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A STUDY ON MODERN TECHNIQUES (ICT) IN NON INVASIVE HEALTH MONITORING

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Abstract

The need for health monitoring has significantly increased by a huge number around the world with the increasing number of health problems and diseases. Over the past few decades, life expectancy has been on the rise in most countries, thanks to advancements in medicine, public health initiatives, and improved personal and environmental hygiene. However, this has resulted in an aging population, combined with a decline in birth rates, leading to potential socio-economic challenges in the near future. It is crucial to develop cost-effective and user-friendly healthcare systems to address the needs of the elderly population. One solution to this problem is remote health monitoring through wearable sensors, actuators, and modern communication and information technologies. This approach allows for easy and efficient monitoring of elderly patient's health and well-being in their homes, reducing the need for costly hospitalization. Non-invasive blood glucose monitoring technology has become a subject of global research, providing relief to a large number of patients. These remote monitoring systems also allow healthcare professionals to monitor patients' vital signs in real-time and provide feedback from distant facilities.This paper makes a survey on several recent ICT based methods used for non invasive health monitoring system..

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I. INTRODUCTION

The importance of health has always been a top concern, especially with the recent outbreak of the coronavirus, which has negatively impacted the global economy. In areas where epidemics have spread, remote non-invasive health monitoring technology can be a useful tool to monitor patients' health. Internet of Things (IoT) based non-invasive health monitoring systems have emerged as a solution for this purpose. Remote patient monitoring systems enable the monitoring of patients outside traditional clinical settings, which increases access to facilities at lower costs. Non-invasive methods for measuring glucose levels are essential in preventing complications of diabetes and organ damage. Invasive methods for glucose level measurement are painful and can cause nerve damage; therefore, non-invasive methods are preferred.

Non-invasive health monitoring involves the use of technologies that do not require the insertion of any instruments into the body or the use of radiation. Some modern techniques (ICT) used in non-invasive health monitoring include:

Wearable devices: Wearable devices such as fitness trackers and smart watches have become increasingly popular in recent years. These devices can monitor various health parameters such as heart rate, sleep patterns, and activity levels. They are also being developed to monitor other health metrics such as blood pressure, blood glucose levels, and hydration status.

Remote monitoring systems: These systems allow healthcare providers to monitor patients from a distance. This is particularly useful for patients with chronic conditions who need regular monitoring but cannot travel to the hospital or clinic. Remote monitoring systems can be used to track vital signs such as heart rate, blood pressure, and oxygen saturation.

Telemedicine: Telemedicine involves the use of telecommunications technology to provide medical care from a distance. This can include video consultations with doctors, remote monitoring of patients, and virtual consultations with specialists.

Artificial intelligence (AI): AI can be used to analyze large amounts of data and identify patterns that may not be noticeable to humans. This can be particularly useful in detecting early warning signs of disease or monitoring the progression of a condition.

3D printing: 3D printing technology has been used to create models of organs for surgical planning and simulation. It can also be used to create customized medical devices such as prosthetics and implants.

Biosensors: Biosensors are devices that can detect and measure biological and chemical substances. They are being developed for a range of applications in healthcare, including monitoring glucose levels, detecting infections, and monitoring drug levels in the bloodstream.

Overall, modern ICT techniques are providing new ways to monitor and manage health conditions without the need for invasive procedures. These technologies have the potential to improve patient outcomes and reduce healthcare costs by providing more efficient and effective care.

II. RELATED WORKS

The paper [1] is discussing a research study in which an algorithm was developed to monitor blood glucose levels using electrocardiogram (ECG) data. The researchers split the ECG data of each participant into two equal parts, one part for training and the other for testing. The algorithm was designed to automatically extract common and unique features of each individual's ECG data at different blood glucose levels. The proposed algorithm, which uses a combination of density-based spatial clustering of applications with noise (DBSCAN) and convolution neural networks (CNN), improved the accuracy of blood glucose level monitoring compared to the approach without using DBSCAN. However, the algorithm had lower accuracy in monitoring moderate glucose levels than in monitoring low and high glucose levels. The proposed CNN model consisted of 5 convolution layers and 3 fully-connected layers, with max-pooling used to reduce the number of neurons. The CNN method can automatically learn highly discriminative features from the ECG waveforms, without the need for manual feature extraction. Additionally, important ECG information was visualized to make the deep learning model more transparent and reveal interesting details about the underlying physiological meaning. The onset of the P wave and PR segment of ECG were mainly highlighted as important in most participants at a low glucose level, indicating that the low glucose level has an impact on the atria. The QT interval was also indicated as important at low glucose ranges, which is consistent with other literature.

The paper [2] describes a health monitoring system designed to quickly measure a variety of health factors. The system uses sensors to measure pulse rate, SpO2, and body temperature, which are then processed by an Arduino Uno microcontroller. The microcontroller is connected to a mobile app and LCD display via a Bluetooth module, allowing users to view their measurement data. Here, patients will measure their pulse rate and SpO2 using the MAX30100 sensor and body temperature using the LM35 sensor, and patients can see the measured data in the mobile app and LCD display. With this device the patients are able to share their health parameters instantly with the doctor with a single application.

The paper [3] discusses the recent advancements in healthcare informatics that involve the acquisition of vital data through the use of the Internet of Things (IoT). The review found that non-invasive data acquisition still faces many challenges, such as limitations in real-time sensing and integration with the IoT. To overcome these challenges, a non-invasive means of acquiring vital data in real-time that is accessible and easy to use is needed. This can be achieved by using a high-speed digital signal processing unit to perform non-invasive data acquisition in real-time, which will optimize the usage of vital data acquisition and provide a continuous report of the patient's condition. The IoT can be used to enable real-time communication between the patient and the doctor, but it requires a multi-frequency structure for IoT sensor nodes and an IoT broker that can enable communication over long distances using different frequencies. The design of the broker needs to be well-designed and developed with stable, secure, and flexible communication between nodes to enable an increase in node numbers. Communication with different frequencies will enable data to be communicated over different distances via specific bandwidths. The review also highlights several points regarding the state of the art in vital data acquisition. Computer vision algorithms can extract heart rate vital signs in real-time without requiring high processing power, but this solution may not be convenient for use in intensive care units in hospitals. Body temperature can be sensed via IR without incurring high costs, but the sensing process has to target the middle of the forehead, and the algorithm's error at room temperature is ±0.5–3.5 ◦C. The IoT network can be heterogeneous in the physical layer and the ability to communicate with widely different devices. Software design has a high impact on enhancing data acquisition algorithms and minimizing hardware platform processing power usage. Finally, the development of smart non-invasive sensing techniques is expected to pave the way for reliable, cost-efficient, and rapid smart healthcare systems.

The paper [4] describes a wearable health monitoring system for elderly patients that can predict unidentified and untreated health issues. The system includes three sensors: temperature, respiratory, and heartbeat sensors that are embedded in a wearable belt. The sensors measure heart rate, temperature, and respiratory rate and provide output data to the Arduino microcontroller. If the output data exceeds the optimum estimate value, a warning report data will be transmitted to the patient's family members and doctors for emergency situations using a GSM module and IOT cloud. The paper provides hardware and software descriptions of the proposed system, including specifications for each component. The LM35 temperature sensor is used to measure body temperature, the heartbeat sensor measures heart rate, and the respiratory sensor counts the number of breaths per minute. The output data from each sensor is transmitted to the Arduino microcontroller, which processes the integrated data and generates output through an LCD display. The paper also provides information about the GSM module, which is used as a communication bridge for transmitting voice and data services operating at different frequency bands. The system uses end-to-end encryption of data for security and can send location information and processed data to the patient's family members or registered health center. Overall, the proposed system is a valuable tool for monitoring elderly patients.

The paper [5] describes that rapid advancements in technological capabilities in the healthcare sector have surpassed the ability to implement various novel RPM interventions into actual practice, despite their potential. There is limited evidence available that demonstrates the improved health outcomes of noninvasive RPM interventions, and even fewer studies have shown any cost benefits. This systematic review reveals that there is a prevalent trend towards using multicomponent interventions for monitoring chronic conditions in the elderly population. Therefore, further research utilizing robust study designs is necessary to evaluate the efficacy and value of RPM technology for various stakeholders, such as decision-makers, developers, researchers, clinicians, and investors. This study can aid decision-makers in comprehending the current state of peer-reviewed evidence and assist in planning future studies to address the identified gaps. To confirm the benefits of RPM across different sectors and populations in healthcare systems and identify the ideal patient for maximum RPM utility, large-scale implementation is required. Furthermore, potential obstacles to implementation, such as provider training, data reliability, security, and the integration of RPM data into routine care, should be assessed.

The paper [6] discusses the progress made in non-invasive glucose monitoring technology in recent years. The new technology offers continuous real-time blood glucose monitoring, which overcomes the limitations of traditional invasive blood glucose meters that require repeated fingertip blood samples. This technology has the potential to revolutionize the way diabetics monitor and manage their blood glucose levels, and has a broad market application prospect. Non-invasive blood glucose monitoring methods can be divided into three categories: optical, microwave, and electrochemical methods. While optical and microwave methods are highly non-invasive and provide continuous monitoring without causing discomfort, the measured value may not be highly correlated with the actual blood glucose value and the linear range is narrow, requiring subsequent algorithm correction. There are also challenges related to individual differences and complicated detection means. Electrochemical methods mainly rely on the correlation between some biofluids and blood glucose concentration, but they have their own limitations, including low sensitivity, delay of measurement results, need for calibration, poor comfort, and easy skin injury. Furthermore, there is a lack of clinical trial data for a large sample population. To improve the sensitivity of glucose sensors, nanometer electrodes are commonly used, but they bring other problems such as high raw material cost and unsuitable mass production. While all of these techniques estimate blood glucose levels indirectly, electrochemical methods have more advantages in the prospect of commercialization of non-invasive blood glucose monitoring. In future research, combining physical parameters and other biomarkers associated with blood glucose can help correct measurement results and improve the accuracy of non-invasive skin glucose measurement, achieving continuous monitoring of patients with hyperglycemia and hypoglycemia. This requires interdisciplinary cooperation between various fields, including biomaterials, medicine, computer science, and electrochemistry, to develop a more robust and reliable, sensitive and efficient, portable and comfortable, and intelligent non-invasive monitoring and closed-loop drug-delivery device that meets market expectations.

The paper [7] introduces a noninvasive glucose monitoring system that utilizes Internet of Things devices and can aid in managing diabetes. The system is based on taking images from the finger or ear instead of blood samples, and uses an ANN model to estimate and classify blood glucose concentrations from the images. Results from the prototype show that the accuracy of the GlucoCheck is 79% when using finger images and 62% when using ear images. However, the dataset used in the study is limited, and further research is needed to address three main limitations: (1) expanding the database size; (2) working with biomedical and hardware engineers to improve the prototype enclosure design; and (3) analyzing external factors such as skin color, skin thickness, and ambient temperature. If these limitations can be overcome, the GlucoCheck has the potential to be a life-changing technology for individuals with diabetes.

The paper [8] presents a novel system for non-invasive measurement of hemoglobin, glucose, and creatinine levels using a deep neural network (DNN) model based on photoplethysmography (PPG) signals obtained from fingertip videos. The system enables real-time monitoring of blood components from the comfort of one's home. To obtain PPG signals, a smart phone equipped with an 850 nm near-infrared LED is used to illuminate the fingertip, and the video is recorded. The PPG signal is then analyzed by extracting 46 characteristic features using first and second derivatives and Fourier analysis. The feature selection process is carried out using a genetic algorithm-based correlation-based method. Finally, DNN-based models are developed, and a 10-fold cross-validation method is applied to validate the models. The results demonstrate that the combination of feature selection and DNN models is highly effective in estimating blood component levels. Additionally, the proposed method is compared with existing methods, which further highlights its applicability. The authors plan to enhance their work in the future by increasing the dataset size, using different smart phones for video recording, automating the fingertip video collection process, making the whole estimation process cloud-based, and creating a smart phone-based application for end-users to capture and analyze data with the models.

The paper [9] discusses recent advancements in blood pressure (BP) monitoring and hypertension management, focusing on two main areas: physiological models and machine learning. Physiological models attempt to improve BP estimation accuracy by fitting parametric arterial volume-pressure models to measured pressure oscillations and combining them with the Windkessel's model of the arterial system. Machine learning models utilize multivariate linear regression (MLR) and support vector regression (SVR) models with various features based on waveform morphology and time intervals, including PTT from PPG and ECG signals. Deep learning algorithms have also been tested on digital stethoscope measurements and have successfully separated normotensive from hypertensive subjects. Wearables and smartphones have also been developed for BP estimation, with telemonitoring systems having the potential to improve hypertension management and reduce healthcare costs. Although good progress has been made, most continuous BP monitoring devices and mobile apps for BP measurement have yet to be approved by regulatory agencies.

The paper [10] discusses the development of a VIS-NIR optic device that measures the intensity of light transmitted through aqueous glucose solutions. The device uses multi-wavelength measurements to extract more quantitative information about the glucose concentration in solution, improving the accuracy of non-invasive prediction of glucose values. The passage then goes on to discuss the results obtained using regression and classification models to predict glucose concentration values. The FFNN regression model with an R-squared value of 0.96 and a RMSE of 11.1 mg/dL outperformed the MLR model, but classification algorithms such as KNN, SVM, and DT were better at classifying data samples into normal, hypo and hyperglycemic ranges. The SVM model was found to have the highest F1-score, the lowest percentage of glucose readings within zone D of the Clarke error grid, and a comparable RMSE value to the FFNN model.

Whatever is currently existing it is just a single vital that is based on non invasive glucose system.The proposed work includes various other vitals apart from non invasive glucose and here we are trying to display the previous values of the patient using RFID.

III. Proposed Work

The core objective of the proposed work is the design and implementation of a smart patient health tracking system. Fig.1 shows the overview of the proposed system. Usually, to monitor health people have to visit the hospital or their doctor. There are IoT sensors and models developed for temperature, heart rate, blood pressure and SpO2 using arduino microcontroller and displaying in LCD and the web server. Glucose is currently measured using invasive method by pricking and removing the blood and then measuring it, this is very difficult for elderly people. So all these vitals are displayed in the custom designed web browser and each person with a unique tag can view their data.

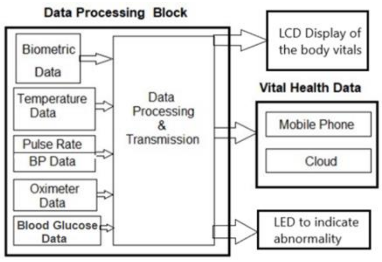

Fig.1---Non Invasive health monitoring

SENSORS

1) Temperature Sensor - MLX90614

The MLX90614 is an Infra Red thermometer for non-contact temperature measurements. Both the IR sensitive thermopile detector chip and the signal conditioning ASSP are integrated in the same TO-39 can. The MLX90614 is factory calibrated in wide temperature ranges: -40°C…125°C for the ambient temperature and -70°C…380°C for the object temperature. The measured value is the average temperature of all objects in the Field Of View of the sensor.

2) Pulse Oximeter and Pulse-Rate Sensor IC -MAX30100

The MAX30100 is an integrated pulse oximetry and heart rate monitor sensor solution. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart-rate signals.

2) Blood Pressure Sensor Module

The BP Sensor Module is a state-of-the-art blood pressure monitoring device that is designed to provide accurate and reliable measurements with ease. It features intelligent automatic compression and decompression technology, making it effortless to measure the blood pressure.

One unique feature of the BP Sensor Module is its interfacing driver circuit, which allows the device to be connected with microcontrollers such as Arduino. This feature enables to integrate the BP Sensor Module into the existing projects and applications. The device is powered by an external +5V DC power source, which ensures stable and reliable performance. It also features serial output data, which allows for external circuit processing or display of your blood pressure readings.

3) Glucose

The Glucose is based on Near-Infrared (NIR) optical technique. NIR light source of 940 nm wavelength is used because it is suitable for measuring blood glucose concentration. The setup consists of NIR transmitter and NIR receiver (photodetector) positioned on either side of the measurement site (fingertip). When the NIR light propogates it gets absorbed in our skin, and through the fingertip it interacts with the glucose molecule present in the blood, a part of NIR light gets absorbed depending on the glucose concentration of blood and remaining part is passed through the finger tip. The amount of NIR light passing through the fingertip depends on the amount of blood glucose concentration. This is our proposed work through which we can measure the glucose level accurate enough to compete over the Non Invasive one [11].

IV. CONCLUSION

Frequently measuring the various vitals of our body is very important for early detection and treatment. So thus we have designed a compact health monitoring system which can measure the essential body vitals easily and can be compared to the previous values of the patient.

One of the unique vital that is measured is glucose using Non Invasive technique using NIR sensor as the currently used invasive method is painful and costly. All these body vitals are displayed on the web browser. Each patient's data is stored separately and with the help of unique tag the patient's data can be accessed. This can be used for monitoring blood glucose level of the patients at the home as well as health care centers.

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