International Journal of Scientific Engineering and Research (IJSER)
ISSN (Online): 2347-3878
Index Copernicus Value (2015): 62.86 | Impact Factor (2015): 3.791

BSN Care: Secure Patients Monitoring and Display System Using IOT

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Abstract: ***Advancement in wireless information and communication technologies has led to the emergence of Internet of Things (IOT). The use of the IOT technology in the modern health care environment helps to connect physicians and patients from remote areas. They are applied to various medical areas (such as healthcare management, real-time monitoring and patient information management). The body sensor network (BSN) technology is one of the attractive technologies of IoT. In BSN a patient can be monitored using lightweight sensor nodes which are of very small power. However, the development and implementation of this new technology in healthcare applications without considering security makes patient privacy vulnerable. In this project, we have taken care of security requirements in BSN-based modern healthcare system. Subsequently, we have proposed a BSN care: secure patients monitoring and display system using IOT which can efficiently accomplish those requirements.***

Keywords: IOT, BSN, PMS, Raspberry PI 3B, MCP3008, GSM 900

1. Introduction

In a modern days health is one of the challenges for humanity. BSN technology is one among the most spectacular technologies used in IOT based modern health care system. It's the gathering of low power and light-weight sensor nodes that are used to monitor the human body function. The system desires high security to forestall malicious interaction with the system because BSN nodes collect sensitive information of the patient.IOT has became one of the most powerful communication frame work of the 21th century that makes these health care remote monitoring system technically feasible. In existing system security issue was the major disadvantage. Due to these lack of security some. Patient's vital information is lost which lead to the vulnerability of the patient privacy.

In the proposed design mainly concentrates on the security of the patient's information. The proposed system design to measures and monitor patients parameters such as Temperature, pulse rate, ECG, fall detection and motion detection. The measured result will be recorded using Raspberry PI and result will be uploaded to the web page using PHP. Doctors OR the concerned care taker can login to the website and view those results. In case of emergency the message will be sent to the doctor or the concerned care taker using GSM module. The data saved in the data base can be accessed only by the doctors or by the authorized person(care taker). The doctors, patient or his family members can be given authorization. In the existing system a patients monitoring system (PMS) was designed which provided quality of the healthcare without disturbing patients comfort. The projects concentrated on the cost effectiveness, power consumption and reliability of the prototype, but security was the major issue which is greatly imperative for critical application.

2. Related Works

The advanced technologies in the field of BSN have made patients monitoring more feasible. Recently several healthcare researches and projects where proposed which mainly aimed about continues monitoring of the patients in ambulance, in hospitals, in open environment.

One among them is CODEBLUE [1] which is the popular health care research project based on BSN. The basic idea of the project was to straightforward a patient's query to the doctor using personal digital assistant. In this project several bio-sensor are placed on patient's body which transmit patient's parameters wirelessly to end user device for further analysis but security is still pending.

Heterogeneous network architecture was designed at the University of Virginia and was named Alarm-net [2]. The design was mainly for patient's health monitoring in the assisted living and home environment. The architecture consists of BSN and environment sensing network. The design facilitates network and data security for physiological, behavioral, environment parameters about the residents.

The department of computing, Imperial college, London proposed another BSN based healthcare system UbiMon[3] the project aimed for analyzing the issues related to usage of implementable and wearable sensors for distributed mobile monitoring. This project was widely accepted without considering the security of wireless healthcare monitoring.

In year 2006 a mobile healthcare project called mobicare[4] was developed by Chakravorty. This project gave a wide area mobile patient monitoring system. Although project provided a continuous and timely monitoring of the patients status security was d drawback of the project.

Recently Johns Hopkins University proposed a new system called mediSN[5] which was specially designed for patients monitoring in hospitals and during disaster was reported. They considered a battery powered motes which were equipped with sensors for collecting patients biological parameters. Here author did not mention which

crypto-system was used for data privacy, and how the integrity has been checked for receiving the data.

As we saw above the researches enable automatic patients monitoring and provide quality of the healthcare without disturbing patients comfort. All projects concentrated on the cost effectiveness, power consumption and reliability of the prototype, but security was the major issue which is greatly imperative for critical application.

3. Proposed System Methodology

BSN sensor network helps to monitor the patient condition from the remotely place. The architecture of the proposed system is shown in the fig. It consists of the Raspberry Pi, GSM SIM 900, MCP 3008, Wi-Fi module, Temperature sensor, ECG Sensor, IR sensor, PIR sensor, Heart beat sensor.

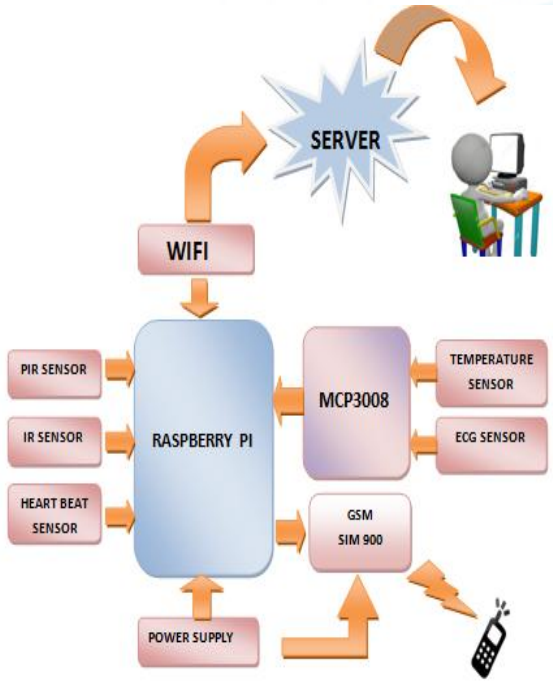


Figure 4.1: Block diagram

3.1 Raspberry Pi

Raspberry pi 3B is used as a controller which is the 3rd generation raspberry pi model or raspberry pi foundation in UK. It is the low cost, credit card sized computer that can be plugged in to monitor.

3.2 MCP3008

The raspberry pi computer does not have a way to read analog inputs. It's a digital-only computer. Analog inputs are handy because many sensors are analog outputs, so we need a way to make the pi analog-friendly. We will do that by wiring up an MCP3008 chip to it. The MCP3008 acts like a bridge between digital and analog. It has 8 analog inputs and pi can query it using 4 digital pins. That makes it a perfect addition to the pi for integrating simple sensors.

3.3 PIR sensor

PIR sensor is used here for the motion detection. The PIR (passive infra-red) sensor is a pyroelectric device that detects motion by measuring changes in the infrared levels emitted by surrounding objects.

3.4 IR sensor

IR sensor is used here for fall detection. An infrared sensor is an electronic instrument which is used to sense obstacles by emitting and detecting infrared radiation.

3.5 Hearts beat sensor

Heart beat sensor used here is TCRT1000 which finds the pulse rate. TCRT1000 simplifies the sensor because both infrared light emitter diode and detector are arranged side by side in a leaded package which blocks the surrounding ambient light which may affect the sensor performance.

3.6 Temperature sensor

Temperature sensor is device which is designed specifically to measure the hotness or coldness of an object. Here LM35 temperature sensor is used because it measure more accurately than with a thermostat.

3.7 ECG sensor

ECG sensor used here is AD8232. It's an integrated signal conditioning block for ECG and other bio-potential measure application. It is designed to extract, amplify and filter small bio-potential signal in the presence of noisy conditions, such as those created by motion or remote electrode placement. This design allows for an ultralow power ADC or an embedded microcontroller to acquire the output easily.

3.8 GSM900

GSM SIM900 is used here for sending message to authorized person in case of emergency. Emergency condition is when the patients reading crosses the normal range or the person falls and IR sensor output is high. In such conditions a message "check patients condition" will be sent to the authorized phone no.

3.9 Server

The patients parameters are sensed by raspberry pi are stored on a server and uploaded to the web-page which is created using PHP which makes it globally accessible. And security is provided by providing the login id and password only authorized person can login to the page and access patient's parameters from anywhere.

3.10 Putty software

Putty is a free and open-source terminal emulator; serial console and network file transfer application. It's a very versatile tool used to remote access the raspberry pi with help of its IP address.

4. Design Flow

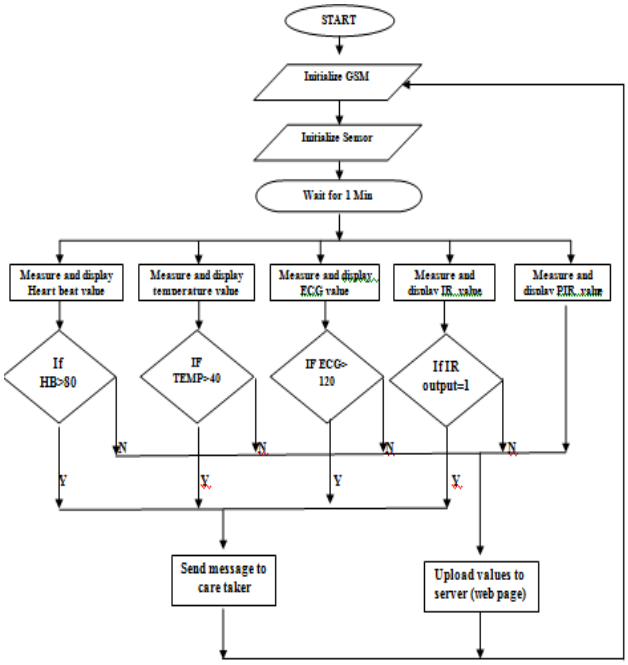


Figure 4.1: Design Flow

When the raspberry pi is powered and it 1st initializes the GSM SIM900 with AT commands. To check Whether GSM is initialized give command as AT and press enter then GSM should respond as OK. Once the GSM is initialized the controller initializes all sensors and waits for 1 min to take the value because heart beat ECG are taken for 1 min.

Heart beat rate varies from one aged person to other aged person but generally we take 60-80Bpm as the normal heart beat rate. heart beat less than 50Bpm is considered as a abnormal condition called bradycardia (slow heart rate) and heart beat above 100Bpm is also considered as abnormal condition called tachycardia(too fast heart rate). The heart beat sensor output is connected to 3rd pin which is the GPIO of the raspberry pi. The sensor output is displayed on the putty command window. If the heart beat rate crosses 80 that is in case of tachycardia the message will be sent to authorize number. Authorized number can be a care taker's number or doctor's number.

Name of disease	Range	Action taken
Bradycardia	<50Bpm	Message is sent to mobile number
Normal heart beat range	60-80Bpm	No action taken. Value is displayed on web page
Tachycardia	>100Bpm	Message is sent to mobile number

As a temperature sensor is a analogue sensor its output is converted to digital value using MCP3008 converter and its given as a input to raspberry pi. The normal body temperature of a human varies between 35^0C to 40^0C. If the body temperature is less than 35^0C then it's considered as hypothermia and if it's greater than 40^0C then it's considered as hyperthermia. The sensor output is displayed on the putty command window and then is updated to the web page. In the case of hyperthermia the message will be sent to authorize number. Authorized number can be a care taker's number or doctor's number.

Name of disease	range	Action taken
Hyperthermia	>40^0C	Message is sent to mobile number
Normal range	35^0C-40^0C	No action taken. Value is displayed on web page
hypothermia	<35^0C	Message is sent to mobile number

ECG is again an analog sensor the electrodes placed on body picks up the bio potential signals generated by the body and those signals are filtered amplified and are feed to the MCP3008 analogue to digital converter. The digital converted values are given as an input to the raspberry pi.. These values are displayed on the putty window and are successfully uploaded to the webpage. In the case of emergency the message will be sent to authorize number. Authorized number can be a care taker's number or doctor's number.

IR sensor is used here for the fall detection. If the IR sensor output is high then it's considered as the patient has meat with some obstacle and is fallen down. At such conditions the message patient is unconscious is displayed on the putty window and also successfully uploaded to the webpage and message will be sent to authorize number. Authorized number can be a care taker's number or doctor's number.

IR sensor output	Patient condition	Action taken
Low	Patient is normal	No action taken. Value is displayed on web page
High	Patient is unconscious	Message is sent to mobile number

PIR sensor is used for motion detection of the patient is the body parameters varies depending on whether the person is in rest or in motion. If the motion is found then its displayed on the web page else its displayed as patient is at rest. For this sensor there is no emergency message alert is set.

5. Results

a) Putty window outputs

This window is the putty software window which shows the outputs of the sensors before uploading to the web page. The OK is the response from the GSM for the AT command showing it's initialized. Hb=67 shows the heart beat rate is 67. And PIR sensor output is Low so there is no moment found. Temperature sensor was not connected to body so it's showing the room temp that is 28. ECG output was 236 on connecting to human body. IR sensor output was Low as there was no obstacle so it displayed as patient normal. The result {u'status':u'success', u'message':u'data updating successful'} indicates that patients parameters are successfully uploaded to the web page. Once the values get uploaded to the web page the

controller restarts with initializing spi devices and process repeats. As shown in figure.

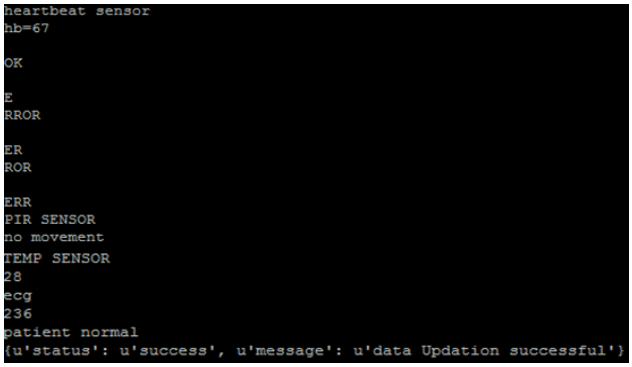


Figure 5.1: putty window output

b) Web page

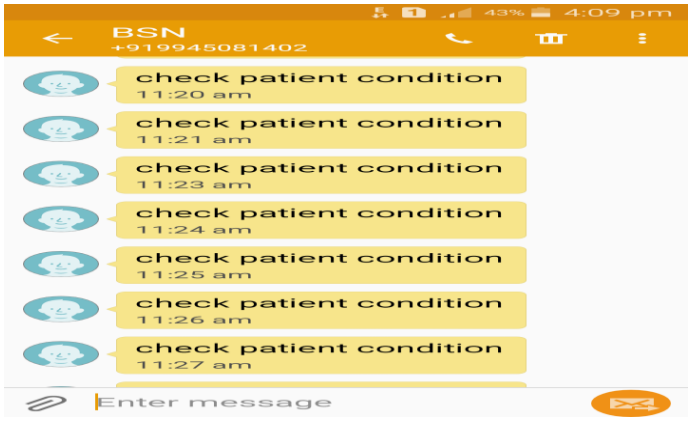
The web page is created and it can be accessed from any remote place using mobile, laptop or a desktop. We are using the PHP and HTML languages to develop a web pages or web applications. MySQL and PHP languages are used as Back End language and HTML language is used as Front End language.

Login page: The login page is used for the security issues only authorized person can login to the page and view the patient's parameters. Once u login to the page you are on dash board page which shows which all the parameters of patiensts are being checked. Dashboard consist of the buttons with a parameters name, on pressing they take you to the page of parameter were the current reading of the sensor is displayed.

Figure 5.1: Web Pages

b. GSM output

When the patients sensor parameters excides the normal range or when IR sensor output is high i.e. patient is unconscious the message will be sent to the care taker.



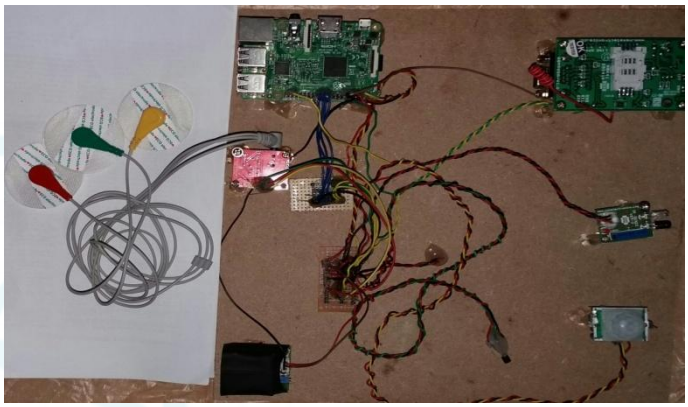


Figure 5.2: GSM output and proposed design

6. Conclusion

The IOT based BSN system is designed to measure and monitor patients parameters such as Temperature, pulse rate, ECG, fall detection and motion detection by the use of low power, light weight sensors. The measured results are recorded using Raspberry PI and results are uploaded to the web page using PHP. The login page is created to overcome the security problems. In case of emergency the message is sent to concerned care takers using GSM.

Acknowledgement

I would like to thank my guide Dr. Meghana Kulkarni (Associate Professor, Department of VLSI Design and Embedded Systems) for the key guidance, adequate support, time and constant encouragement towards the project. And also I would like to thank all co-guides for their constructive suggestions.

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