

A SECURE IOT-BASED MODERN HEALTH CARE SYSTEM USING BSN

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Abstract :In the modern health care environment, the usage of IoT technologies brings convenience of physicians and patients since they are applied to various medical areas (such as real-time monitoring, patient information management, and health care management). The body sensor network (BSN) technology is one of the core technologies of IoT developments in healthcare system, where a patient can be monitored using a collection of tiny-powered and lightweight wireless sensor nodes. It is the networking which can accessible us from anywhere via internet.

However development of this new technology in healthcare applications without considering security makes patient vulnerable. We propose a secure IoT based healthcare system using BSN, called BSN-care, which can efficiently accomplish those requirements.

By using this system, it is possible to handle from anywhere without bothering about range or territories. Here we will make a web page along with our needs and then we can control our network from our PC or from our phone, such anywhere have internet connection.

It makes all patients who are all having identity in the webpage, which is created for the communication, more efficient consulting. And also they can enjoy their life without depending others and can also be the part of modern health care system.

Key Words:IoT, BSN, Tmega328 Microcontroller, Heart beat sensor, Humidity sensor, LCD, Pressure sensor, SIM300C, Temperature sensor(Thermistor)

I. INTRODUCTION

The advances in information and communication technologies have led to the emergence of IoT and BSN. Now, Internet of Things (IoT) has become one of the most powerful communication paradigms of the 21th century. In the IoT environment, all objects in our daily life become part the internet due to their communication and computing capabilities (including micro controllers, transceivers for digital communication). IoT extends the concept of the internet and makes it more pervasive. IoT allows seamless interactions among different types of devices such as medical sensors, monitoring cameras, home appliances so on.

We design a BSN (Body Sensor Network) powered by IoT. Here the system can access internet via the Wi-Fi modules... i.e. sensors can be handling more efficiently via an IoT concept. Whole devices/sensors can directly access via internet, can monitor via internet. So it is possible to handle from anywhere without bothering about range or territories. It is the networking which can accessible us from anywhere via internet. That is we will make a web page along with our needs and then we can control our network from our PC or from our phone. Such anywhere have internet connection. Here patient's health condition details can access by his/her doctor as well as his/her family members via a smart phone App.

Some researchers from different nations found that about 89% of the aged peoples are likely to live independently. However, medical research surveys found that about 80% of them are older than 65 suffering from atleast one of chronic disease causing many aged people to have difficulty in taking

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care of themselves. Accordingly, providing a decent quality of life for aged people has become a serious social challenge at that moment. The rapid proliferation of technologies is enabling innovative healthcare solutions and tools that shows promise in addressing the aforesaid challenges.

Extensive studies from different nations say that 80% of aged peoples of total population are suffering from at least one of chronic diseases. And providing good quality of life to the aged people who are like to live independently is become a social challenge. Thus we provide decent quality of life for aged people from their chronic diseases. And make them to enjoy modern medical healthcare services anywhere, anytime independently.

II. LITERATURE REVIEW

KomkritChooruang and PongpatMakalakeeree[1] proposed a paper for Heart Rate Monitoring system using MQTT which paper presents the heart rate monitoring system using ESP8266 Wi-fi module on the Arduino microcontroller and Message Queuing Telemetry Transport (MQTT) for messaging protocol that designed for lightweight communication. The developed system is intended to remotely monitor real-time heart rate of a patient. This design use simple infrared light and photo detector to detect and pick up the rate of heart beat signal and send measured data wirelessly to the MQTT broker where running on a Raspberry Pi, a low-cost, credit-card sized computer. The preliminary result demonstrated that the system provides useful information and helpful for nursing related health care task.

Heart related diseases are on the rise. Cardiac arrest is quoted as the major contributor to sudden and unexpected death rate in the modern stress filled lifestyle around the globe. A system that warns the person about the onset of the disease earlier automatically will be a boon to the society. To monitor individual heart functions Dr. Mrs. R. Sukanesh, S. PalanivelRajan, S. Vijayaprasanth, N.S. Aiswarya, P.Gracy Angela [2]proposed an Intelligent Wireless Mobile Patient Monitoring system. This is achievable by deploying advances in wireless

technology to the existing patient monitoring system. This paper proposes the development of module that provides mobility to the patient and doctor, by adopting a simple and popular technique, detecting the abnormalities in the bio signal of the patient in advance and sending an alert SMS to the doctor through Global System for Mobile (GSM) thereby taking suitable precautionary measures thus reducing the critical level of the patient.

Sakshi Sharma, RashmiVashisth[3] proposed a new system using Zig-Bee network for efficient and cheap rate communication. Centralized patient monitoring systems are in huge demand as they not only reduce the labor work and cost but also the time of the clinical hospitals. Earlier wired communication was used but now Zig-bee which is a wireless mesh network is preferred as it reduces the cost. Zig-bee is also preferred over Bluetooth and infrared wireless communication because it is energy efficient, has low cost and long distance range (several miles). In this paper we proposed wireless transmission of data between a patient and centralized unit using Zig-bee module. The paper is divided into two sections. First is patient monitoring system for multiple patients and second is the centralized patient monitoring system. These two systems are communicating using wireless transmission technology i.e. Zig-bee. In the first section we have patient monitoring of multiple patients. Each patient's multiple physiological parameters like ECG, temperature, heartbeat are measured at their respective unit. If any physiological parameter value exceeds the threshold value, emergency alarm and LED blinks at each patient unit. This allows a doctor to read various physiological parameters of a patient in real time. The values are displayed on the LCD at each patient unit. Similarly multiple patients multiple physiological parameters are being measured using particular sensors and multiple patient's patient monitoring system is made. In the second section centralized patient monitoring system is made in which all multiple patients multiple parameters are displayed on a central monitor using MATLAB. ECG graph is also displayed on the central monitor using MATLAB software. The

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central LCD also displays parameters like heartbeat and temperature. The module is less expensive, consumes low power and has good range.

Other than the above three papers a new paper was introduced by Bhoomika B.K, K N Muralidhara [4]. In this technology plays main role and can be add more number of sensors and using IoT these connected sensors can be monitored easily. Technology plays the major role in healthcare not only for sensory devices but also in communication, recording and display device. It is very important to monitor various medical parameters and post operational days. Hence the latest trend in Healthcare communication method using IOT is adapted. Internet of things serves as a catalyst for the healthcare and plays prominent role in wide range of healthcare applications. In this project the PIC18F46K22 microcontroller is used as a gateway to communicate to the various sensors such as temperature sensor and pulse oximeter sensor. The microcontroller picks up the sensor data and sends it to the network through Wi-Fi and hence provides real time monitoring of the health care parameters for doctors. The data can be accessed anytime by the doctor. The controller is also connected with buzzer to alert the caretaker about variation in sensor output. But the major issue in remote patient monitoring system is that the data as to be securely transmitted to the destination end and provision is made to allow only authorized user to access the data. The security issue is been addressed by transmitting the data through the password protected Wi-Fi module ESP8266 which will be encrypted by standard AES128 and the users/doctor can access the data by logging to the html webpage. At the time of extremity situation alert message is sent to the doctor through GSM module connected to the controller. Hence quick provisional medication can be easily done by this system. This system is efficient with low power consumption capability, easy setup, high performance and time to time response. [8] discussed about a project, in this project an automatic meter reading system is designed using GSM Technology. The embedded micro controller is interfaced with the GSM Module. This setup is fitted in home. The energy meter is attached to the micro controller. This

controller reads the data from the meter output and transfers that data to GSM Module through the serial port.

With the wide use of internet this work is focused to implement the internet technology to establish a system which would communicate through internet for better health. Internet of things is expected to rule the world in various fields but more benefit would be in the field of healthcare. Hence present work is done to design an IOT based smart healthcare system using a PIC18F46K22 microcontroller. In this work the MCP6004 based Pulse oximeter is designed and DS1820B temperature sensor is used to read the temperature and heart rate of the patient and the microcontroller picks up the data and send it through ESP8266 Wi-Fi protocol. The data is also sent to the LCD for display so patient can know his health status. During extreme conditions to alert the doctor warning message is sent to the doctor's cell phone through GSM modem connected and at the same time the buzzer turns to alert the caretaker. The doctors can view the sent data by logging to the html webpage using unique IP and page refreshing option is given so continuously data reception achieved. Hence continuous patient monitoring system is designed. The Microcontroller is connected to GSM Modem which provides information to doctor/caretaker when the heart rate is greater than 90 or less than 60 and when the temperature is less than 20 or greater than 35. During this time the buzzer turns on and alerts the caretaker. LCD is connected to microcontroller to display the transaction process and healthcare data. And the user interface html webpage will automatically refresh for every 15 seconds hence patient health status is continuously sent to the doctor. Hence continuous monitoring of patient data is achieved.

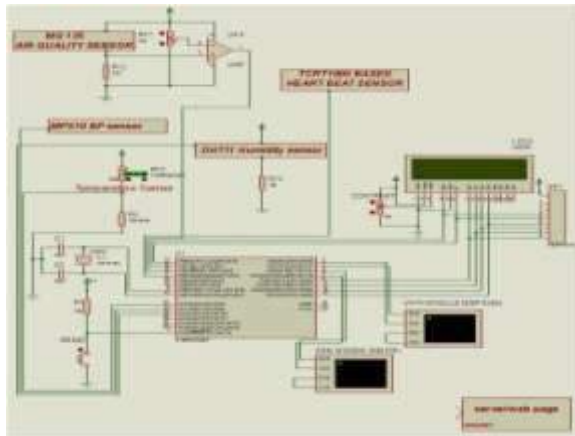
III. PROPOSED METHOD

In the case of network issue or Wi-Fi connectivity issue the Physician Could not reply for patient's updation. This is the worst case when it is an emergency case. Addition of a GSM/GPRS module will recover almost connectivity issue. The SIM300C is a GSM/GPRS module and which plug-in compact. Using internet is an optional case as compared to

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using mobile with a SIM. Propose technique to send SMS to Physician (or) Family members (or) emergency clinic by connecting a GSM. And also provide facility to repeat the alert when the patient doesn't get response from anyone.

Fig 1 Circuit Diagram of Proposed System



IV. HARDWARE DESCRIPTION

MQ-135 Air quality gas sensor applies SnO₂ which has a lower conductivity in the clear air as a gas-sensing material. In an atmosphere where there may be polluting gas, the conductivity of the gas sensor raises along with the concentration of the polluting gas increases. MQ-135 performs a good detection to smoke and other harmful gas, especially sensitive to ammonia, sulfide and benzene steam.

The new version uses the TCRT1000 reflective optical sensor for photoplethysmography (for heart beat sensing). The use of TCRT100 simplifies the build process of the sensor part of the project as both the infrared light emitter diode and the detector are arranged side by side in a leaded package, thus blocking the surrounding ambient light, which could otherwise affect the sensor performance.

The MPX10 series silicon piezo resistive pressure sensors provide a very accurate and linear voltage output, directly proportional to the applied pressure. These standard, low cost, uncompensated sensors permit manufactures to design and add their own external temperature compensation and signal conditioning networks. Compensation techniques are simplified because of the predictability of Freescale's single element strain gauge design.

DHT11 digital temperature and humidity sensor is a composite Sensor contains a calibrated digital signal output of the temperature and humidity. Application of a dedicated digital modules collection technology and the temperature and humidity sensing technology, to ensure that the product has high reliability and excellent long-term stability. The sensor includes a resistive sense of wet components and NTC temperature measurement devices, and connected with a high-performance 8-bit microcontroller.

These thermistors have a negative temperature coefficient. The device consists of a chip with two solid copper tin plated leads. It is grey lacquered and color coded, but not insulated. The thermistors are packed in bulk or tape on reel, see code numbers and relevant packaging quantities. The thermistors are marked with colored bands, see dimensions drawing and "Electrical data and ordering Information". By soldering in any position it can be mounted and not intended for potted applications.

The Atmel AVR® core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in a single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

It has the distinct advantage of having a low power consumption than the LED. Low power consumption requirement has made it compatible with MOS integrated logic circuit. Its other

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advantages are its low cost, and good contrast. The main drawbacks of LCD are additional requirement of light source, a limited temperature range of operation (between 0 and 60⁰ C), low reliability, short operating life and slow speed.

The SIM300C is a complete Tri-Band/Quad-Band GSM/GPRS solution in a compact plug-in module with DIP board-to-board connector. The GSM/GPRS 900/ 1800/1900MHz or 850/900/1800/1900MHz performance for voice, SMS, Data and Fax in a small form factor and with low power consumption.

V. EXPERIMENTAL ANALYSIS

This system describes the secured BSN for health care applications. And the existing system can be explained by two ways ,

- Section 1
 - Sensors
 - Microcontroller
 - LCD
- Section 2
 - PC/Mobile
 - Application/Webpage

These sensors sense the patient body and transmit the sensed physical parameters wirelessly to the end-user device (Laptop, PC/Mobile).

Security is the most important aspect of any system. Persons have different perspective regarding security and hence it defined in many ways. In general, security is a concept similar to safety of the system as whole. Now, the communication in sensor network applications (like BSN) in healthcare are mostly wireless in nature. This may result in various security threats to these systems. These are the security issues cloud pose serious problems to the wireless sensor devices.

A. Data Privacy

Data privacy is considered to be most important issue in BSN. It is required to protect the data from disclosure. BSN should not leak patient's

vital information to external or neighboring networking.

B. Data Integrity

Keeping data confidential does not protect it from external modifications. This altered data can be forwarded to the coordinator. Data loss can also occur due to the bad communication environment.

C. Data Freshness

Data freshness implies that the data should be fresh and no one can replay the old message.

D. Authentication

It is one of the most important requirements in any IoT based healthcare system using BSN, which can efficiently deal with impersonating attacks. In BSN Based healthcare system, all the sensor nodes send their data to a coordinator. Then the coordinator sends periodic updates of the patient to a server. Authentication helps to confirm their identity to each other.

E. Anonymity

A more satisfactory property of the anonymity is the intractability, which guarantees that the adversary can neither discern who the patient is not can tell apart whether two conversations originate from same (unknown) patient. Thus anonymity hides the source of a packet during wireless communication.

F. Secure Localization

Most of application requires accurate estimation of the patient location. Lack of smart tracking mechanism allows an adversary to send in correct reports about the patient location by reporting false signal strengths.

Experimental setup Existing System

This is an experimental setup of heart beat sensor connected to human body and it will sense the heart rate and update to the app.

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When the BSN-Care server receives data of a person (who wearing several bio sensors) from LPU, then it feeds the BSN data into its database and analyzes those data. Subsequently, based on the degree of abnormality, it may interact with the family members of the person, local physician, or even emergency unit of a nearby healthcare center. Precisely, considering a person (not necessarily a patient) wearing several bio sensors on his body and the BSN-Server receives a periodical updates from these sensors through LPU. Now, our BSN-Care server maintains an action table for each category of BSN data that it receives from LPU. Table denotes the action table based on the data received from BP sensor, where we can see that if the BP is less than or equal to, then it informs family members of the person. If the BP rate becomes greater than 145 and there is no one attending the call in family, then the server will contact the local Physician.

Data	Action	Response
BP ≤ 120	No Action	Null
BP > 130	Inform Family Members	FR:T/F
BP > 160 and FR:F	Inform Local Physician	PR:F/T
BP > 160, FR:F and PR:F	Inform Emergency	ER:T/F

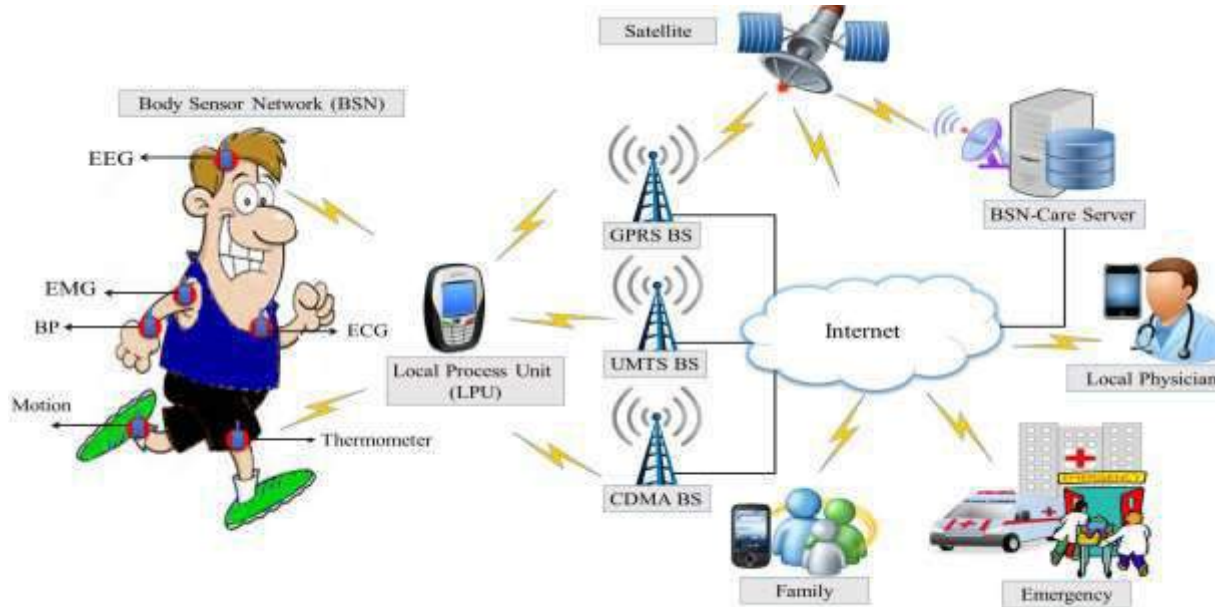
FR: Family Response ; PR: Physician Response ; ER: Emergency Response

Furthermore, if the BP rate of the person cross 160 and still there is no response from the family member or the local physician then the BSN-Care server will inform an emergency unit of a healthcare center and securely provides the location of the person. Here, the response parameters “FR”

Example of Action Table Using BP Data

BSN BP	Action	Response
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(Family Response), “PR” (Physician Response), and “ER” (Emergency Response) are the Boolean variables, which can be either true (T) or



false (F). If the value of any response parameter is false, then the server repeats its action. For example, when the family response parameter “FR: F”, then

the server repeatedly call his family members. Once, the family members of the concern person pick-up the call, then the value of the family response

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parameter (FR) will become true i.e. "FR: T". Now, if "FR:F" and BP > 130 then the BSN-Care server will call the local physician. In case, when the physician also does not respond to the server's call, then the value of the physician response parameter "PR" will stay in false. In this regard, the server will repeatedly call both the family members and the physician. Unless any of the response parameter (FR, PR) value becomes true. Meanwhile, if "FR: F", "PR: F" and BP >160, then the BSN-Care server immediately inform to the emergency unit of a healthcare center nearest to the concern person. Once the emergency unit responds, then the value of the emergency response parameter "ER" will become true i.e. "ER: T". It should be noted that, our BSN-Care system is not only designed for the patient, instead of that it can be useful for providing a decent quality of life for the aged people.

INTERNET OF THINGS

The Internet of things (IoT) can be defined as connecting the various types of objects like smart phones, personal computer and Tablets to internet, which brings in very new-fangled type of communication between things and people and also between things. With the introduction of IoTs, the research and development of home automation are becoming popular in the recent days. Many of the devices are controlled and monitored for helps the human being. Additionally various wireless technologies help in connecting from remote places to improve the intelligence of home environment. An advanced network of IoT is being formed when a human being is in need of connecting with other things. IoTs technology is used to come in with innovative idea and great growth for smart homes to improve the living standards of life.

The theory and development of computer system able to perform task normally requiring human intelligence such as visual perception speech recognition decision making, and translation between language. Artificial intelligence (AI) is the intelligence exhibited by machines or software. It is an academic field of study which generally studies the goal of emulating human-like intelligence. The Internet of Things (IoT) is very closely related to

Artificial Intelligence (AI). In fact, IoT would not be very powerful without AI. Iot will connect devices from the high end, like computers, to the low end like sensors. Instead we will place a value on predictability give each device limited AI. In an IoT solution, AI can help to review and analyze the data you've collected to find patterns or similarities that can be learned from, so that better decision can be made. The data has to be analyzed in terms of what's normal and what's not. Similarities, correlations and abnormalities need to be quickly identified based on the real-time streams of data. The data collected, combined with AI, makes life easier with intelligent automation, predictive analytics and proactive intervention

VI. CONCLUSION

In this paper, at first we described the security and privacy issues in healthcare applications using body sensor network (BSN). Most of the previous projects fail to embed strong security services that could be preserve patient privacy. We proposed a secure IoT based healthcare system using BSN, called BSN-care, which can efficiently accomplish various security requirements.

Addition of a GSM/GPRS module will recover almost connectivity issue. The SIM300C is a GSM/GPRS module and which plug-in compact. Using internet is an optional case as compared to using mobile with a SIM.

It can be applied for any type people who are suffering from chronic diseases at anywhere and at anytime. And also it will be helpful for them to know about their health status without any risk.

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