

IoT Based Healthcare Monitoring & Alert Generation System

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Abstract - In the most recent decade, the medicinal services observing frameworks have drawn significant consideration of specialists. The essential objective was to build up a dependable patient checking framework with the goal that the human services experts can screen their patients, who are either hospitalized or executing their ordinary day by day life exercises. This article provides information to create an IoT based health care monitoring system which would give real time data about patient's physiological conditions. With the help of multiple Sensors and Microcontrollers we develop a system which can gather information about patient's physiological conditions. Also, the proposed framework can send Alarming message about the patient's basic wellbeing information by instant messages. With using the data received through text message or e-mail the healthcare professional can provide necessary medical advice.

Keywords—Internet, IoT, Monitoring, Health Care, Data, User, Trust.

I. INTRODUCTION

Owing to the change in lifestyle, diet and a shift to a busier lifestyle people tend to have been more frequently and severely ill due to negligence towards health care.

Two major factors that disturb the normal functioning biological system of the human body causing fatalities and loss of life is mainly due to cardiovascular arrest and fluctuations in blood pressure.

- Heart Diseases: - Cardio Vascular Arrest (CVA), heart attacks
- Diseases due to fluctuations in blood pressure: - Ischemic heart disease due to high blood pressure, hypotension due to low blood pressure.

Both these factors remain the number 1 reason that account for sudden deaths. The deaths are not mainly caused due to the occurrence of the above factors but due to the lack of immediate response to such events.

Patients/Victims have consecutively failed to inform either their respective physicians or either their members of family. The lack of enough agile methods to react to such incidents eventually causes deaths. The first step is to inform the physician about any fluctuations in the heart beats or blood pressure. The implementations of an IoT based Healthcare Monitoring & Alert Generation System can help dodge many such fatalities and eventually the deaths. There has been a ton of data available in the hospitals which have been collected from the ECG Machines, heart rate monitors and other sensors continuously transmit data which is viewed by the doctors but once the patients' are discharged while still being under sensitive conditions there is no

track of any conditions of their heart or blood pressure etc. There is no provision to check the parameters when they return to home & hence there is a chance that the disease may return. Say the regular body temperature of a patient is 37°C whereas one person feels feverish if his body temperature is above 37°C. By observing the patient's data carefully one can easily figure out what threshold is to be set. Utilizing Android Application in doctor's Smartphone, he can see his patient's wellbeing status. If any of the sensors collect value which is beyond the predefined threshold value, an alert message is sent spontaneously to the doctor as well as the guardian

A. Using IoT to Implement Patient Healthcare Monitoring & Alert Generation System.

[5] With an improvement in innovation and scaling down of sensors, there have been endeavors to use the innovation in different territories to improve the nature of human life. One fundamental territory of research that has seen an appropriation of the innovation is the human services area. The general population needing social insurance administrations think that it's over the top expensive.

Accordingly, this task is an endeavor to tackle a human services issue as of now society is confronting. The fundamental target of the task was to plan a remote healthcare system. It comprises of three main parts.

- 1) Detection of patient's vitals using sensors.
- 2) Second for sending data to cloud storage.
- 3) Providing the detected data for remote viewing to a doctor spouse or a guardian. Remote review of the information empowers a specialist or guardian to screen a patient's wellbeing progress far

from medical clinic premises and revert to the situation of crisis in the event of observable vacillations.

4) Generating an alert message when the heart rate or blood pressure exceeds or drops below a certain level. The message is sent to the respective doctor and family of the patient.

II. LITERATURE SURVEY

[1] A. Dilip Roy Chowdhury. Applied a back propagation neural network. The system is used to recognize a pattern for prediction and diagnosis of neonatal diseases. Milan Kumari et al. illuminate cardiovascular illness dataset utilizing diverse information mining calculations, These algorithms are analyzed for performance through several statistical analysis factors such as: sensitivity, specificity, accuracy, error rate.

A support system for determination of Congenital Heart Disease has been proposed by Vanisree Ket al. The core of the proposed system is based on Back propagation Neural Network (multi layered Feed Forward Neural Network). Niti Guru et al. created a neural network for predicting heart diseases, blood pressure and amount of sugar in the blood. On the basis of data mining techniques a prototype Intelligent Heart Disease Prediction System (IHDPS) has been proposed by Sellappan Palaniappanetal, Shantakumar B. Patil et al developed an efficient system to track the heart beat patterns in order to develop algorithms from it and predict the rate of heart attack in a patient. Wireless health monitoring system (WHMS) has drawn impressive consideration from the examination network just as an industry during the most recent decade. Various and yearly expanding innovative work endeavors have been posted in the writing. We have included only some of the very recent related works. Continuous versatile medicinal services framework for observing elder patients from indoor or outdoor areas has been created. A bio-signal sensor and an advanced mobile phone are the primary parts of the framework. The data collected by the various sensors are sent over to the GPRS system through a smart server. The system can screen the versatility, areas and crucial indications of the elder patient from a remote area. Windows Mobile-based framework for observing body parameters has also been created . The framework utilizes a body sensor system to quantify and gather physiological information. The data is transmitted to a mobile device through a Bluetooth module. The dependability and power of the proposed System has been checked by the creators. The trial results demonstrate that the proposed framework can screen the physiological information of patients under versatility condition.

A total remote body zone organizes (WBAN) framework has been structured. The proposed system consists of medical band which includes sensors to execute a wireless system to obtain physiological data. The system uses multi hopping technique in order to increase the range and send data directly to the internet. The creator has picked medical bands to decrease the obstruction between the sensor gadget and other existing system gadgets. To build the working reach multi-jumping system has been utilized and a restorative door remote board has been utilized in such manner. This passage has been utilized to interface the sensor hubs to a neighborhood or the Internet. By utilizing Internet, the medicinal services experts can get to patients' physiological information from anyplace whenever. Numerous health monitoring systems utilize sensors which produce a persistent stream of information and produce numerous false cautions; due to this the system is deprived of use in the medical clinics. To

overcome this issue health monitoring systems data is combined with clinical observations to predict any threats to the patient's health. Oxford University Hospital tests the effectiveness of such approaches.

The test outcomes demonstrate that the proposed framework can effectively consolidate information procured from the wearable sensors. Combining data from the sensors with manual observation the patient's health condition is kept a check upon. Cloud computing has been incorporated in a health care system. The creators have proposed a cloud-based intelligent health care monitoring system (CIHMS) for giving medicinal input to a patient through the cloud. The proposed framework can acquire satisfactory information identified with patient's ailment and convey the information to a remote area by utilizing distributed computing gadgets. Albeit cell phones are constantly viewed as a promising device to screen and deal with patient's own wellbeing status, these gadgets have some innate constraints in calculation or information serious errands. Remote medicinal services framework for observing electrocardiographic and temperature information has been exhibited. The system consists of three modules. The hardware module is used for data acquisition.

The Bluetooth module is used for data transmission. At last, the information is shown by utilizing the display module. The procured clinical information is sent to a database server by utilizing GPRS or Wi-Fi. The system has been tested on various patients and the results have been proved to be highly helpful to the physicians. Cell phone based social insurance framework for observing patients with Alzheimer's illness has been created and displayed. The system can furnish parental figures and medicinal expert with the capacity to be in contact with the patients constantly.

This framework has been field tried by the Alzheimer's malady guardians and the underlying outcomes demonstrate that the system is exceptionally successful for them. A peripatetic system for monitoring the physical improvement of the patients has been developed. The framework comprises of a multi-sensor-based checking gadget, a cell phone with the customer application, an administration arranged engineering based server arrangement, and an application. The framework has been attempted in a controlled circumstance involving some solid volunteers and some congestive heart frustration patients. He proposed system is built in order to detect and monitor congestion in the heart and the rate of heart failure due to it with also having the ability to schedule a follow up with the nurse on regular intervals. Continuous pervasive medicinal services framework for observing ECG motions by utilizing cell phone has been introduced.

By utilizing this framework, the client can screen his ECG flag. An algorithm is developed for detection of abnormal heartbeat and to produce an abnormal heartbeat check map (AHCM).

[2] B. Zhao, Wang, and Nakahira, 2011 examined the likelihood and related issues of giving propelled administrations of human wellbeing the executives and they have provided additionally exploration guidance of medicinal innovation on IOT. They have examined diverse wellbeing related sensors and convention and raised a few issues which should be solved. The Decision Support and Home Monitoring System were structured by Chiuchisan and German in 2014. This framework contributes in conclusion, home observing, medicinal treatment, therapeutic remedies, restoration and advancement of his patients with Parkinson's infection. Their paper proposed for future expanded research on Neurological

Disorders with the assistance of e-Health and Internet of Things innovation.

15 characteristics are connected with anticipating heart attack in and information mining strategy like ANN, time arrangement, bunching, and affiliation principles can be drawn closer for this expectation (Soni and Sharma, 2011). For exactness of the Decision Tree and Bayesian Classification, they proposed to apply a hereditary calculation to diminish the real information size to get the best subset of property fitting for coronary illness expectation. Durairaj and Ranjani, 2013 additionally thought about numerous methodologies and various instruments and their effect on the healthcare sector. They utilized the data mining application for distinguishing and distributing important human services data. For diagnosing bosom malignancy, information mining procedure can be utilized by diminishing the number of highlights of determination. Ahmad, 2013 connected the Adaptive Neuro-Fuzzy Inference System (ANFIS) with the decreased dataset. He found 98.24% exactness from his methodology.

Pulse changeability can possibly pass judgment on the job of autonomic sensory system vacillations in typical solid people and in patients with different cardiovascular and non-cardiovascular scatters. HRV examined by Task Force of the European Society of Cardiology (1996) and lift up the comprehension of physiological marvels, the activities of meds, and illness systems. This Task power recommended - "Longitudinal investigations are expected to decide the affectability, particularity, and prescient estimation of HRV in the distinguishing proof of people in danger for consequent dreary and mortal occasions". Stein and Conger (1994) drew nearer to an estimation of pulse inconstancy (HRV), time and recurrence area. Their figuring's depend on the examination of bury beat interims of ordinary beats decided from a normal 24 hours mobile electrocardiogram.

III. PROBLEM STATEMENT

[3], [6] A heart attack happens when the stream of blood to the heart is blocked. The blockage occurs mainly due to excess body fat and cholesterol etcetera, which form a plaque in the arteries that feed the heart (coronary arteries). The plaque eventually, breaks away and forms a clot. This clot causes interruption in blood supply to various body parts and possibly may damage or destroy some heart muscle. A heart attack, also known as myocardial infarction, can be fatal, but the remedy to this has excelled adequately over the years. Cardiovascular ailment is the main worldwide reason for death. The insights arranged by the American Heart Association, the Centers for Disease Control and Prevention, the National Institutes of Health and other government sources (Mozaffarian and Huffman 2015) causing 17.3 million deaths every year, which is relied upon to ascend to more than 23.6 million by 2030. Canto and Iskandrian, 2003 investigated some hazard factor of heart illnesses. Some customary fantasies identifying with pulse and heart assault are distributed in the wellbeing related site e (<http://www.webmd.com>) is as follows:

The normal heartbeat is 60-100 BPM. Be that as it may, pulse higher than 76 pulsates every moment when in resting might be connected to a higher danger of a heart assault.

Having an unpredictable heartbeat doesn't mean having a heart attack. However, on the off chance that it's another side effect, or in the event that you have chest torments or issues breathing, might be the fundamental indicators of a heart attack.

Moderate rates are just an issue if additionally go out, feeling dazed, are shy of breath or have chest torment.

In this paper distinctive health-related information with pulse utilized for the forecast of heart assault and uncover these fantasies.

Studies have exhibited that 30 percent of patients with a discharge finish of heart disillusionment are readmitted at any rate once inside 90 days with readmission rates going from 25 to 54 percent inside 3 to a half year. Hence the main problem that should concern us is the unavailability of a system that would not only store and monitor all the data of heart rate, temperature and blood pressure etc but also automatically sends an alert message to the respective doctor or guardian.

The patients suffering from such problems, under critical conditions won't be able to contact either a doctor or relative, hence to overcome this, the **Alert Generation System** is proposed which would automatically send an alert message if the data crosses certain threshold, not only this but also continuously stores all records in the cloud database which can be viewed any time by the doctors.

IV. EXISTING SYSTEM

A. Confirm Rx™ ICM.

[8] Overview :- The Confirm Rx™ ICM offers advantageous, associated and constant observing for understanding into your patients' conditions and indications, including syncope, palpitations, and AF previously or after abscission treatment and cryptogenic stroke – causing fewer interruptions to their daily lives.

The Confirm Rx™ ICM is the world's first insert able cardiac monitor that combines a quick and minimally invasive procedure with Bluetooth® low energy wireless technology, allowing patients to connect using their own mobile devices.

An all-in-one integrated transmitter and symptom recorder, functional via my Merlin™ Smartphone app, eliminates the need for a traditional radio-frequency (RF) based bedside transmitter, which can be intrusive and cumbersome for patients and limits their mobility.

The application naturally associates with the gadget by means of Bluetooth® low-vitality remote innovation and advises patients of effective gadget checks and facility planned transmissions, without intruding on their day by day lives.

The device is inserted by means of surgery, right besides the heart to get continuous data of the BPM (Beats per Minute) of the heart and other information which is monitored by the doctor via a mobile application my Merlin Smartphone app.

-Disadvantage

For the Confirm Rx to start functioning effectively the person must undergo an expensive surgery to implant the monitoring sensor near the heart. This sensor then is connected via Bluetooth to the patient's phone. The sensor then transmits data from the sensor through Bluetooth to my **Merlin** app hence the phone always needs to be within range. With expensive cost of the surgery and no system to send an alert message although there is continuous availability of data.

B. Real Time Wireless Health Monitoring

[4] Rafiah Awang has talked about the execution of the Wireless Health Monitoring System consisting of the following components ECG Electrodes, LM35 Temperature Sensor, Blood Pressure Sensor, Blood Glucose Sensor, and Microsoft Pro Tablet. The device works as the restorative expert utilized three anodes of ECG on the patient's body and interfaces the Arduino shield with a temperature sensor, a blood glucose level sensor and a circulatory strain sensor. From the Arduino shield, we interface a remote hub and the Tablet or the Smart telephone that has Lab View programming running on it to take perusing of the patient's Physiological information. The information is spared by the time and introduced in a report group and the information is then distributed in the web by utilizing a tablet or advanced mobile phone with the goal that the patient's report can be gotten to by the approved medicinal services individual from remote areas whenever.

C. U-Healthcare Monitoring Systems

[7] Structure and Applications revolves around arranging compelling U-social protection systems which require the joining and improvement of information development organization/workplaces, remote sensors advancement, remote particular instruments, and limitation methodology and human services observing, alongside the popularized administration on the rise, clients can keep a check and remotely deal with the wellbeing states of their folks. Besides, setting mindful administration in u-social insurance frameworks incorporates a PC which gives a wise administration dependent on the client's various conditions by sketching out fitting data applicable to the client's circumstance. Such hypothetical information would assist researchers with combining different sensors, remote system frameworks, and microcontrollers to build up an effective U-Healthcare Monitoring System.

-Disadvantage

Any of the systems implemented above doesn't have any form of technology which generates/sends any form of alert message either to the doctor or any guardian. The systems only provide just enough sufficient technology to gather and store data for future monitoring. There must have been a threshold set for gathered data which if exceeded would generate an alert message. This is exactly what our proposed system is supposed to do

V. PROPOSED SYSTEM

The proposed system constitutes of a Temperature Sensor, Blood Pressure Sensor, Heart Rate Sensor, Arduino Mega and a Wi-Fi module. The Arduino has been programmed to store readings from the sensors to the cloud storage. Also, the Arduino needs to be assigned a threshold value which when exceeded would spontaneously send an alert message to the numbers of doctor and the guardians of the patients.

A. Arduino Mega

It is suggested to choose Arduino Mega rather than UNO as Mega has a greater number of input/output pins and it becomes easier to connect multiple pins of all the sensors and to connect the Wi-Fi module. It consists of a central microcontroller board, the ATmega2560. It has 54 digital I/O pins of which 14 can be utilized as PWM, USB association and a power jack. It contains everything expected to help the microcontroller. It can be powered

up by connecting it to the computer or laptop by a USB or with an AC-to-DC adapter or battery.

B. LM35 Temperature Sensor

The LM35 is a sensor that can be utilized to gauge temperature with an electrical yield corresponding to the temperature (in °C.. It measures temperature more precisely than a thermistor. The LM35 produces a higher output voltage than thermocouples and may not require the output voltage to be further amplified. The LM35 produces corresponding output voltage to that of the Celsius temperature. The scale factor is .01V/°C.

C. Pulse Sensor

Pulse sensor is a minimal effort little sizes a plug and play pulse sensor for Arduino. It will, in general, be used by understudies' authorities' rivals' makers and entertainment convenient originators who need to easily join live heartbeat data into their endeavors. An amped Pulse Sensor provides a noise cancellation and amplification circuitry to the hardware. It's fast and easy to get reliable pulse readings. Pulse Sensor functions on a 3V or 5V Arduino. A Color-Coded Cable, with standard male header connectors.

D. Blood Pressure Monitor Hack

SBM30 (hl868ba) is the blood pressure monitor that needs alteration with its internal circuit to connect it to the Arduino mega and get the desired results.

[11] For teardown of SBM30

[12] Code & Pin Connections with Arduino Mega

The SBM30 needs to be opened and a few pins need to be connected to the Arduino to gather data.

E. ESP8266 Wi-Fi Module

[13]The ESP8266 is a minimal effort Wi-Fi chip with TCP/IP stack and microcontroller ability. This module empowers microcontrollers to interface with a Wi-Fi network and makes clear TCP/IP affiliations using Hayes style headings.

F. Setting a Threshold for Sending an Alert Message.

It is important to understand some biological factors as to what the normal range of human body temperature should be, blood pressure and heart rate, anything above or below this normal range can cause discomfort or even fatalities. When we are fully aware of this information it becomes easy to set a threshold value in the Arduino program which, when crossed would result in generation of an alert message sent to the doctor.

G. Normal Temperature Range

[9] Normal body temperature varies from person to person. The normal body temperature is generally 37°C (98.6°F). Studies have shown that the "normal" body temperature can vary from 36.1°C (97°F) to 37.2°C (99°F). A temperature over 38°C (100.4°F) most often means you have a fever caused by an infection or illness.

- Hence from this we get to know that the temperature threshold should be set to >100°F (38°C), if this threshold is crossed an alert message should be generated.

H. Normal Blood Pressure Range

[10]Blood pressure readings have two numbers, for example 140/90mmHg.

The number above is your Systolic Circulatory Strain. (The most elevated weight when your heart pulsates and pushes the blood around your body). The last one is your Diastolic Circulatory Strain. The most minimal weight when your heart unwinds between pulse rates. Hence from the below chart we get to know that if the blood pressure is ≥ 180 mm Hg (Systolic) or ≥ 120 mm Hg (Diastolic) an alert message should be generated.

| Blood Pressure Category | Systolic mm Hg (upper #) | | Diastolic mm Hg (lower #) |
|---|-----------------------------|--------|------------------------------|
| Normal | less than 120 | and | less than 80 |
| Elevated | 120-129 | and | less than 80 |
| High Blood Pressure (Hypertension) Stage 1 | 130-139 | or | 80-89 |
| High Blood Pressure (Hypertension) Stage 2 | 140 or higher | or | 90 or higher |
| Hypertensive Crisis (Seek Emergency Care) | higher than 180 | and/or | higher than 120 |

Source: American Heart Association

Fig. 1 Blood Pressure Chart

I. Normal Pulse Rate

[14] With regards to your pulse, it's somewhat like the speed of your vehicle. What you need isn't excessively quick, not very moderate nor whimsical. Truth be told, often, heart musicality and pace are not things you have to consider. Also, except if something abnormal is going on, you're likely totally ignorant of what your heart is doing.

An ordinary pulse is typically expressed as 60 to 100 beats for each moment. Slower than 60 is bradycardia ("moderate heart"); quicker than 100 is tachycardia ("quick heart"). In any case, a few specialists trust that a perfect resting pulse is more like 50 to 70. Notwithstanding what is viewed as ordinary, it's vital to perceive that a sound pulse will fluctuate contingent upon the circumstance. Hence from this we get to know that if the pulse sensor has number >100 BPM or <60 BPM an alert message should be generated.

VI. MEHTODOLOGY

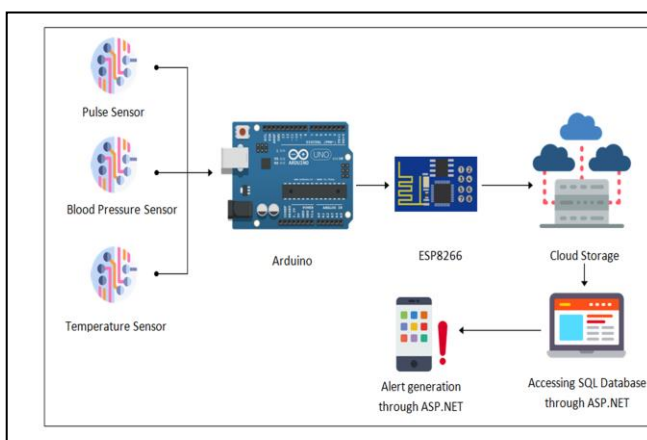


Fig. 2 Connectivity Diagram

A. Methodology Used in the System

The basic methodology used for the system can be explained by the diagram above. All analog data from the sensors is sent to the Arduino for processing and conversion to digital format, this data

is stored to the cloud storage at regular intervals. ESP8266 module acts as a bridge to connect the Arduino to the Cloud. This data stored in the cloud can be monitored by the doctor anytime through the Software.

The Doctor/guardian would be alerted by a text or email incase the data generated/acquired from the sensors crosses the threshold value. These values should be predefined in the software. Through ASP.NET we design the software to generate an alert and send it to necessary people via text or email.

Only in case of the threshold value being exceeded this is predefined for all three sensors, is when the alert message is sent to the Doctor/Guardian.

B. System Modules

The system has 4 Modules.

- First module consists of Sensors Used for Sensing Patients Physiological Parameters.
- Second module consists of Data Processing Microcontroller (Arduino).
- Third module consists of ASP.NET for generating and sending alert messages on exceeding threshold value.
- Fourth module consists of Cloud Data Storage of sensor value
- Sensors Used for Sensing Patients Physiological Parameters.

This module consists of the 3 sensors used for gathering data of the human body namely the temperature, heart rate and the blood pressure. The sensors used are SBM30, Pulse Sensor and LM350 for blood pressure, heart rate in BPM (Beats per Minute) and body temperature respectively.

All these sensors produce data in analog format which is converted by the Arduino microcontroller which converts it into digital format so that we can easily read it.

- Arduino Used as the Data Processing Microcontroller.

Arduino MEGA basically is the brain of the system which is the Central Processing unit for data conversion and storage. All of the Sensors, the Wi-Fi module and also the cloud is connected to and controlled by the Arduino. Opting for Arduino MEGA is suggested as there are more number of pins which would prove useful for connection of complex circuitry.

- To Send Message from ASP.NET

[15] After setting threshold values for data received from sensors, with reference to the code in the above link, add the four namespaces in your code as mentioned in the linked code, and copy the rest of the method. To get a message whenever a threshold is crossed go to textlocal.in, this will provide you with API keys after signup which would allow you to send 10 free and unlimited paid messages.

To Connect SQL Database to ASP.NET

[16] Open Project tab and choose SQL Server database. You can add the page (SQL Server database). Add > New item. Now select Visual C# and choose SQL Server database. Then, click "OK" button. Open the new Window and click YES button. Add this to the database in the project and go to the Server Explorer and add your database. Click the Tables >Add New Table. One can now fill data in the new table.

VII. FUTURE PLANS

The implementation of the above system is possible with easily available microcontrollers and sensors without the need of complex wired systems.

The system proves useful to accomplish the following objectives: Gather data from sensors and send it to cloud for permanent storage.

- Consists of threshold values which when exceeded would lead to generation and deployment of an alert message.

The system would prove useful to avoid critical situations which can be avoided. Alert messages would prove useful by informing doctor and guardian which would prove useful in situations which require spontaneous response in order to be avoided.

CONCLUSION

With all the information displayed above it gives out one clear message that implementation and development of such remote health care monitoring system is not only important but necessary. With gathered data we have known that most of the heart related deaths are caused even after surgery when the patients are left unattended at their home. With blood pressure and temperature which may fluctuate unknowingly such a system would prove greatly helpful to escape such scenarios. Such critical situations can be avoided but due to lack of attention towards the patients these situations become inevitable, while systems as such which not only continuously monitor, gather and store data in the cloud but also generate alert messages as the patient won't be able to do so voluntarily in case of any critical condition

By analyzing, classifying various papers we have conducted a systematic study about IoT based HCMS. When we look at present state of the art technologies, we can easily judge the impact and use of such IoT based technologies in the coming years. This report documents the methodology of implementing a Health Care Monitoring System with alert generation. While the current technologies make the concept of Health Care Monitoring feasible, there is still a need of a more advanced system.

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