Survey on Real-Time Health Monitoring System based on IOT

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ABSTRACT
Monitoring medical parameters in critical, unpredictable and post operational days play a major role. The probability of collapse and the consequences of conditions that cause danger to life are minimized due to real time and periodic health monitoring. Whenever a saline is fed to any patient, the patient needs to be continuously administered by a nurse or the caretaker. Because of the negligence and inattentiveness towards saline bottles by doctors, nurses or caretaker of the patients and lack of number of nurses with efficient skills in hospitals and their excessive workload, a large number of patients are dying and are being harmed in the hospitals. In wide range of healthcare applications Internet of things (IoT) plays a significant role and also serves as an incentive for the healthcare. Hence adaption of the latest orientation in Healthcare communication technique using IoT is done. In this project various sensors communicate through a gateway which is basically an Arduino Uno R3 microcontroller. The sensor data is accessed by microcontroller and sent to the network through Bluetooth. Therefore it procures a real time monitoring of the medical management parameters for doctors. The controller is attached with an alarm to alert the caretaker about varied parameters of sensors. But the major concern in monitoring system is that it monitors patient remotely and the data has to be channeled with security to the destination. When an extreme situation is reached system sends an alert notification to the concerned ward staff. This system is agile, efficient along with low power consumption capacity, time to time response, high performance and easy setup .This proposed system can be utilized efficiently in homes as well as hospitals.

General Terms
Internet of Things (IoT), SSL Encryption, Naive Bayes Classification Algorithm.

Keywords
Pulse Oximeter Sensor, Temperature Sensor LM3, Blood Pressure Sensor, Accelerometer, Saline, Load cell, Bluetooth, Wi-Fi ESP8266.

1. INTRODUCTION
Today Internet has become one of the major concerns in our day to day lives by changing the way people live, work, and play and learns. Internet is utilized in many things like educations, finance, business, industries, entertainment, E-Commerce, Social Networking, Shopping, etc. The next new shift in Internet is going to be Internet of Things (IOT).This is the world of the Internet of Things (IOT). IOT is generally summed as connecting objects to the Internet and using that connection for control of those objects or monitor remotely. Considering in market today the machine to machine market today this definition was referred as a part where IOT was evolved. The concept of IOT is based on sensors, gateway and wireless network which enable users to communicate and access the application/information. "Health is wealth" is exceptionally important for making use of the innovation for better well being. So a shrewd healthcare service groundwork where client information is retrieved by the sensor and delivered through Bluetooth to cloud only allowing access to information to the approved clients.

2. PROBLEM STATEMENT
To develop a health care monitoring system using IoT and efficient communication technology providing a secured data encryption. To provide constant monitoring of the different healthcare parameter. To provide smart monitoring of critical level of saline in the saline bottle. To provide notification and alert system during extreme condition or changes in threshold health parameter of the patient.

3. EXITING SYSTEM
3.1 Current scenario:
In utmost of the developing countries today the healthcare framework is very poor. There are very few hospitals in compared to the increasing population which are inadequately equipped and have very few doctors. The basic diagnostic equipment for the diagnosis of various life threatening diseases are not present. The monitoring of saline level has to be done continuously by the nurse or caretaker. If we could build a low-cost portable health sensing device, comprising of various sensors which is capable of measuring the important attributes of a human body, and has the ability to communicate with the database provided at the hospital.

3.2 System implementation technologies:
3.2.1 Using PIC Microcontroller, ESP8266 Wi-Fi module. [1]:
Healthcare system using a PIC18F46K22 microcontroller in which the MCP6004 Pulse oximeter is used and DS1820B temperature sensor reads the body temperature and heart rate of patient. The microcontroller accesses the data and transmits it through ESP8266 Wi-Fi protocol. The data is displayed on the LCD so patient can know the status of his health. During emergencies message is delivered to the doctor's cell phone by GSM modem connected and simultaneously the buzzer buzzes to alert the caretaker. The doctors can access the data by logging to the webpage with unique IP and page refreshing options and continuous data reception is achieved. The data is also displayed on LCD so patient knows his health status

3.2.2 ARM LPC2148 and NFC Reader connected to Arduino microcontroller. [2]:
With the combination of electronic sensing, NFC and internet of things, the health care services are improved significantly by regularly monitoring the patients, consolidating reports and alerting concerned doctors in case of emergencies.

3.2.3. Sensors connected to ArduinoR3 & Android using Ethernet. [3]:

and heart beat can be wirelessly monitored through laptop or personal computer.

4. COMPARITIVE STUDY

Table 1. Comparative study on the current implementation technologies

Analysis Parameters	**Solution 1**	**Solution 2**	**Solution3**	**Solution4**
Health monitoring Sensors used	Temperature(LM3) Pulse Oximeter (TCRT1000)	Temperature LM3 Heart Beat RKI3156 Blood Pressure(BMP180)	Accelerometer ADXL335 ECG Sensor(MOD-EKG) Heart Beat RKI3156 LM3 Temperature Sensor	Accelerometer ADXL335 ECG Sensor MOD-EKG
Microcontroller	PIC 18F46K22	ARMLPC2148 and Arduino	Arduino 3	Arduino UNO for ADC And Raspberry Pi3.
Communication	Wi-Fi	Ethernet, NFC Technology	Ethernet	Zigbee
Notification service	Yes.(GSM)	Yes. Using GSM Module	Yes. Android Application	No.
Alarm	Yes.	No.	No.	No.
Security provision	Unique IP Address	RFID NFC.	No	SSL Algorithm
Constant Monitoring	Yes. Very Efficiently	Yes.	Up to Some Extent	Yes. Efficiently
Complexity	Moderate	Complex	Simple	Complex
Bulky	No	A bit.	Not at all	Yes.
Cost (Sensor and hardware used)	DS18B20 Temp Sensor- 57/- Pulse Oximeter (TCRT1000)- 1400/- PIC - 250/- GSM Modem- 500/- Total= 2270/- (approx)	LM3 Temp Sensor-57/- Heart Beat RKI3156 - 400/-Blood Pressure (BMP180)-500/- Arduino- 550/- NFC Module - 1000/- ARM7LPC2148 - 1849/- Total (Approx) = 4500/-	Accelerometer (ADXL335) - 430/- ECG Sensor (MOD-EKG)-2000/- Heart Beat RKI3156-400/- LM3 Temperature Sensor Arduino 3 - 350/- Total (Approx) = 3200/-	Accelerometer (ADXL335)-430/- ECG Sensor MOD-EKG -2000/- Arduino Raspberry Pi 2000/- Zigbee - 990/- Total(Approx) = 5500/-
Cost Effective	Yes.	No.	Up to Some Extent	Not at all.
Can be applied	At Hospitals &Home	At Hospitals	At Hospital & Home	At Hospitals

parameters data are stored and can be published online. Hence doctors and caretakers monitor their patients from a remote location any time.

3.2.4 Using Raspberry Pi and ECG Signal [4]:

A model of patient monitoring system using wireless sensor network. A wireless communication is created between Zigbee modules and Arduino Uno board to process the data information and displayed on the monitor. The ECG signal

5. PROPOSED SYSTEM

Technology performs a significant role in medical services for sensory devices, communication, recording and display device. It is necessary to monitor various health maintenance parameters in operational days. Hence there is adaption using IOT for Healthcare communication which has been the latest shift. Internet of things plays an important role in wide range of health maintenance applications and also serves as a catalyst for the medical services. In this project various sensors such like temperature sensor and heart rate sensor communicate through a gateway which is basically an Arduino Uno R3 microcontroller. [3] The sensor data is read by microcontroller and delivered to the network through Bluetooth [7]. Thus it procures a real time monitoring of the health care parameters to doctors. There is always need for efficient, time saving means of communication between doctors, hospitals, patient and all other concern persons. We can enhance this system by building collaborative system comprised of smart phones/tablets, automated Sensor node which will be connected with a system at hospital and with all concern persons. In this system, we are using three types of sensors for detecting patient's health. They are: weight sensor which is basically a load cell, temperature sensor and a heart beat sensor.[2] In this system one sensor node which is the load cell is hung to the saline bottle of patient and the weight of saline bottle is monitored, and when saline bottle gets empty an alert notification will be sent to the concerned ward staff's mobile application or to the admin.[5] Similarly, the heart rate sensor is mounted on patient's finger, when the heart rate goes beyond the threshold heart rate value the alert notification is send to ward staff mobile App. This heart rate is set according to patient's BP level, age criteria, sex and disease which can be done using the Naive Bayes Classifier. [6] Similarly, the last sensor node is used to monitor the patient's temperature level. We can maintain the graph of temperature level by continuously monitoring them. We are measuring saline level of bottle, temperature of body in case of typhoid and similar diseases for which monitoring temperature graph is of utmost importance, heartbeats are measured using this heart rate sensor and immediately informed to the respective ward admin for his/her care in extreme condition.

5.1 Implementation Methodology:

In this system Arduino Microcontroller retrieves the data from various sensors and transmits it through Bluetooth. The secured data sent can be accessed anytime by the doctors ubiquitously. Buzzer buzzes and information is procured to the doctor/caretaker during emergencies. Patient health status is provided to the doctor/ward staff on daily basis. Hence continuous monitoring of patient data is achieved. Considering the best out of the four implementations we studied, the health monitoring system using Arduino Uno R3 [3] and Bluetooth [7]. Our idea is to advance the same system with more sensors like the load cell for smart saline monitoring [5]. Taking into consideration the security we can apply SSL for encryption [4]. Also, the patient's threshold heart rate and heart risk can be analyzed using the Naive Bayes Classifier Algorithm by creating tuple for respective patient against the dataset

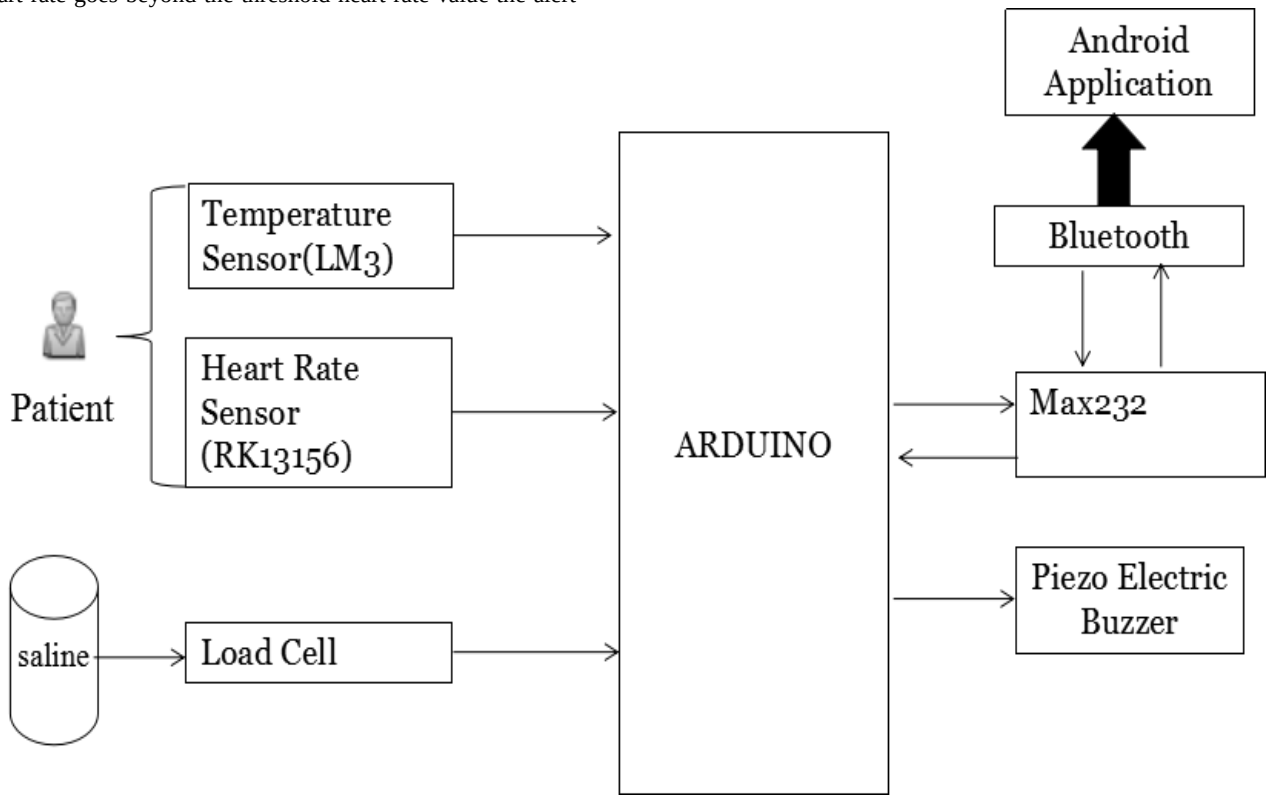

Fig 1: Proposed System Block Diagram

5.2 Hardware Description:

5.2.1. Arduino Uno R3 Microcontroller [3]

Arduino Uno is an ATmega328P (datasheet) based microcontroller board. It comprises of 14 digital input/output pins (6 may be used as PWM outputs), 6 analog inputs, a power jack, a 16 MHz quartz crystal, a USB connection, an ICSP header and a reset button. It is provided with everything which is needed to support the microcontroller; one has to simply connect it to a computer with a data cable or power it with an AC-to-DC adapter or battery.

5.2.2 Bluetooth Module (HC-05) [7]:

HC-05 module is a Bluetooth SPP (Serial Port Protocol) module which is easy to use, designed especially for transparent wireless serial connection. The HC-05 Bluetooth Module is mainly used in a Master or Slave configuration, making it a significant solution for wireless communication. This serial port Bluetooth module is completely qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3 Mbps Modulation with complete 2.4GHz radio transceiver and baseband. CSR Blue core 04-External single chip Bluetooth system is used with CMOS technology and with the AFH (Adaptive Frequency Hopping Feature).

5.2.3. Temperature Sensor (LM3) [2]

DS18S20 is 1-wire digital thermometer of 9-bit Celsius temperature and incorporates alert capacity with client programmable trigger and operates at the temperature range of -100C to +850C.

5.2.4. Load Cell [5]:

A load cell which is a force sensing module – a metal structure designed carefully, with small elements called strain gauges placed in precise locations upon the structure. Load cells are designed to measure a specific force, and which ignores other forces being applied. The electrical signal output by the load cell is extremely small and requires specialized amplification factor.

5.2.5. Heart-Rate Sensor (RK13156) [2]:

The heartbeat sensor based on the principle of photo phlethysmography measures change in the volume of blood through any organ of the body which causes a change in the light intensity through that particular organ (a vascular region). In case of applications where the heart pulse rate is to be monitored mainly, the timing of the pulses is extremely important. The flow of blood volume is decided by the rate of heart pulses and because the light is absorbed by blood, the signal pulses are equivalent to heart beat pulses.

5.2.6. MAX232 [1]

Max232 is a dual driver/receiver which converts TTL level to RS232 level. These receive the threshold of 1.3v and can accept +/- 30v supply. When Max-232 IC receives the TTL level it converts it in to voltage levels i.e. logic0 changes to voltages between +3 and +15v and logic1 changes to voltages between -3 and - 15v.

5.2.7. Piezo Electric Buzzer [1]

Buzzer is used to produce sound which is used to send an alerting message to the caretaker during emergencies. This sound indicates that the patient's health is at stake.

5.2.8. SSL Algorithm [4]

SSL (Secure Sockets Layer), for sending private documents over the Internet. SSL provides security to Netscape navigator, Internet Explorer and many other web sites. Also use the protocol to access confidential user information, such as credit card numbers. SSL uses a cryptography system that uses two keys to encrypt data - a public key known to everyone and a private or secret key known only to the receiver of the message. By convention, URLs that require an SSL connection start with https instead of HTTP. Secure HTTP(S-HTTP) is another protocol for transmitting data securely over the World Wide Web.

5.3 Algorithm:

5.3.1. Naive Bayes Algorithm [6]:

Naive Bayes classifiers is a probabilistic classifiers based on applying Bayes' theorem with strong (naive) independence assumptions between the features. A Naive Bayesian model is easy to build, with no complicated iterative parameter estimation which makes it particularly useful in the field of medical science for diagnosing heart patients. Despite its simplicity, the Naive Bayesian classifier often does surprisingly well and is widely used because it often outperforms more sophisticated classification methods. Bayes theorem provides a way of calculating the posterior probability, $P(c|x)$, from $P(c)$, $P(x)$, and $P(x|c)$. Naive Bayes classifier assumes that the effect of the value of a predictor (x) on a given class (c) is independent of the values of other predictors. This assumption is called class conditional independence

5.3.2. Equations [6]:

$$P(c/x) = \frac{P(x/c)P(c)}{P(x)}$$

$$P(c/X) = P(x_1/c) \times P(x_2/c) \times \ldots \times P(x_n/c) \times P(c)$$

- P (c|x) is the posterior probability of class (target) given predictor (attribute).
- P(c) is the prior probability of class.
- P (x|c) is the likelihood which is the probability of predictor given class.
- P(x) is the prior probability of predictor

Where C and X are two events (e.g. the probability that the train will arrive on time given that the weather is rainy). Such Naive Bayes classifiers use the probability theory to find the most likely classification of an unseen (unclassified) instance. The algorithm performs positively with categorical data but poorly if we have numerical data in the training set.

5.4 Advantages of the Proposed System:

1. Cost Effective
2. Less Bulky
3. Ceaseless and Secure Monitoring
4. Notification &Alarm Service.
5. Less Complex System Architecture.
6. Can be used at hospital as well as home level.
7. Automated System reduces Human Interface.
8. By integrating and streamlining your hospital workflow, it allows you to increase patient volumes without increasing staff.

6. CONCLUSION

Thus, we have studied various methodologies which will be significantly useful in developing a continuous patient health monitoring system using various different sensors, communication technology and microcontrollers processing them. This system presents an approach to the automatic system. The system is capable of measuring the saline level, body temperature, and heartbeats automatically and it is very helpful for doctors and patients. With advances in digital medical equipment, wireless sensors it is possible to gather data timely and precisely. We found the optimal solution by analyzing various parameters in relation with our objectives i.e. a health monitoring system using Android and Bluetooth which is portable and low cost system. Adding additional sensors and improving the security provision through SSL

encryption we can develop an advanced health monitoring system.

6. REFERENCES

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