IoT Based HRV Monitoring System for Hypertensive Patients in Remote Areas

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Abstract: **Remote Health Care Monitoring System (RHCMS) has drawn considerable attentions for the last decade. As the aging population is increasing and at the same time the health care cost is skyrocketing there has been a need to monitor a patient from a remote location. Moreover, many people of the World are out of the reach of existing healthcare systems. To solve these problems many research and commercial versions of RHCMS have been proposed and implemented till now. In these systems the performance was the main issue in order to accurately measure, record, and analyze patients' data. With the ascent of wireless network RHCMS can be widely deployed to monitor the health condition of a patient inside and outside of the hospitals. In this work we present a Wi-Fi based wireless healthcare monitoring system that can provide real time information about the health condition of a patient. The proposed system is able to send data related to the healthcare professional about the patient's critical condition to Cloud. In addition the proposed system can send reports to monitoring system, which can be used by the healthcare professionals to make necessary medical advices at any time. The measurement of heart rate variability is a simple test that has been in existence for thousands of years due to the low-tech requirements for measurement. Heart Rate Variability (HRV) is determined by measuring the time gap between heart beats that varies as you breathe in and out. Heart rate (HR) is measured in terms of beats per minute. HRV monitoring is highly sensitive for highly risks linked with cardiovascular disease, Diabetic Mellitus disease and Hypertension patients. Measurement of HRV by using some parameters for such cases of high risk will useful in for providing adequate medical care at needed times. Our idea in the proposed system, HRV parameters are derived using Wireless Wi-Fi based pulse sensor and the care taker and doctor are intimated through Short Message Service in order to provide adequate medical help in case of emergency situations. At present there are no HRV monitoring systems that alarm the high risk hypertensive patients along with the aid of a remote doctor; the proposed system aims to achieve the same. The proposed system combines the dual benefits of Wi-Fi technology. This idea successfully fulfills all the ideal traits of a remote health monitoring system in terms of low-cost, long range, security, promptness and easy-to-use that serves in saving lives.**

Index Terms – Microcontroller, pulse sensor, Wi-Fi etc..

1. INTRODUCTION

Recently, human's work and life are increasingly tight with the rapid growth in the development of communications and information technology. The society has changed human being's way of life as well as challenged the traditional residence and also living standard keeps raising up day by day that people have a higher requirement for abode functions. Industrial automation is the use of control systems that handles different processes and machineries in an industry to replace human efforts. The purpose of automation was to increase productivity and to reduce the cost associated with human operators. Nowadays, the focus of automation has shifted to increasing quality and flexibility in a manufacturing process. Industrial automation eliminates healthcare costs and paid leave and holidays associated with a human operator. Although it is associated with a high initial cost it saves the monthly wages of the workers which leads to substantial cost savings for the industry. The maintenance cost associated with machinery used for industrial automation is less because it does not often fail. If it fails, only computer and maintenance engineers are required to repair it. Industrial automation fulfills the aim of the industry to run a manufacturing plant for 24 hours in a day 7 days in a week and 365 days a year. This leads to a significant improvement in the productivity of the industry. Automation alleviates the error associated with a human being. It produces better outcomes because of less errors. Industrial automation can make the production line safe for the employees by deploying robots to handle hazardous conditions. With the rapidly growing need for timely medical services, the traditional method of treatment at the clinic or hospital more often falls short in accomplishing success with respect to emergency cases. A method to sense life threatening risks prior to the actual happening sounds to be the need of the hour. IoT for healthcare offers to be a vital solution in adjourning such a serious issue. IoT, the inter-networking of various real world objects has become a popular phenomenon. With the rise in advent of sensors and actuators for use with various platforms, healthcare industry is being revolutionized by breaking the traditional methods. Hypertension has become common a serious disease that remains as the root cause for major Cardiac mortality and Stroke mortality. Hypertension is a condition where the blood pressure in the arteries of the body is higher than 120/80 mm Hg (more than 120 systolic and more than 80 diastolic).Risks health events like Stroke or Heart attack related to Hypertension does not happen all of a sudden; rather it is a continued risk factor that results in such life threatening events. HRV is as an important parameter that uncovers even dilates intricacies regarding health condition. The study of HRV enhances our understanding of physiological phenomenon, the actions of medications and disease mechanisms [8]. HRV parameters acts to be a predictor for Cardiovascular disease risk [7]. Thus, the proposed system aims to remote monitor as well as alert in critical situation based on the HRV parameters and Heart rate for borderline Hypertensive patients. The proposed system that is based on IoT shares the results of sensor data in terms of graph and manipulated HRV data to a remote medical practitioner through a web application. This helps in following up the patient's condition without a

hospital visit and to check the effectiveness of the treatment offered by the doctor. Currently, there are several standards and proprietary devices that support sensor networks [9]. Of all comparable standards, Zigbee are believed to be reliable standards.

2. RELATED WORKS

Internet of Things (IoT) technology based Remote patient monitoring using web services and cloud computing has been built in [1]. The system uses an IOIO microcontroller board that obtains ECG signals and sends it to the mobile device wirelessly using Bluetooth technology. An android application had been used to collect, store and transfer the ECG data further. The application also visualizes the data collected at the front-end. The collected data was saved as a binary file. The patient at the mobile device end was connected to the File Transfer Protocol server (FTP) via File zilla to upload the files. The server also supports multiple user logins with authentication. At the other end, the medical professional can download all the uploaded data of the patient from the FTP server for analysis of the patient's ECG waves. The highly unstructured binary files uploaded through a FTP server is stored in a filetable. The file table manages the files and the file metadata in a synchronized manner. The system incorporates a higher level of communication like machine to machine communication. Remote monitoring system of ECG and Temperature signals was implemented using Bluetooth technology in [2].

It uses an Arduino Uno board with ATmega328 microcontroller as data acquisition unit and for Analog/Digital conversion. ECG acquisition takes place on a 3-lead module followed by filtering and amplification of acquired signals. The INA 128P integrated circuit was used for its recommended usage in the medical devices. Data was transferred to a local device (Personal computer or Mobile phone) through Bluetooth technology. Captured and visualized signals are then sent to a remote database for storage which could be accessed by a web application deployed on server. A wireless 3-channel ECG transmission system that caters to monitor the health of the old using a Personal Digital Assistant (PDA) phone had been developed in [3]. The system consists of two ATmega328L microcontrollers, one with Zigbee transmitter and another with Zigbee receiver. The transmitter end collects data, stores in a Secure Digital (SD) card and transmits. The receiver send collected data to a remote server. It aims to cope with sudden attacks of diseases by continuous monitoring. A vital sign monitor based on wireless sensor networks and Telemedicine has been executed to measure the vital parameters like ECG, Heart rate and Respiration rate in [12]. It uses Bluetooth technology with sensor to transmit data to a smart phone.

A specialist application shall also provide a window based look into the patient's condition from the obtained data. Remote physiological parameters monitoring system has been designed and developed in [4]. The system comprises of heart rate sensor and temperature sensor to be worn by an at-risk person that is connected to a computer wirelessly. The device monitors as long as the data is logged into the system and sets up an alarm through the connected computer in the home when the parameters are found to be in risk level.

3. METHODOLOGY

The main aim of the project is to monitoring the health conditions such as temperature, Pulse, Heartbeat, Sweat on body and oxygen of human body and these values uploaded into the cloud based on internet of things (IoT). The measurement of heart rate variability is a simple test that has been in existence for thousands of years due to the low-tech requirements for measurement. Heart Rate Variability (HRV) is determined by measuring the time gap between heart beats that varies as you breathe in and out. Heart rate (HR) is measured in terms of beats per minute. HRV monitoring is highly sensitive for highly risks linked with cardiovascular disease, Diabetic Mellitus disease and Hypertension patients. Measurement of HRV by using some parameters for such cases of high risk will useful in for providing adequate medical care at needed times. Our idea in the proposed system, HRV parameters are derived using Wireless Wi-Fi based pulse sensor and the care taker and doctor are intimated through Short Message Service in order to provide adequate medical help in case of emergency situations. At present there are no HRV monitoring systems that alarm the high risk hypertensive patients along with the aid of a remote doctor; the proposed system aims to achieve the same. The proposed system combines the dual benefits of Wi-Fi technology. This idea successfully fulfills all the ideal traits of a remote health monitoring system in terms of low-cost, long range, security, promptness and easy-to-use that serves in saving lives.

4. IMPLEMENTATION

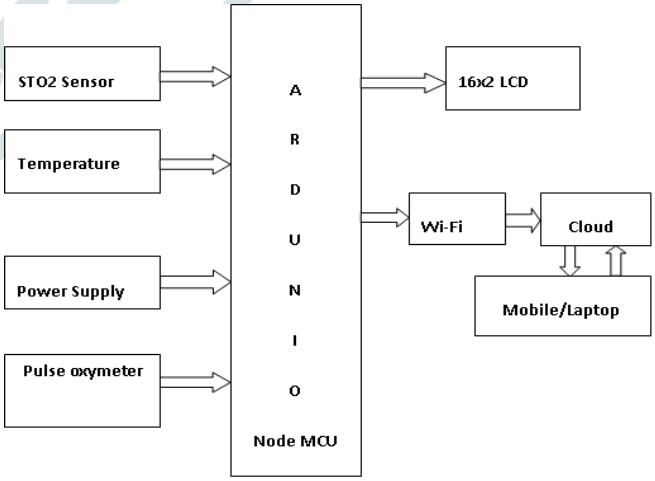

Fig.1 Proposed Block diagram

A. Arduino Nano

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.0) or ATmega168 (Arduino Nano 2.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works

with a Mini-B USB cable instead of a standard one. The Nano was designed and is being produced by Gravitech.

Fig.2 Arduino Nano Board

B. TEMPRATURE AND HUMIDITY SENSOR

DHT11 Temperature and Humidity Sensor include a temperature and stickiness sensor complex with an adjusted computerized flag yield. By utilizing the selective advanced flag securing strategy and temperature and dampness detecting innovation, it guarantees high unwavering quality and astounding long haul soundness. This sensor incorporates a resistive-type moistness estimation part and a NTC temperature estimation segment, and interfaces with an elite 8-bit microcontroller, offering amazing quality, quick reaction, hostile to impedance capacity and cost-viability.

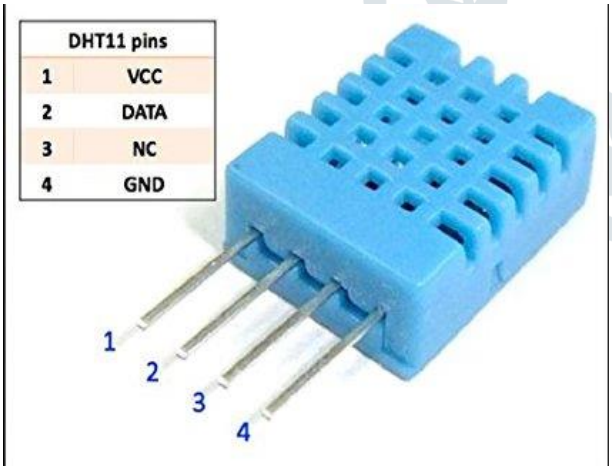

Fig.3 Temperature and Humidity Sensor

C. Wi-Fi

The WiFi module used in our system will help us to operate the web page for a customer.

 The customer can set a particular threshold value to limit the meter reading through these which will be interfaced with the help of MAX232 to ardunio board

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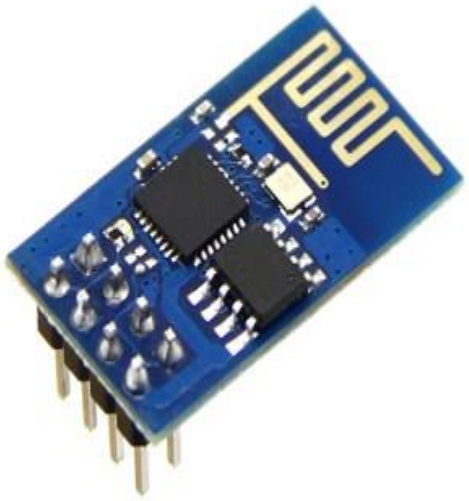

Fig.4 Wi-Fi Board

D. Pulse Oxymeter

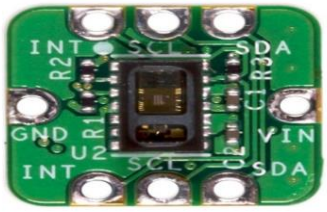

Figure 5.3 Pulse oximeter

The MAX30100 is a coordinated heartbeat oximetry and pulse screen sensor arrangement. It joins two LEDs, a photodetector, enhanced optics, and low-commotion simple flag preparing to identify beat oximetry and pulse signals. The MAX30100 works from 1.8V and 3.3V power supplies and can be shut down through programming with unimportant backup current, allowing the power supply to stay associated consistently. Heart rate data can be really useful whether you're designing an exercise routine, studying your activity or anxiety levels or just want your shirt to blink with your heart beat. The Pulse Sensor Amped is a plug-and-play heart-rate sensor. Simply clip the Pulse Sensor to your earlobe or finger tip. The system consists of an infrared (IR) LED as transmitter and an IR photo-transistor as a receiver that acts as a fingertip sensor. The sensor consists of a super bright red LED and light detector. The LED needs to be super bright as the maximum light must pass spread in finger and detected by detector. Now, when the heart pumps a pulse of blood through the blood vessels, the finger becomes slightly more

opaque and so less light reached the detector. With each heart pulse the detector signal varies. This variation is converted to electrical pulse. This signal is amplified through an amplifier which outputs analog voltage between 0 to 5V logic level signal.

5. EXPERIMENTAL RESULTS

By implementing this we can increase the lifetime of devices and machineries are monitored and controlled remotely

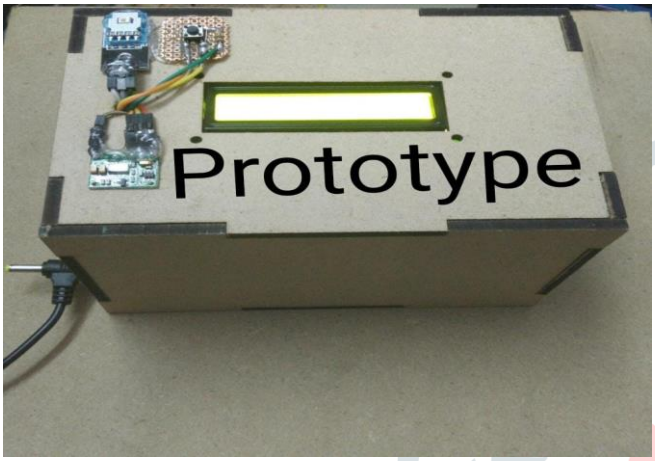

Fig.6 practical prototype model

Fig.7 LCD Showing the Name of the project

Fig.8 LCD Showing the push button operation

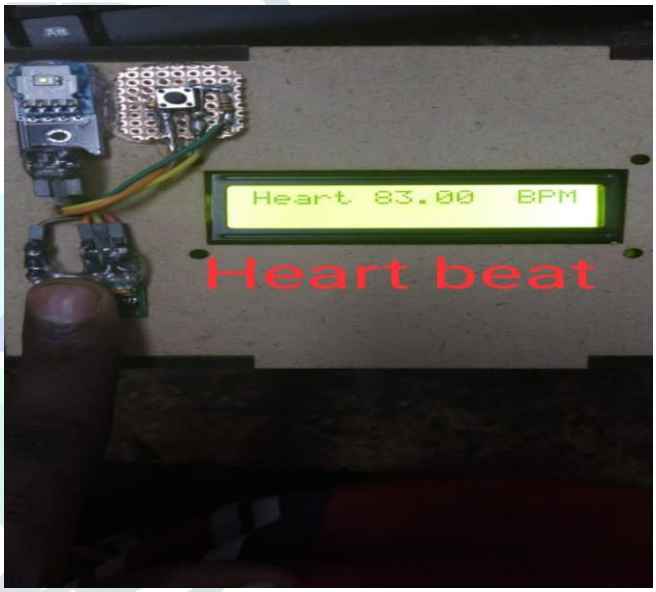

Fig.9 LCD Showing the Heart beat value

Fig.10. LCD Showing the Oxygen content value in blood

Fig.11 LCD Showing the Sweat on body

6. CONCLUSION

The proposed system here has involved solving all limitations and is designed to be more reliable, low-cost, easy-to-use system for Hypertensive patients by combining the WiFi technologies. HRV monitoring for hypertensive patients will prove useful to provide adequate care to serious scenarios such as cardiac mortality and stroke mortality. The proposed system achieves the same. The proposed system is very helpful to monitor the HRV parameters for Hypertensive patients through a web application. The application is used to monitor the HRV parameters and provides results as graph. In case of emergency situations, the system intimates SMS to care taker and doctor to provide immediate medical help. The system was made to analyze the act on 3 normotensive and 3 hypertensive patients. The observation conclude that there is decrease in HRV time domain parameters beneath the normal range for hypertensive patients compared to normotensive person Thus, the proposed system successfully functions to monitor and provide insights regarding Hypertension condition.

REFERENCES

[1] U., Paul Joseph, K., Kannathal, N., Lim, C. M., & Suri, J. S. (2006), Rajendra Acharya, "Heart rate variability: a review," in Medical & Biological Engineering & Computing, 2006 Dec, 44(12):1031-51.

[2] "Measurement of Heart Rate Variability Using an Oscillometric Blood Pressure Monitor", by Saif Ahmad, Miodrag Bolic, Hilmi Dajani, Voicu Groza, Izmail Batkin and Sreeraman Rajan,2010.

[3] M. Urooj, K. K. Pillai, M. Tandon, S. P. Venkateshan "Ttime domain parameters of heart rate variability in indian population and validation in hypertensive subjects and smokers," Int J Pharm Pharm Sci.,vol. 3, pp. 36-39, 2011.

[4] Brüser, Christoph; Stadlthanner, Kurt; de Waele, Stijn; Leonhardt, Steffen (2011). "Adaptive Beat-to-Beat Heart Rate Estimation in Ballistocardiograms". IEEE Transactions on Information Technology in Biomedicine (IEEE) 15 (5): 778-786. Doi: 10.1109/TITB.2011.2128337. PMID 21421447.

[5] P. J. Tello, O. Manjarres, M. Quijano and A. U. Blanco, "Remote monitoring system of ECG and temperature signals using Bluetooth," in Information Technology in Medicine and Education (ITME) Int. Symp., Hokodate, 2012, Vol. 2, pp. 860-863.

[6] M. G. Poddar, V. Kumar and Y. P. Sharma, "Linearnonlinear heart rate variability analysis and SVM based classification of normal and hypertensive subjects," in J. of Electrocardioly, vol. 46, no. 4, pp. e25, 2013.

[7] A study on analysis of Heart Rate Variability in hypertensive individuals Nirmala Natarajan, Arun Kumar Balakrishnan and Kavitha Ukkirapandian in International Journal of Biomedical And Advance Research, 2014.

[8] J. Mohammed, C. H. Lung, A. Ocneanu, A. Thakral, C. Jones and A. Adler, "Internet of Things: Remote patient monitoring using web services and cloud computing," in Internet of Things (iThings), 2014 IEEE Int. Conf., and Green Computing and Communications (GreenCom), IEEE and Cyber, Physical and Social Computing (CPSCom),Taipei,2014, pp. 256-263.

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