International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 08 | Aug 2022 www.irjet.net p-ISSN: 2395-0072

A Review of Physiological Parameters Monitoring Systems

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Abstract –*. Unexpected deaths among humans are an issue that arises from delayed medical attention. Therefore, it is essential to create a system of assessing physical health. Blood pressure, body temperature, pulse rate, respiratory rate, blood oxygen saturation, and numerous electrophysiological signals are human physiological characteristics that indicate how the human body functions and are therefore helpful as benchmarks in assessing a person's health. Wearable devices, contact-free devices, and contact-less devices have all been developed by researchers to monitor physiological indicators. This study reviews the various currently existing physiological parameter monitoring systems, their technologies, the sensors used and their performance, etc.*

Key Words*: *Global System for Mobile Communications (GSM), Electrocardiogram (ECG), Adaptive neural fuzzy inference system (ANFIS), Near-Infrared (NIR) transmitter, General Packet Radio Service (GPRS), SPO2 – Blood Oxygen Saturation, Physiological parameters, Virtual Instrumentation, Sensors

1. INTRODUCTION

Today's health care is mostly a product of technology. It may be beneficial for patients or elderly people who receive home care to have their health condition monitored in order to reduce expenses and provide increased comfort. As a result, alternative monitoring equipment with compact size, low power consumption, and environmental adaptability is needed. A physiological monitoring system evaluates certain facets of human functioning, and either takes appropriate action or notifies the user to act. Temperature, heart rate, breathing, attentiveness, and activity may all be measured and recorded using these physiologic sensors or instruments [1]. In the wearable biological parameter monitoring system sensors fitted into the wearer's cloth transfer information about the wearer's physiological signals wirelessly to a distant control station [2]. Sometimes it is difficult to utilize these contact-based devices[3].

This article examines different physiological parameter assessing systems. In Chapter 2, the different methods of identification are discussed. The comparison of the various approaches is shown in Chapter 3. The study's conclusion is presented in Chapter 4.

2. LITERATURE REVIEW

A cost-effective system that would be able to track physiological indicators, such as body temperature and heart rate has been implemented in [4]. In the system, the user wears a wrist strap and finger glove which are mounted with sensors. LM35, a customized sensor, was used to measure the temperature, and heart rate, and ADXL3 11 accelerometer were used to detect falls of the patient. The three sensor circuits produce analog voltages that are supplied to a Nordic nREF24E 1 microcontroller's ADC inputs. Three distinct components made up the hardware design. The impact sensor, temperature sensor, and connectors for the NIR transmitter and sensor were built into a sensor card. All the analog processing circuitry required for the sensors, particularly for processing the heart rate information, was developed on a separate analog board. The sensors' entire analog processing circuits, including that needed to handle heart rate data, were mounted on a distinct analog board. The microcontroller was placed on a different card with the antenna link. The receiving unit comprises an antenna, a 5V AC adaptor, a serial interface port, and a nR EF24E1 microcontroller that continuously gets updates on a patient's health status.

In [5], a wireless T-shirt-based system for monitoring biological indicators has been presented. All sensors employed in this system for measuring ECG, breathing rate, heart rate, and fall rate possess noncontact features. The acceleration signals acquired by the accelerometer give vital info about the user's actions, including moving, running, and sleeping. The specific processing circuits transform the sensor signals to levels suitable for digitization. The Bluetooth 2.4 GHz module links the control module and the T-shirt module by sending this data to a computer or mobile device. The data collecting unit's actions are controlled and coordinated by a microcontroller. At the distant monitoring center, the data is analyzed, and automatic alarms are set up or forwarded to the Internet for remote assistance.

Physiological indicators such as blood sugar level, oxygen level, sugar level, body temperature, and EEG signal are measured via a patient monitoring system that has been proposed in [6]. The system continuously tracks these physical characteristics and compares them to a predefined value. The five parameters that need to be monitored are detected by the appropriate sensor, and information is sent to the ARM processor. If they exceeded a certain threshold,

send an SMS warning and alert the doctor. Zigbee wireless is used to transfer processed information from different sensors and the data is subsequently forwarded to the PC. When the detected parameter's value crosses the permitted range, a notification is sent via GSM modem to the doctor's cell phone. The GSM network subsystem's authentication center provides user privacy and locates the subscriber's place. The data transmitted are temporarily stored on an AT89S52 microcontroller.

Temperature, SpO2, and ECG are monitored based LabVIEW in [7]. The most effective software available today for building test, evaluation, and control systems is called LabVIEW.LM35 and Thermistor have been used to sense temperature values. The concentration of oxygen in our blood is measured with a pulse oximeter. The bioelectric currents measured by several electrodes, referred to as leads, are sampled to create ECG data. The wavelet transform reduces relevant ECG signal noise. The significant ECG signal distortion is reduced via the wavelet transform. To obtain the SpO2 level, a transmitter unit made of two LEDs and a receiver unit made of Photodiode has been used. The quantity of oxygenated hemoglobin is calculated by the processor by calculating the optical absorption of the two wavelengths. Passcode-based security measures made it difficult for anybody without the required access to see or alter the LabVIEW scripts and GUI settings. The doctor, who is situated in a distant location, may access all of this information by using a variety of online publishing tools in LabVIEW. (2014)

A non-contact method of measuring human breathing rates using Passive infrared thermography has been developed in [8]. Utilizing an infrared camera, infrared thermography creates a thermogram of a subject with a temperature above absolute zero by detecting its thermal radiations. This is a contactless technique. By using this method, temperature changes across the nostrils while breathing are observed.

In [9], a movable monitoring system based on the MSP430 microcontroller was presented. ECG, Sp02 heart rate and body temperature are monitored in this system. When the important biological indicator is abnormal, the device immediately sounds an alarm. The entire system is developed in micro power design or with minimal power usage. The major control component of the system is the l6-bit, low-power MSP430F4616 microcontroller chip. The monitoring physiological data is stored in A T25DF641 chip. OLED12864 LCD module shows the value of a biological indicator. Here, the biological data can be gathered in one of two ways: directly via data acquisition modules or via various types of sensors. Then, these data are processed and enhanced. Using a WLAN, GPRS, or 4G module, one kind of information is delivered to the physician's cell phone or remote medical monitoring station. The other information is transmitted to the central hub of the wireless monitoring network using Zigbee or Bluetooth. (2016)

By combining the Internet of Things and adaptive neural intelligence, the proposed system in [10] aims to create wearable wireless body sensor devices. Three sensor nodes are used to collect physiological data including body temperature, pulse rate, and fall detection. The rate of heartbeats is measured using a pulse sensor, temperature by LM35, and motion by accelerometer ADXL335. These sensors capture and send the patient's important measures over Wi-Fi to the ThingSpeak IoT platform. ThingSpeak delivers live data through Wi-Fi. Any gadget can be used to examine the continually detected data. The ANFIS system receives sensor data from the Central HUB. The acquired raw data is converted using fuzzy logic into linguistic variables that are trained in the ANFIS to determine the patient's state. The Central HUB provides sensor data to the ANFIS system. To identify the patient's condition, the obtained data is transformed using fuzzy logic into linguistic variables that are trained in the ANFIS. An ANN determines the priority of a patient's health state based on their condition to determine which patients are critical and require intensive care.In order to determine which patients, need intensive treatment, an ANN prioritizes a patient's health state based on their condition.

Six physiological measures, including body temperature, respiratory rate, blood oxygen saturation, pulse, blood pressure, and ECG are monitored in a system developed in [11]. The remote monitoring center keeps track of pertinent information and, if required, uses the GSM network to provide diagnostic advice. Shenzhen Midland Electronic Technology Co., Ltd.'s YSI-400 thermistor is utilized to precisely monitor body temperature. For measuring pulses, a novel polymer-based piezoelectric sensor SC0073 based on PVDF (Polyvinylidene Fluoride) was employed. Human respiration signals are identified using a discrete Fourier transform method. Mobile communication technology is sued for data transmission. The remote monitoring device uses a microprocessor, the S3C44B0X. The monitoring center receives data via a different mobile communication modem based on the TC35i standard, and the serial communication interface is made up of RS 232-C. The global mobile communication system network provides the diagnostic advice as necessary to the user.

4. COMPARISON

The comparison of various physiological parameter monitoring systems is shown in Table 1.

Table 1: Comparison of various physiological parameter monitoring systems

No	Name	Physiological Parameters	Sensor Position	Techniques/Technologies used	Communication network/protocol / technology
1	Design of a Low-cost Physiological Parameter Measurement and Monitoring Device [3]	Temperature, Heart rate, Fall detection	In wrist strap	Radio Frequency (RF) wireless technology.	Radio Frequency (RF) wireless technology.
2	Multi-parameters wireless shirt for physiological monitoring [4]	ECG, Heart rate, Respiratory rate, Acceleration and position	In T-Shirt	LabView	Wireless Module 2.4 GHz
3	Wireless Biomedical Parameter Monitoring System Using Arm Microcontroller: A Review. [5]	Body temperature, Heartbeat, ECG, Blood sugar, and oxygen level	In the Wrist strap and a finger ring circuit around the wrist, finger, and the ARM unit	Wireless Networking Technology	Zigbee, GSM
4	LabVIEW-Based Physiological Parameters Monitoring System for Patient Healthcare [6]	Temperature, SpO2, and ECG	Biopac MR150 instrument Pulse Oximeter	LabView, Wavelet Transform, LabVIEW, Virtual Instrumentation	TCP/IP
5	Infrared Thermography-based Human Physiological Parameter Monitoring [7]	Breathing rate		Passive Infrared thermography	Wired Communication
6	Portable Monitoring Instrument of Physiological Parameter Based on MSP430 Microcontroller [8]	ECG, Sp02 heart rate and body temperature	DAQ module	Micropower Design Zigbee	Zigbee
7	A Real Time Healthcare Monitoring System Based on Open Source IoT and ANFIS [9]	Body temperature, pulse rate, and fall detection	The wearable body sensor module	Adaptive Neural Fuzzy Inference System IOT	IOT Wifi TCP/IP
8	Health Monitoring of Human Multiple Physiological Parameters Based on Wireless Remote Medical System [10]	Body temperature, respiration, SpO, pulse, blood pressure, and ECG	OEM Module	Discrete Fourier transform algorithm GSM	GSM Bluetooth

5. CONCLUSION

Modern technology has made life more comfortable. The health metrics of a patient cannot be measured manually every time. Currently, multiple technologies are employed to monitor the biological parameters of the patients in order to maintain their health. Clinical staffs can be alerted of changes in a patient's medical status through physiological monitoring devices that continuously assess crucial physiologic parameters. Sensors, a control unit, and a data transmission unit are some of the common parts of these systems. The sensors are either wearable or non-wearable. In this paper, multiple physiological parameters monitoring systems and how they operate are reviewed. In most of the systems reviewed, heart rate, respiratory rate and temperature are the most monitored physiological parameters.

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