing output in a three-directional format. This system proves particularly beneficial in monitoring and caring for elderly or disabled individuals, eliminating the need for a third-party caregiver. Moreover, during emergencies or epidemics, this technology can provide valuable assistance to nurses and medical professionals by swiftly analyzing raw medical data. The prototype of this system has been designed to be user-friendly and straightforward. Its application holds significant potential in the treatment of infectious diseases such as the coronavirus, thereby enhancing the existing healthcare system, and potentially saving many lives. Although the current system may appear relatively large, advancements in manufacturing capabilities will soon lead to its reduction in size, resulting in a more compact device. To facilitate face-to-face consultations between patients and doctors, the introduction of a video component can be considered.

VII. FUTURE SCOPE

Potential applications of this project are extensive in the future, leveraging the combination of sensing devices and IoT to enhance various uses. Further research can expand the scope to incorporate additional metrics crucial for assessing a patient's condition, such as diabetes levels and respiratory monitoring. It is important to note that the current system relies on continuous network connectivity. Therefore, there is room for future innovation to develop an alternative method that can serve as a failsafe in the event of network connectivity loss. This would ensure that the wearable device can still take necessary actions, such as alerting mediators and emergency contacts, and notifying nearby individuals through audible alerts, until network connectivity is restored. The development of such an alternative method on the client device would provide added reliability and resilience in detecting falls and responding appropriately.

VIII. REFERENCES

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