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SYSTEM FOR MONITORING AND FORECASTING COVID-19 QUARANTINED PATIENTS' HEALTH SIGNS IN REAL TIME THROUGH EDGE COMPUTING

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***Abstract*: Presently, the Medical Environment has been shaped by computers and Wireless Sensor Nodes Technology. Both SARS-CoV-2 patients as well as heart disease patients are faced with the challenging situation of unforeseen death due to the specific reason of heart or lungs problems, most of which can be traced back to the lack of adequate medical care for these patients at the required moment. The data will be used to specifically monitor the SARS-CoV-2 patients and inform their doctors and families. In an effort to reduce such sudden death rates by employing sensor technology and the edge computing, I am proposing an thesis title to let loved ones know when there is a problem. Whenever a change in patient heart rate or body temperature occurs, cloud platform illustrate real time result for the patient. Statistical analysis also project the patient's past, present as well future health based on the live temperature and heartbeat data tracked over the cloud. This IoT-enable system can monitor patient health by using the internet, and it can assist the user in monitoring their loved ones at work and provide life-saving information to the user.**

***Keywords:* Internet of things (IoT), Heart Diseases, SARS-CoV-2 (COVID-19), Edge computing, Remote monitoring, Architecture, Statistical Analysis, Diagnosis, Prognosis, Treatment, Weighted Average, Predictive Analytics.**

I. INTRODUCTION

Since Feb 2020, India's public health systems have been challenged incomparably by SARS-COV-2 (COVID 19). Today, the medical industry maintains an intimate relationship with embedded systems, in which a smart system of sensors and devices are connected to the internet. The healthcare industry is quickly being transformed by embedded wireless technology thanks to new health tech start-ups. In an isolation home, it can be difficult to maintain track of the health status of both patients with COVID and heart patients due to our hectic schedule and work. Regular monitoring is especially important for elder patients. Internet of Things, a technique that leverages smart sensors and the Internet to solve problems faced by networks, businesses, and governments everywhere. Security and surveillance, farm automation, healthcare, traffic control, smart cities, and other sectors have a range of IOT applications. In order to take advantage of these features, I've presented an system that includes an embedded system with an inbuilt Wi-Fi module, sensors, and cloud storage (An innovative system that automated this task with ease). It may show the patient's heart health in real time, allowing the doctor to make an informed and timely choice from a distance. Our technology implements a patient health care system that combines hardware and the cloud to monitor patient health parameters such as heart rate, blood oxygen level, and body temperature. In this work, we will learn how to develop a monitoring system using edge computing. We will use some sensors which are helping to monitor primary health. Similarly Patient needs to be placed in a room with a certain temperature and humidity level so that he doesn't feel uncomfortable. In order to do that we need to monitor the room temperature and humidity as well. We can analyze the real-time data which are captured by the sensors and stored in the cloud. Every real-time data will be analyzed by using statistical analysis to predict whether the patient will be in good health in the future as well as whether he will need to be admitted to the hospital again or not. Logging in with the credentials created by the system administrators will permit the doctor, family members, as well as the ministry of health (optional) to view all health information. Chinese health monitors developed earlier than those in foreign countries using IoT. It has been possible to perform remote consultations, monitor blood pressure, glucose levels, and gather certain medical information via remote means. By developing a real time monitoring system for patients using wearable sensors and cloud technology, the current study addresses the issue of integrating wearable sensors into smart technology.

II. OVERVIEW OF MONITORING SYSTEM

A health monitoring system (HMS) is a sophisticated technology that provides an different ways to traditional patient as well their health management. It consists of a wearable wireless device, such as a bracelet or as a chest cloth,

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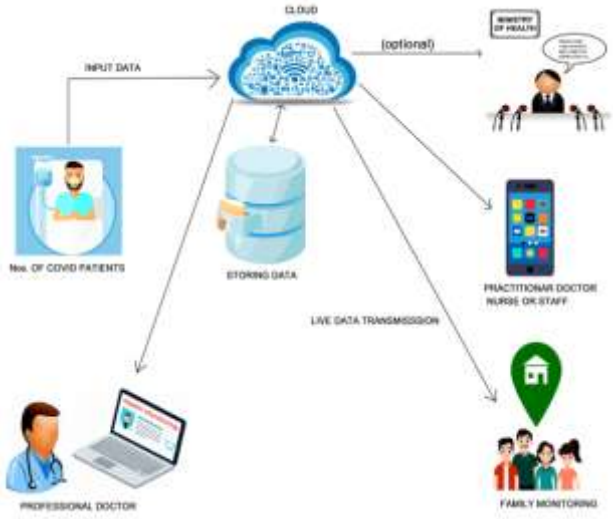
that contains many sensors such as heart beat, sp02 as well body temperature and is connected to an virtual application that allows a doctor to obtain medical data.



[Fig.1: Process of IoT-enabled Medically monitoring system]

A. Why Is Technology Important When Monitoring Individuals' Health?

It is a universal truth that modern medicine has many more patients than doctors. Globally, there is an urgent need for qualified doctors as a result of the recent pandemic. New technologies can ease the burden on the medical staff that is available. When it comes to health monitoring, technology can help doctors be more efficient in two main ways. Health Monitoring handles a large volume of data without the need for manual processing. AI-powered systems illustrate warning when a patient's symptoms begin to worsen or when the risk of things becoming dangerous is predicted. With the help of a health monitoring system, doctors can save time and effort. By implementing the health monitoring software, more hospital beds will be available for patients in need of urgent care. Using artificial intelligence, a system may recommend that a patient be discharged home and receive medical care remotely after analyzing health indicators. Doctors can then devote more time to ensuring the health of the most vulnerable patients. Besides helping you recover from surgery and heart attacks while at home and staying connected to your doctor, the Health Monitoring system can assist you with managing your medications. all are can also benefit from the system.

B. Exactly how does remote monitoring work?

According to the data analysis for statistical approach, the medical monitoring system actually operates in practice. The system is technically divided into four components:

Physical layer: Information about the patient is read through this layer. This software can be programmed to track data such as the patient's location, blood pressure, and sugar levels (important for patients with amnesia)

Networking layer: Data from a patient must be transferred once it has been received. It is at this point that the network layer comes into play. The device on the patient is responsible for transferring data quickly to the doctor.

The data processing layer: is where information is analyzed. Due to its AI capabilities, the system can determine quickly whether a patient requires immediate medical attention, and can notify a physician if this is the case. Furthermore, the embedded artificial intelligence in the health monitoring system allows it to make attempts to predict when a patient may get worse even if everything appears normal at the time.

Application layer: The doctor receives a result in an app installed on his or her smart phone, tablet, or PC after the data has been processed. With a thorough understanding of the patient's condition, the doctor can decide if further treatment is needed, allowing the patient to return home, or changing the treatment plan if necessary. Furthermore, a doctor can receive AI-based recommendations on diagnosis and action from the most advanced health monitoring system powered by deep machine learning.

III. PROBLEM STATEMENT

SARS-CoV-2 as well heart disease patients are facing a tuff situation of unforeseen demise due to the specific reason of heart or lungs problems which is because of nonexistence of good medical maintenance to patients at the needed time. So Primarily work on making monitoring system, for increase the ratio of trust on physicians. Improvement in effectiveness in system, low cost, low latency, long-distance communication and data analysis. To reduce such death rates by using this system that uses sensor technology and uses the internet to communicate to loved ones in case of problems. Any abrupt changes in patient heart rate or body temperature alert are sent about the patient using IoT. Also, showing patients' temperature and heartbeat tracked live data with timestamps over the cloud and predicts the patient's future health by Statistical analysis. Design and implement of edge computing system to analyze the real time data which are captured by the sensors and stored in cloud. Every real time data will be analyze by using statistical analysis to predict whether the patient will be in good health in future as well as whether he will need to be admitted to the hospital again or not.

IV. METHODOLOGY

A. FEASIBILITY STUDY ON DATA ANALYSIS METHOD

Data analysis clearly relates to the procedure of examining data to uncover usable information. Inspection, cleaning, transformation, and modeling data are all done with analytical

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and statistical tools, which we'll go over in more detail. The importance of data analysis can be further explained below.

1. Organizations are better able to make business decisions when data is properly analyzed. Businesses collect data constantly nowadays, including through surveys, online tracking, marketing analytics, subscriptions, and social media monitoring.
2. Now Data analytics is useful at every step in a patient's journey, including diagnosis, prognosis, and treatment. Data analytics can also inform remote patient monitoring and reduce adverse events. On a more macro level, Data analytics can improve care quality while reducing costs.

B. Relation between Health Care and Data Analytics

By analyzing raw datasets, data analytics uncovers patterns, draws conclusions and helps identify improvement opportunities. Analyzing health care data allows business and patients to make informed decisions based on current and historical information, both macro and micro. In the context of health data analytics, improving patient care means finding diagnoses faster, developing preventive measures, enhancing treatment and making informed decisions. Business operations can be simplified, costs can be lowered, and more.

C. How Data Analytics Can Help Improve Healthcare System

In recent years, data collection in healthcare system has been streamlined. Not only did the data help improve day-to-day operations and care of patient, but it was also better used in predictive methods. In addition to looking at historical information or present information, we can use both datasets to track trends and make predictions accordingly it. we can now take precautions and track the results. Nowadays many medical institutions, hospitals, practitioner doctors are deploying medical device for gathering data and that data will help to diagnosis for patients themselves. Well right now technology has been changed. medical instruments are as well connected to wireless node technology for collecting and sharing the data of patients.

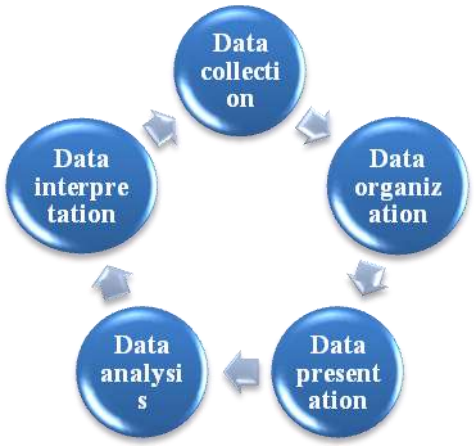
[Fig 2 : Types of Data Analysis]

1. **Descriptive Analytics:** Descriptive analytics compares and discovers trends using previous data. This form of study is most useful for answering questions regarding the previous. With descriptive analytics, we can learn about the history.
2. **Predictive Analytics:** Predictive analytics makes future forecasts based on current and historical data. This form of analytics produces the finest models for answering queries about what might happen next. With predictive analytics, we can see into the future health.
3. **Prescriptive Analytics:** Prescriptive analytics would also create forecasts for the future. This form of analytics heavily relies on machine learning. The data available can assist in determining the right plan of action. Prescriptive analytics can provide insight into the best course of action for achieving the best result.

As a result, data analysis is critical in condensing such data into a more relevant and accurate form, making researchers' jobs easier. Researchers can use a variety of tools in data analysis, including descriptive statistics, statistical tests, and quantitative analysis. To summaries, data analysis provides academics with better data as well as improved methods for analyzing and studying that data.

D. Statistical Analysis Process

There are five major steps involved in the statistical analysis process:



[Fig 3: Process cycle of Data Analysis]

1. **Data collection:** Data gathering is the initial step in statistical analysis. Assessments, management software, practice tests, patient's data, and business tools are all examples of primary and secondary data sources. we get to choose data on a sample that is representative of the target population to guarantee the data is valid. A hospital might, for example, collect data from patient they ca be store in Data-warehouse or data management system.
2. **Data organization:** Data organization comes next after data collecting. This stage, commonly referred to as data scrubbing, entails locating and eliminating duplicate data and discrepancies that may hinder you from doing an effective analysis. This stage is critical because it can

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assist businesses in ensuring that its data as well as the results they get from the research are correct.

3. **Data presentation:** Presentation of data is a subset of data preprocessing, as it entails organizing the data for cheval analysis. To summaries the data, you can utilize descriptive statistics techniques. Collection of information can also assist you in determining the best approach to show statistics based on its layout.

4. **Data analysis:** Data analysis entails applying statistical techniques like predictive as well as comparative statistical analysis to manipulate data sets in order to find patterns, trends, and relationships. You may automate this procedure and lessen the possibility of human mistake inside the statistical analytical process by using computer tools such as spreadsheets. This can help you examine data more effectively.

5. **Data interpretation:** The final step in the data interpretation, which yields conclusive conclusions for the analysis' goal. After the analysis, you can communicate the results to non-professionals as charts, reports, scorecards, and dashboards. For example, in a small city with a population of 100,000 people, interpreting the influence of a 25000 person on income rate can reveal a dropping rate of employment activities. This decline could be represented by a line graph.

E. How do we compute a weighted average?

The total represents that certain components of the data have greater "weight," or relevance, than the other or occur more frequently, which differs from obtaining an ordinary average of a data collection. The weighted average of a series of data is computed by multiplying each value inside the set by its weight, then adding the products. Following these steps for a more detailed explanation of a weighted average formula:

$$W = \frac{\sum_{i=1}^{n} w_i X_i}{\sum_{i=1}^{n} w_i}$$

W = weighted average
n = number of terms to be averaged
w {i} = weights applied to x values
X {i} = data values to be averaged

Weighted average is a machine learning strategy that aggregates predictions from multiple models, with the contribution of each model weighted according to its capability or performance. Voting ensemble is tied to the weighted average ensemble. Each data point in a set is multiplied by a value determined by the quality of the contribution to the data point in the weighted mean calculations. Once researchers have data on effect sizes, they can then weigh them according to the sample for each study. The system's purpose is to provide patients, researchers, the medical sector, and doctors with the knowledge they need to make educated decisions about health management and improvement, not just to monitor and collect data.

V. PROPOSED SYSTEM

I have proposed IoT network between sensor devices and feasibility study on selection of components for prototype hardware and cloud. However we have designed architecture of IoT-enabled system as which is given below. In this system by using MAX 32994, DS18B20 body temperature sensor and ESP8266 Node MCU model we have created one code which establish the network over platform.

[Fig 4: Block diagram of Proposed methodology of System]

After completion of design and implementation process , we have to planned testing hardware for getting right values and data. It has been illustrated in previous work how to monitor a particular patient. The weighted averaging method is to be used in all terms of COVID-19 monitoring in medical applications (heart/lungs). A major focus of my work will be creating a prototype of hardware to collect accurate patient data. Afterward, we will work on managing the database. Following successful management of all data successfully stored in cloud data base, the data is refreshed every 5-10 seconds. In the statistics analysis, weighted averaging will be utilized. This type of analysis is very useful for the medical industry since it can be used to predict the health of patients. We can diagnose health in advance by estimating how it will be in the coming days.

VI. RESULTS

As previously stated, our goal is to integrate real-time data monitoring and to use these data to anticipate or predict patient health in the future.
For the patient's real time monitoring of data given below.

Patient No: 20
Patient's name: Priyank Modi
System ID: e -health-care-system-XXXX,
Serial number: 6XXXXXXXXX

Now, whenever the we start the hardware prototype for work or task, the sensor can begin collecting data from human objects. The data is continuously captured and sent to the

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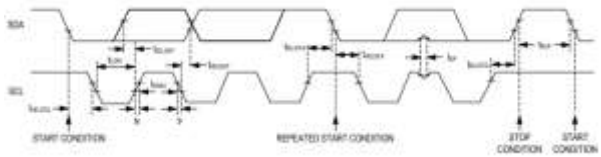
ESP8266 as an edge device.

Data Collection through Sensors for Monitoring and Forecasting System

First, we check whether the sensor transmit power is working properly. The suggested system will be created to integrate a device in a remote clinic using IoT (Internet of Things). The device will collect data from the patient's heartbeats, body temperature, oxygen level, and blood pressure and communicate it to the appropriate hospital doctor. The doctor will use the cloud to examine the patient's condition and advise the remote region clinic staff about the necessary actions for the optimal care of the heart patient.

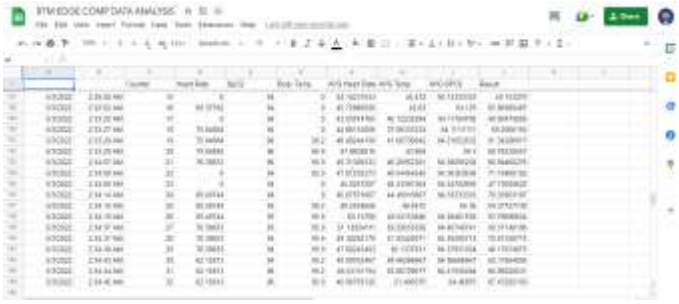


[Fig 5: I2C (SDA/SCL) Signal Output]
Source: datasheet of max30100

The output signal seen above is commonly referred to as an I2C signal by engineers. The data and clock signals are provided through the SCL and SDA pins. Normally, logic 1 is used first, followed by logic 0. The architecture shown in Figure depicts a logical signal perspective with all of the proposed system's components. Three sensors make up the system: a body temperature sensor, an oxygen pulse sensor, and a heartbeat sensor.

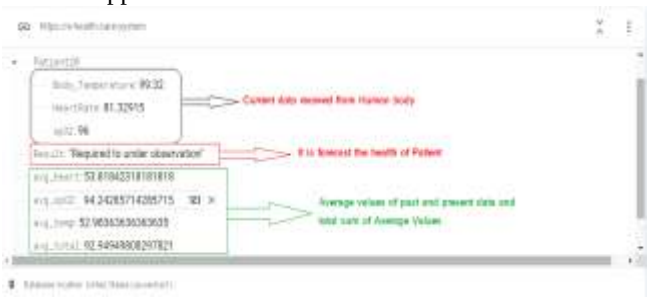
[Fig 6: Hardware belt design for patients]

To gather and classify patient data, all three sensors are attached through NodeMCU. Cloud network and storage equipment control data delivery. The decision-making tools are provided by data analytics, and the present status is provided by firebase cloud in this configuration. The doctor view allows hospital workers to observe and engage with patients from a remote location. IP address is used to establish a Cloud connection and transfer sensor data to the cloud database. The cloud database allows for real-time database monitoring and storage.



[Fig 7: Google spread sheet: real time database storage for data analysis using statistical approach]

The real-time data base for data analysis utilizing the weighted averaging method for statistical approach is shown in this visual illustration. This sheet displays historical and current health information. It is also calculated the weighted average of historical data and compared to current data for all acquired data such as heart rate, body temperature, and SpO2 using the statistical approach.



[Fig 8: Dashboard of real time monitoring with contain average values of past data and current patient data]

Following the average values, this value compares the data to typical health data like A healthy adult's body temp could range from 97.8 °F (36.5 degrees C) to 99 degrees F (37.2 degrees Celsius). A healthy adult's pulse rate 60 - 100 beats / minute. Normally, a typical level of oxygen is 95 percent or above. Normal levels can be as high as 90% in persons with persistent lungs illness or sleep apnea. A pulse oxymeter's "SpO2" value indicates the proportion of oxygen in the blood. If our home SpO2 value is less than 95%, we should contact our doctor. As a result of our average readings, it can anticipate on real-time monitoring display if you're in good health or need to be monitored.

VII. CONCLUSION

A real-time monitoring system for COVID-19 quarantine patient ase using edge computing is implemented in this thesis. The system measures events such as the heart rate, oxygen saturation, and body temperature, as well as the patient's physical health signs, in order to balance the need for and demand for the coupling of resources. Besides utilizing sensors for measuring body temperature, pulse rate, and SpO2 to assess the condition of the patient under observation, virtual healthcare was introduced for monitoring basic important

signs of patients such as heart rate, body temperature, and some measures of patient condition. For deciding the possible conditions and cure, the system used a knowledge base and IoT system to probably make decisions about patient care, monitoring, and data management. In all cases of the developed healthcare system, the success rate between observed data and actual data is approximately 82%. We find that some technologies deploy IoT to monitor heart disease by GSM/GPRS as well over Bluetooth in Android phone. But the technology is only suitable for short-distance communication. I have tried to improve the effectiveness of the patient monitoring system in terms of time, cost, and long distance communications as well as increasing the features of analyzing the data captured by sensors and stored in the cloud. Using weighted analysis for a statistical approach, we can predict the patient's health probably. Compared to the currently used system, the patient monitoring is reasonably accurate and cost effective. Although patients perform the tests outside of hospitals and in isolation wards, the medical staff can view and track data in real-time. During epidemics or other crises, nurses and doctors will also benefit from the system, since raw medical data can be analyzed quickly. A prototype of the system has an extremely simple design. In the case of infectious disease such as a novel Corona virus (COVID-19) treatment, the system proves very practical.

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