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An Intelligent Medical Monitoring System Based on Sensors and IoT

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Abstract: ***In this Medical monitoring system, all the intelligent things are connected and monitored. Many hospitals have been already made use of mobile phone apps for appointment registration, inquiring electronic medical records etc.Inexisting work, an architecture that connects the intelligent things like heart beat sensor, temperature sensor, infusion pump, IR sensor and collects the data from it, based on its working, it updates the data with the help of NB-IoT through Wi-Fi module . And it sends the alert message via mobile application. The drawback is to send the sensed data frequently. To overcome this issue, data validation algorithm is used .By this algorithm, the collected data from the sensor sends in every 30 minutes time interval or if any deviation from a normal conditions it sends a message alert via mobile application.***
Keywords: Smart hospital, Internet of Things(IoT), Sensors, Infusion pump.

I. INTRODUCTION

In recent years the development of IoT and sensor plays a vital role in hospitals .The patient monitoring systems is one of the major improvements because of its advanced technology. It connects the intelligent things like temperature sensor and heartbeat sensor and ultrasonic sensor so that we can monitor the patient's condition simultaneously. These sensors collect the data and sends it to the microcontroller that is connected with it .The data in the microcontroller is transferred to the cloud platform and validated by the algorithm it sends alert message through mobile application. By using this architecture it reduces manual work by which the architecture doesn't need a separate person for continuous monitoring the patient , increases data rate by which the quick loading of the data will be done and it retrieves the data at any time when needed. By this, the patient's health records are continuously monitored and saved. It will be used for quick reference of patient details for future use in case of any immediate surgery.

II. LITERATURE SURVEY

The opportunity for patients to have constant monitoring of their health state is now possible by means of intelligent sensors. The continuous monitoring of health status is a fundamental practice for patient suffering from various diseases. In a hospital either the nurse or the doctor has to move physically from one person to another for health check-up of patients, due to which it is not possible to monitor their conditions continuously. Thus, any critical condition cannot be identified easily unless the nurse or doctor checked the person's health at that time. To develop a system which keeps a patient health record and can wirelessly monitor the patient. Many researches have been carried out in design of health monitoring devices.

Warsuzarina Mat Jubadi et al [1] have proposed Heart Beat Monitoring via Alert. This alert system is used to monitor the heart beat rate of a patient. This heart rate measurement is based on the principle of photoplethysmography (PPG) technique. Then this PPG signal is processed using PIC16F87 microcontroller to check the heart beat rate per minute. An alert was given to medical experts or family members via SMS.

Jaiee Sitaram Adivarkar et al [4] have proposed Patient Monitoring System Using GSM Technology .This system is used to monitor the patient heart rate and temperature. Heart rate is measured from the index finger using IRD (Infrared Device) sensor. The device alarms when the heart beat and body temperature exceed the provided threshold value. The sensors measure the information and transmit it through GSM Modem on the same frequency as on which cell phones work.

Alexsis Bell et al [4] have proposed Wireless Patient Monitoring System. It has a device arm band, which is intended to obtain vital signs like pulse rate and temperature from each patient and relay that information back to a central computer. The data was collected by sensors and then processed and packaged by an Arduino Uno board, which then sent it to the computer using the XBee modules.

Darshana Varma et al [2] have proposed Development Of Home Health Care Self Monitoring System. It used heart rate sensor, oxygen saturation sensor, body temperature sensor. The obtained bio-signal from the each sensory unit is transmitted using a

Bluetooth wireless communication at home to the smart phone. This technique used accelerometer or Buzzer to alert other family members.

Bandana Mallick etal[1] have proposed Heart Rate Monitoring System Using Fingertip Through Arduino and Processing Software. A technique in which the measurement of the heart rate through a tip and arduino. It is supported the principal of photophelthysmography(PPG) that is non-invasive methodology of measure the variation in blood volume in tissue employing a source of illumination and detector. The signal may be amplified and is shipped to arduino with the assistance of port communication. With the assist of process computer code pulse watching and investigating is performed.

R.Assuncao et al[6] have proposed Developing The Control System Of a Syringe Infusion Pump. It is used in a situation where high precision and low flow are needed. Its control may be either volumetric or non-volumetric. Microprocessor is responsible for storing the data derived from the sensor and setting off the alarms whenever necessary.

Zan Gao et al[6] have proposed Multi-Camera Monitoring Of Infusion Pump Use. This design is mainly used to operate a infusion pump in home. When people uses the infusion pump, the multi-camera that is around the infusion pump will record the video and by the use of robust MoSIFT algorithm, detects interest points and encodes not only the local appearance but also explicitly models local motion to describe the action.

Rui Correria et al[4] have proposed Development Of An Application For Remote Syringe Pump Control In Anaesthesia Infusion, Lab VIEW application was developed to control the drug in the infusion pump using serial communication protocol. This application combines in a single output file, synchronized signals from drug infusion and commands have been sent.

Shivakumar Chandrasekaran et al[1] have proposed MAS-Med Alert System. This system has a strip patch, which is attached to the patient's body and monitors the heart rate, blood pressure and blood sugar level by using sensors. It sends the data at a regular interval of time to a mobile application. The mobile application analyses the data and the data is not in the acceptable range then it sends the alert message to the doctor.

Hasmah Mansor et al[4] have proposed Body Temperature Measurement for Remote Health Monitoring System. The temperature sensors can send the readings to a microcontroller mistreatment Xbee wireless communication. To send the period information to health watching info, Wireless Local Area Network (WLAN) has been used. Arduino with LAN defend supported IEEE 802.11 standard has been used for this purpose. Test results from a bunch of voluntary shows the period temperature reading.

III. ARCHITECHTURAL DESIGN

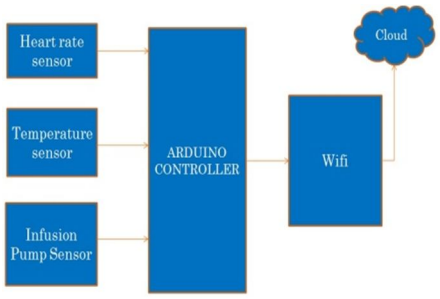

Fig 1: Architecture Diagram

A. Heart Rate Sensor

The working of the pulse/heart beat sensor is very simple. The sensor has two sides, on one side the LED is placed along with an ambient light sensor and on other side we have some circuitry. The LED on the front side of the sensor is placed over a vein in a human body. This can either be used in fingertip or ear tip, but it should be placed directly on top of a vein.

Now the LED emits light which will fall on the vein directly, the veins will receive more blood when the heart is pumping, so if we monitor the flow of blood we can monitor the heart beat as well if the flow of blood is detected then the ambient light sensor will pick up more light since they will be reflected by the blood, this minor change in received light is analyzed over time to determine our heart beats. To use the sensor simply power it using the VCC and ground pin, the sensor can operate both at +5V or 3.3V system. Once powered connects the signal pin to ADC of the microcontroller to monitor the change in output voltage.

B. Temperature Sensor

LM35 is one kind of commonly used temperature sensor that can be used to measure temperature with an electrical output comparative to the temperature (in degree Celsius).It uses the fact that as temperature increases the voltage across diode increases at known rate-actually the drop across base emitter junction of transistor. Usually, a temperature sensor is a thermocouple or a Resistance Temperature Detector (RTD) that gathers the data from the patient's body and sends it to the aurdino.

C. Infusion Pump

An infusion pump infuses fluids, medications or nutrients, oxygen etc into the patient circulatory system. Normal working of Infusion pumps is all driven via a stepper motor. If a motor rotates in clockwise direction it pushes a medication out and if it rotates in a anti-clockwise direction, it stops the medication flowing out. In infusion pump we uses liquid or gas type. For measuring the liquid parameter, uses ultrasonic sensor. This sensor emits ultrasonic waves and by which the quantity of liquid could be measured. This sensor gets the output as analog value. For measuring the amount of oxygen gas content, uses weight sensor. This gets the output as digital and coverts into analog.

D. Aurdino Controller

The Arduino UNO is a open source microcontroller based on the microchipATmega328P. The board is equipped with sets of digital and analog input/output pins that may be interfaced to various expansion boards and other circuits. The board has 14 digital pins,6 analog pins and programmed with the Arduino IDE(Integrated Development Environment) via the USB cable. It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltage between 7 and 20 volts.

E. Cloud Environment

Cloud makes computer system resources, especially storage and computing power, available on demand without direct active management by the user. Cloud computing and the IoT both serve to increase efficiency in everyday tasks and both have a complementary relationship. The IoT generates massive amounts of data and cloud computing provides a pathway for this data to travel. The benefit of cloud for the IoT is that cloud computing enables better collaboration which is essential for developers today. By allowing developers to store and access data remotely, developers can access data immediately and work on projects without delay.

F. WIFI

Data transfer mechanism for IoT vary from small, intermittent payloads like utility meters to large amounts of continuous data. WiFi is a wireless protocol that was built with the internet. It is used to transfer the data. Its main goal is to provide off-the-shelf, easy to implement, easy to use short-range wireless connectivity with cross-vendor interoperability.

IV. METHODOLOGY

A. Collecting Data

In this project the patients are monitored each and every time. The patient details are gathered by using sensor.

For collecting the patient details, many sensors are used. And the sensors like pulse sensor, temperature sensor, ultrasonic sensor and weight sensor.The heart rate of the patient can be measured by using the pulse sensor. The pulse sensor has a LED on the front surface and it is placed over the veins in a human body to see the blood flow. While the heart is pumping it makes contraction and reflection of the heart by which the blood is pumped in the vein. When the heart is in contraction phase it pumps more blood into the vein, by this the emitted LED light gets fall on the vein and reflects back. And it receives less light. In this sense it receiving less light, we can identify there is sufficient blood supply.The temperature of the patient heart rate can be identified by using LM35 temperature sensor. The LM35 temperature sensor is used to detect precise centigrade temperature. When the temperature sensor is either placed on patient's body or beholder by the patient. The output voltage of this sensor changes describes the linearity. The output of this sensor is linearly comparative to the Celsius temperature. By this the temperature of the patient can be obtained.The data from the infusion pump could be gathered by using two sensors. In infusion pump the component may be either liquid or in gas state. In case of liquid, the ultrasonic sensor is used and for gas like oxygen, weight sensor is used. By giving medication like fluid into the patient body the, one should know the timing when the medicine will about to over. For identifying the amount of fluid, ultrasonic sensor emits sound wave to calculate the distance. Sound waves are emitted by the ultrasonic sensor and they are reflected back, by calculating the distance we can easily identifies when the liquid is about to over.

B. Updating The Data

The collected data from the sensors will be updated to the cloud and it is retrieved by the hospital representative. This process could be done with the help of MQTT protocol (Message Queuing Telemetry Transport).MQTT is publish-subscribe based messaging protocol. Here the publisher publishes the data, that is the data from the sensors are updated to the cloud. And the subscriber retrieves the data that are published by the publisher.

C. Validating The Data

After the updating of data, the message is sent as a alert message. In this phase we are using Data Validation Algorithm. By using this algorithm only the validated data will be send as a notification message to the hospital representative. The data above the given threshold value only sends as a message and otherwise all the data are send in a 30 minutes time interval gap. By this algorithm we can save the power consumption and less data usage.

D. *MQTT Protocol*

MQTT is a Message Queuing Telemetry Transport protocol. It is as a light weight protocol that uses publish/subscribe operations to exchange data between clients and server. Furthermore, its small size, low power usage, minimized data packets and ease of implementation make the protocol ideal of the “machine to machine” or “Internet of Things”.

MQTT is based on clients and a server. Likewise, the server is responsible for handling the client requests of receiving or sending data between each other. MQTT server is called a broker and the clients are simply the connected devices. So when a device (a client) wants to send data to the broker, we call this operation a “publish”. And when a device (a client) wants to receive data from the broker, we call this operation a”subscribe”. This client are publishing and subscribing to topics. So, the broker here is the one that handles the publishing/subscribing actions to the target topics.In this architecture, the pulse sensor, temperature sensor, ultrasonic sensor and weight sensor have to send their data to the broker. On the other side, a desktop application wants to receive these values. The broker role here is to take the data and deliver it to desktop application.

D. Data Validation Algorithm

Steps for validating the data

1. Input: Array of sensed data (x)
2. Output: Array of sensed data (x)
3. Select random variable U, V, X, Y
4. Compute U, V, X, Y
5. X[i]=x[V, U, X, Y];
6. $Count_{fault}$=0;
7. For i <- 0 to n do i<-i+1
8. If(x[i]>= β_{min} & x[i]<=β_{max})
9. Then status [i] <- good
10. Else status [i] <- fault
11. Fault [$count_{fault}$]<- i
12. $Count_{fault}$<- i+1
13. End if
14. End

E. Analog To Digital Converter

Analog to Digital Converter samples the analog signal on each falling or rising edge of sample clock. In each cycle, the ADC gets of the analog signal, measures and converts it into a digital value. The ADC converts the output data into a series of digital values by approximate signals with fixed precision.

F. Threshold Value

The threshold limit value of a chemical substance is believed to be a level to which a worker can be exposed day after day for a working lifetime without adverse effects. Strictly speaking, TLV is a reserved term of the American Conference of Governmental Industrial Hygienists.

The below graph explains as Series1 line indicates existing work shows data accuracy low for every minute and Series2 line indicates for proposed work with high accuracy rate.

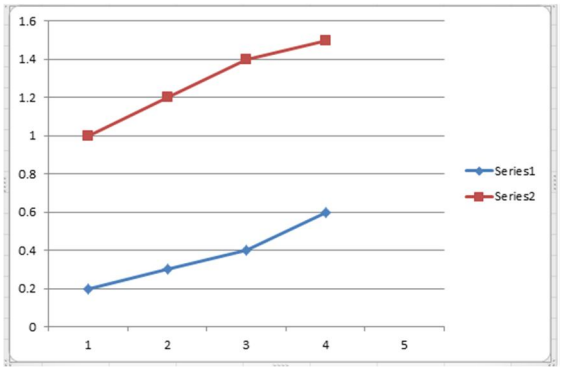

Fig:2 Graph Evaluation

A. CONCLUSION

In this architecture, all the sensors are connected and monitor the hospital in a efficient manner. The pulse sensor identifies the heart rate, temperature sensor identifies the patient body temperature, and infusion is used to identify the data drip rate. In the infusion pump the medication may be a fluids or oxygen. In case of liquid, ultrasonic sensor is used and for oxygen cylinders, weight sensor is used. These data are send to a cloud and by data validation algorithm, the value above the threshold details will be send as a message alert otherwise sends at a 30 minute time interval gap.

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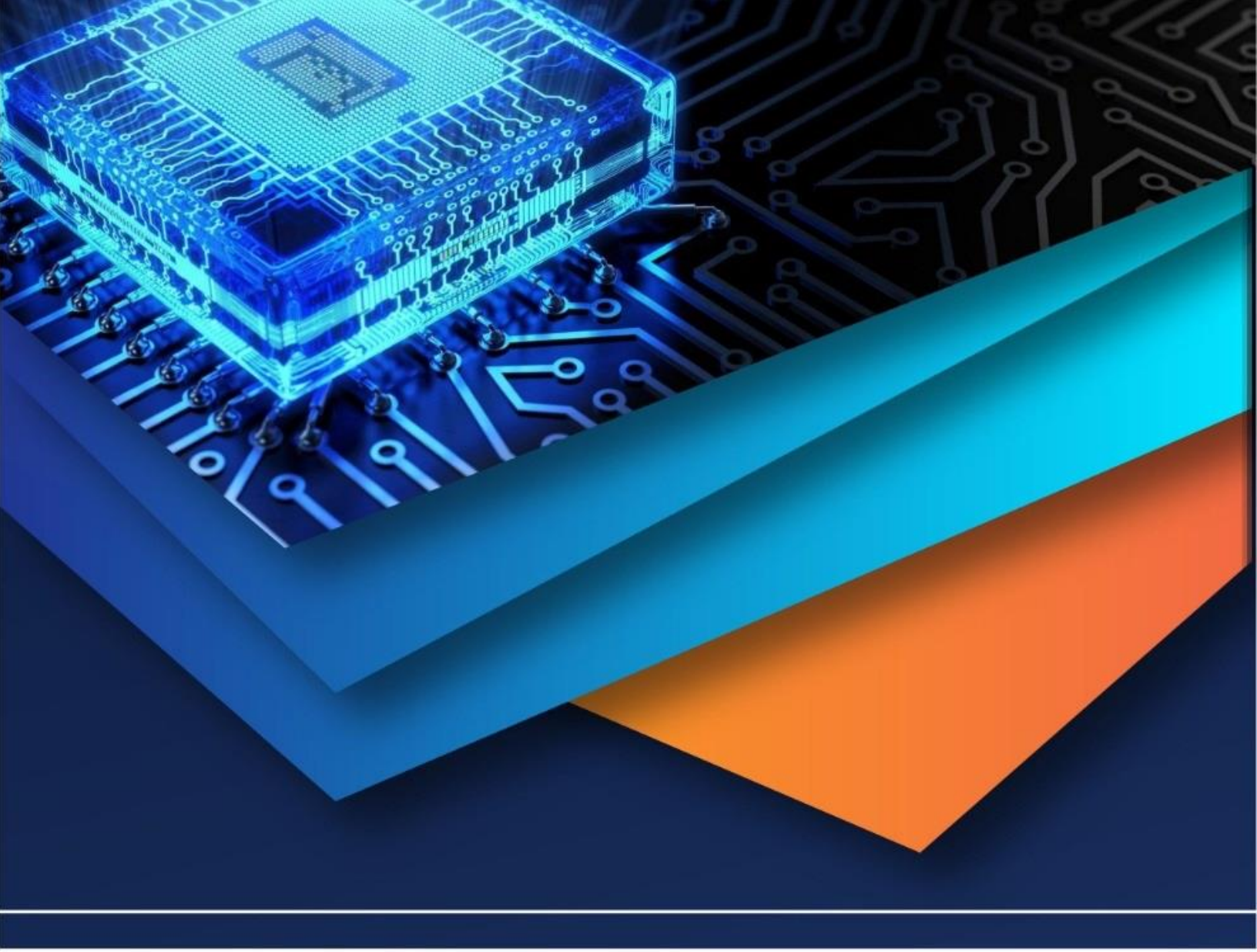

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