Performance Improvization in Health Care Support using Dynamic Sensor Network For Telemedicine Assistance and ECG Analysis of Feature Extracted Critical Components of Diabetic Patients

S. Poonguzhali, Rekha Chakravarthi, S. Poonguzhali, Rekha Chakravarthi

Abstract: People are suffering from chronic diseases like diabetes which has a threat of sudden and unexpected attack in the current healthcare scenario. So, continuously monitoring the vital parameters of the patients became necessary. The proposed system is an emergency telemedicine healthcare support which is used for continuous Electrocardiogram (ECG) signal monitoring, Heartbeat (pulse) along with vital parameters monitoring which will help preventing and alerting about cardiac problems in diabetic patients. This system uses GSM with IoT implementation. This system detects the abnormality in the monitoring system. The ECG signal is processed in the processor to count the heartbeat for one minute. The parameters of some critical components are obtained and processed. The feature extracted from the critical components were values of essential peaks and they were received as analog waveform at receiving end (doctor's device). If any abnormality is detected in the ECG signal, an SMS with a link consisting of patient details are sent to the doctor through GSM modem. The is mainly based on wireless sensor networks in which a group of sensors is taken and processed using a processor. It helps to take the appropriate protective measures by the doctor. It is a real- time system intended to use for telemedicine application.

Key words: Cardiac health monitoring for diabetic patients, Internet of Things (IoT), GSM, vital biological parameters.

I. INTRODUCTION

A set of evenly scattered and devoted sensors for trailing and saving the patient medical records of the environment and aligning the assembled data at an axial location is known as Wireless Sensor Network (WSN). WSN measures patient's physical conditions like Temperature, Heart Beat, and Electrocardiogram (ECG).

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* Correspondence Author
S. Poonguzhali, School of Electrical & Electronics, Sathyabama Institute of Science and Technology, Chennai, Tamil Nadu, India
Rekha Chakravarthi, School of Electrical & Electronics, Sathyabama Institute of Science and Technology, Chennai, Tamil Nadu, India
S. Poonguzhali, School of Electrical & Electronics, Sathyabama Institute of Science and Technology, Chennai, Tamil Nadu, India
Dr. Rekha Chakravarthi, School of Electrical & Electronics, Sathyabama Institute of Science and Technology, Chennai, Tamil Nadu, India

The sensor network in medical applications can be of various types such as: Environment-Embedded, implanted and wearable.

Environment-Embedded systems are placed in the environment and its applications include monitoring an ill patient completely at home or in hospitals. In a human body, the implantable devices are inserted to monitor the body conditions. The places where the wearable devices are placed are near to the body or on the surface of the human body. Nowadays, using wireless sensor network along with Internet of Things (IoT) is more challenging.The combination of sensors and actuators with Internet of Things (IoT) , becomes instances of cyber-physical systems, smart medical systems, intelligent transportation, smart home, smart cities and so on. IoT is a computing logic, which describes the physical objects which are able to identify themselves to other devices are being connected to the internet. In IoT the object is now connected to surrounding objects and database data. Hence, the object itself digitally becomes greater than by itself.IoT devices are used in backward areas to facilitate healthcare monitoring in exigency times. This health observing devices can be the radical devices which are competent of monitoring specialized parameters. To measure these specific parameters a special sensor can be equipped with living spaces to observe the health of patients.

II. RELATED WORKS

[1] Mehak Chhabra, Manik Kalsi, Acquiring the physiological parameters using sensors and uploading these records to cloud are the main aim of the system. The heart rate of the patient is estimated by the system and sends it to the cloud. Doctor examine the ECG of the patient. Real-time health related parameters of the patient can be analysed by the doctors which are not admitted in hospital.[2] Yongming Yang, Xiaobo Huang, Xianghuo Yu, FPGA technology is used by this real-time existing system. This system initializes the programs in FPGA chip. This chip is used to integrate all the modules and implement collection, confines, real-time processing and carrying. The FPGA chip is taken as an axial data microprocessor.

A structured design is applied on Very High-Speed Integrated Circuit Hardware Description Language (VHDL) by the FGPA chip to collect and translate real-time ECG Signals. Uttam U, Deshpande, Milan A, Kulkarni, It is considered as an acute and adequate

Healthcare which meets the needs of amplifying human population and medical expenses[3]. Abnormalities of Health conditions can be disclosed by the system in time and it makes diagnoses according to the extracted data. By using a wearable observing node, ECG data are accumulated and are communicated precisely to the IoT cloud. All these are done by using Wi-fi. IoT makes use of open source protocols. Distinct ECG network includes Wi-Fi, Bluetooth, Zigbee, and BLE are made known and correlated.Abhay Patil, Aniket Kale, This system uses 3 lead electrodes along with a small signal processing block. The technology of Arduino Uno and MATLAB for signal conversion and representation is used [4].

It is a cheap, light weight, portable and provides self-monitoring facility in patient side. Patient's heart conditions in real time can be monitored and diagnosed by the system with an ECG sensor and it can generate alert whenever the deviation is foundBin Yu and Lisheng Xu, Yongxu Li, A wireless ECG monitoring system is developed which is used for the integration of Bluetooth Low Energy (BLE) Technology. A BLE based system is comprised of a single-chip ECG signal acquisition module, a Bluetooth module, and a smart-phone [5].

For mobile device platform, Apple's iPhone 4S is selected which is embedded with Bluetooth v4.0, Wi-Fi, and iOS. The monitoring system is able to acquire ECG signals through 2-lead ECG sensor, transmit the ECG data via the Bluetooth, process and display the ECG waveform in a smart-phone. The physical constraints are eliminated by the system which is imposed by hard wired link using BLE.Stefan Gradl, Patrick Kugler, Clemens Lohmuller, Bjoern Eskofier, It is an application for Android-based mobile devices which acknowledges computerized arrhythmia detection and real-time ECG monitoring by examining ECG parameters. ECG data can be refined and appraised which is afforded by pre-recorded files or accomplished live by procuring a shimmer sensor node via Bluetooth [6]. Pan-Tompkins algorithm for QRS- detection is stationed on the application. It contains further algorithm blocks to disclose anomalistic heartbeats. The Supraventricular Arrhythmia databases shows that, more than 99% of all QRS complexes were disclosed accurately by the algorithm. Overall sensitivity for abnormal beat detection was 89.5% with a stipulation of 80.6%. This application is handy for downloading and may be used for real-time ECG monitoring on mobile devices.Bersain A. Reyes, Hugo F. Posada-Quintero, Justin R. Bales, Amanda L. Clement, George D. Pins, Albert swiston, Jarno Riistama, John P. Florian, Barbara Shykoff, Michael Qin, and Ki H. Chon, This proposed system consists of hydrophobic electrodes which provides the waveforms of all morphological without distortion of an ECG signal for dry and water-immersed conditions [7]. An electrode is comprised of a mixture of carbon black (CB) powder and polydimethylsiloxane (PDMS). Various tests were performed for feasibility testing of the CB/PDMS electrodes. One of the tests included evaluation of the electrode-to-skin contact impedance for a different diameter, thickness, and different pressure levels. Performance comparison of CB/PDMS electrodes to Ag/AgCl hydrogel electrodes was carried out in three different scenarios. A dry surface, water immersion, and post water immersion are the three different scenarios.Padmashree T, Dr. N K Cauvery, Smitha G R, The system continuously monitor the health condition remotely and gives an alert to the doctor if any parameter is assorted. Healthcare system in a mobile application is a fundamental technology for reducing the cost of living occurred in healthcare [8]. The main four units are micro-controller, sensor, GSM, Android phone. The body temperature and heartbeat of a patient should be analyzed by AWTESA. The heartbeat value and the temperature value are converted from analog to digital signal and processed in the micro-controller. This system gives the freedom of mobility to the doctor. Doctor's unit and Patient Unit are the two units present in this. A mobile network with the doctor to send a message using GSM is only needed to transfer the information. AWTESA system is simple and has very less number of wires.Rajasekaran, Kumaran, Premnath, Karthik, In the medical area, wireless devices have become more popular with a wide range of capability. To monitor and gather the data of patient body, six different sensors are used. Mobility is an advantage in this project. The main focus of this paper is on wireless personal area network technologies, WiMAX, Wi-Fi, ZigBee [9]. The use of WSN's as a key infrastructure enabling unobtrusive, continual, ambulatory health monitoring is demonstrated. Wireless technology is the best solution for mass emergency situations like natural or human-included disasters. The databases of the patient were built up by continuous medical monitoring will be updated easily. The paperwork required is dropped down. Wi-MAX technology is based on the IEEE 802.16 standards which has secured wireless data transmission. This standard is the incorporation of AMC, FEC, QoS framework, and OFDM. RFID is used to have potential in positioning and hospital staffs. To improve telemedicine services the cellular systems have the great potential by extending the range of healthcare system. The system architecture is consists of medical sensors, a portable personal server, a hospital server and related services.Dr. V K Bairagi, S Kakade, P Lokande and D Shende, Designing a system which measures blood pressure, pulse rate, the body temperature of the patient is the main focus of this project [10]. The design and development of the system is dealt by this paper. The design consists of different sensors such as blood pressure sensor, temperature sensor, heartbeat sensor and sugar level sensor. All these sensors are interfaced with the micro-controller.

With the help of Global System for Mobile communication (GSM), this provides all these measurements to respective doctors. With the help of ADC, this paper also shows how the different health conditions of the patient are measured by microcontroller in real-time.To a digital form, these readings are converted. GSM is used for mobile communication in this system. This means that the doctor's PC receives all the transmitted readings through GSM network. The patient's health is completely monitored and the respective doctor will be able to access this information [12]. For home and ambulance use, the design of the system is kept simple. This device is mainly designed for ambulance. Further it can be implemented in homes and in rural areas.

The efficiency of the proposed system is being demonstrated. This will be more efficient for doctors to check the patient's health as it gives real-time information regarding the patient's condition. The use of telemedicine is one of the important concerns to provide the medical services to the patients, living in the rural areas of India.

III. PROPOSED SYSTEM

Dynamic wireless sensor network is the principle of the proposed system where the source (patient) is free to move, which gathers all the information from different sensors. The proposed system consists of different blocks such as a controller, heartbeat sensor, temperature sensor, ECG sensor, LCD display, IoT etc.,The HTML is used to send a link to the doctor, if any abnormalities occur in the patient body. Here, the controller acts as the heart of the system. The controller used is an Arduino controller which collects all the information from the sensors and processed using Io Talon with GSM. Here, the sensors are placed on the skin of the patient body. This detects the abnormality and passes the information to the IoT. IoT is a combination of micro-controller and GSM. Hence, the data is uploaded and sends it to the doctor using a link. The link consists of all the information about the patient medical information. So that the doctor can analyze it and take decisions even though the patient is far away from the hospital.

A. Block Diagram

The process starts by switching off the IoT button before resetting the controller. The resetting process helps to erase previous values. All the sensors have to be kept on the surface of the body.

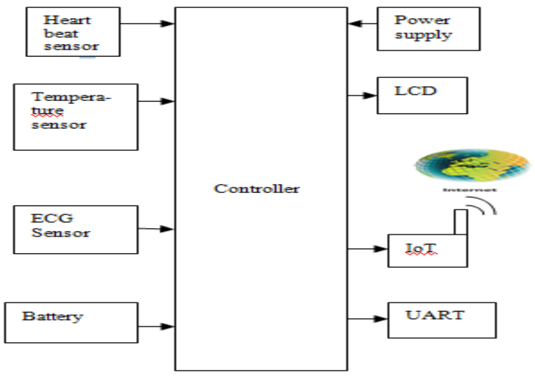


Fig 1. Proposed Block Diagram

Now, automatically the temperature sensor starts calculating the temperature of the body. On the LCD display, the temperature will be displayed. The forefinger has to be placed near the LED of the heartbeat sensor in the next step. When the light starts blinking in a proper manner, the red button in the IoT board should be pressed to calculate the heartbeat. The red button is used since the heartbeat sensor is programmed in a while loop condition.The electrodes of the ECG are placed on the right arm, left arm, and the right leg already. This electrode is very helpful in continuously calculating the ECG rate of the patient. Now, the IoT button has to be switched on, so that the parameters will be uploaded to the server. By using the GSM the message with a link will be sent to the doctor to analyze the parameters. This link is created using HTML. The parameters will be updated into the server automatically by switching on the IoT. These details will be stored permanently and the storage capacity is infinity.

B. Flow Chart

The following chart shows the flow of the whole process carried out in the proposed system

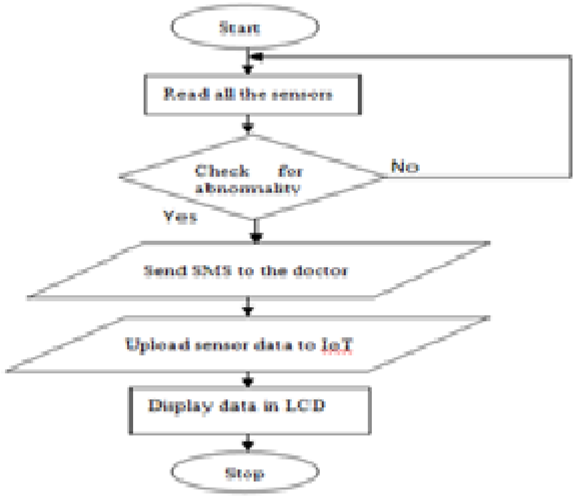


Fig 2. Flow Chart

C. Algorithm

1) Start the program.
2) Read all the sensors.
3) Check for abnormality.
4) If any abnormality present then sends a link consisting of sensor data through SMS to the doctor using GSM.
5) Upload all sensor data to IoT.
6) Display the data in LCD display.
7) Stop the program.

IV. RESULTS

The system circuitry consists of a processor, GSM, IoT, power supply, temperature sensor, heartbeat sensor, ECG sensor. Connections are given precisely to get the output of all the three parameters.

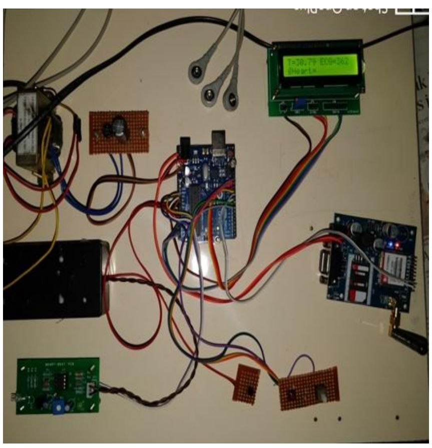


Fig 3. Portable circuitry to measure the vital parameters

The processor used in this is an Arduino Uno R3 processor which is programmed to calculate the parameters. For uploading the data to the server, IoT is used. The uploading of data to the server starts when the finger is placed near the LED of heartbeat sensor and the ECG sensor is placed on the patient. This automatically sends the message with a link to the doctor. Hence, doctor analyses the parameters and prescribe the patient even though the patient is not nearby the doctor.

Fig 4. Heartbeat calculation by placing the finger

The message is received from the kit using GSM. GSM uses SIM 900 with the internet. The message consists of "Please open below link to view patient data" along with a link.

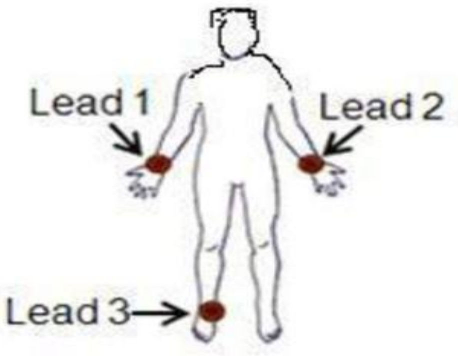


Fig 5. Position of electrode sensors for ECG measurement

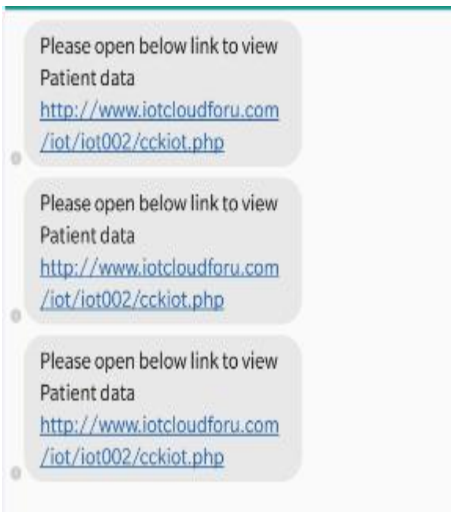
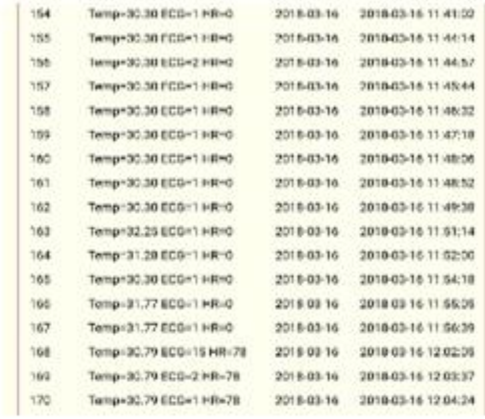


Fig 6. Message with link Received from the kit

When the link is opened it looks as below:



154	Temp=30.30 ECG=1 HR=0	2018-03-16	2018-03-16 11:41:02
155	Temp=30.30 ECG=1 HR=0	2018-03-16	2018-03-16 11:44:14
156	Temp=30.30 ECG=2 HR=0	2018-03-16	2018-03-16 11:44:57
157	Temp=30.30 ECG=1 HR=0	2018-03-16	2018-03-16 11:45:44
158	Temp=30.30 ECG=1 HR=0	2018-03-16	2018-03-16 11:46:32
159	Temp=30.30 ECG=1 HR=0	2018-03-16	2018-03-16 11:47:18
160	Temp=30.30 ECG=1 HR=0	2018-03-16	2018-03-16 11:48:06
161	Temp=30.30 ECG=1 HR=0	2018-03-16	2018-03-16 11:48:52
162	Temp=30.30 ECG=1 HR=0	2018-03-16	2018-03-16 11:49:38
163	Temp=32.25 ECG=1 HR=0	2018-03-16	2018-03-16 11:51:14
164	Temp=31.20 ECG=1 HR=0	2018-03-16	2018-03-16 11:52:00
165	Temp=30.30 ECG=1 HR=0	2018-03-16	2018-03-16 11:54:18
166	Temp=31.77 ECG=1 HR=0	2018-03-16	2018-03-16 11:55:05
167	Temp=31.77 ECG=1 HR=0	2018-03-16	2018-03-16 11:56:39
168	Temp=30.79 ECG=15 HR=78	2018-03-16	2018-03-16 12:02:05
169	Temp=30.79 ECG=2 HR=78	2018-03-16	2018-03-16 12:03:37
170	Temp=30.79 ECG=1 HR=78	2018-03-16	2018-03-16 12:04:24

Fig 7. Patient Health Details in the Link

The doctor can go through the link which is in the message and analyze the parameters present in it. Hence, the doctor can take immediate action before the situation goes out of the hand [9]. The received ECG waveform gives the information about the critical parameters QRS complex and their values instantaneously.

V. PERFORMANCE ANALYSIS

a. Real-time monitoring system.

b. Remotely patient's body parameter can be measured and can be sent to doctors to get emergency support from the doctor.

   c. It will be used in e-hospital.
   d. We monitored 4 different patients by deploying sensors and we got blood pressure and heart beat data and temperature are shown in table below

Patients	Temperature			Blood pressure		
	low	normal	High	Low	normal	High
p1	60	90	91	85	125	164
p2	64	90.2	91	80	130	160
p3	67	89	92	82	127	167
p4	65	89.7	92	70	120	170

Patients	Heart beat		
	Low	Normal	High
p1	70	80	90
p2	72	82	92
p3	74	84	94
p4	76	87	97

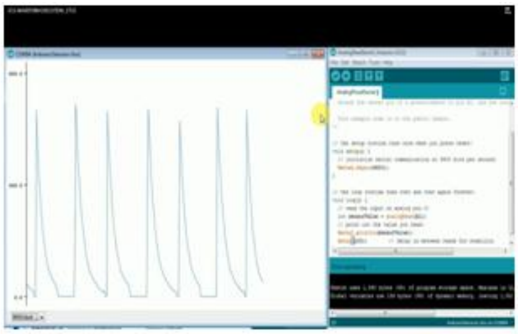


Fig8. ECG waveform received at doctors end device

VI. CONCLUSION

The above system implementation gives the information regarding the patient's health condition at each instant along with the information about blood glucose level and insulin level including other basic parameters. It helps the doctor to send the precautions and prescriptions that has to be followed by the patient. These parameters can be used for analysis[13] and prediction of emergency situation in diabetes. Diabetic patients are majorly prone to unexpected and sudden heart attacks and other heart related problems. This method of monitoring the ECG [14] of diabetic patients will help doctors in diagnosing heart problems at earlier stage and also necessary actions can be taken by instructing from remote place itself,

REFERENCES

1. Mehak Chhabra, Manik Kalsi, "Real-time ECG monitoring system based on Internet of Things", International Journal of scientific and research publications, 2017.
2. Yongming Yang, Xiaobo Huang, Xinghuo Yu, "Real-time ECG monitoring system based on FPGA", The 33rd annual conference of the IEEE industrial electronics society(IECOL), 2007.
3. Uttam U, Deshpande, Milan A, Kulakarni, "IoT based real-time ECG monitoring system using cypress WICED", International Journal of advanced research in electrical, electronics and instrumentation engineering, 2017.
4. Abhay Patil, Aniket Kale, "Real-time ECG monitoring system", International advanced research Journal in science, engineering, and technology, 2017.
5. Bin Yu and Lisheng Xu, Yongxu Li, "Bluetooth Low Energy (BLE) based mobile electrocardiogram monitoring system", Proceeding of IEEE International conference on information and automation, 2012.
6. Stefan Gradl, Patrick Kugler, Clemens Lohmuller, Bjoern Eskofier, "Real-time ECG monitoring and arrhythmia detection using Android-based mobile devices", The 34th annual international conference of the IEEE EMBS, 2012.
7. Bersain A. Reyes, Hugo F. Posada-Quintero, Justin R. Bales, Amanda L. Clement, George D.Pins, Albert Swiston, Jarno Riistama, John P. Florian, Barbara Shykoff, Michael Qin and Ki H. Chon, "Novel electrodes for underwater ECG monitoring", IEEE transactions on biomedical engineering, 2014.
8. Padmashree T, Dr. N K Cauvery, Smitha G R, "Advanced wireless telemedicine application using embedded sensor and Android OS", International Journal of advanced research in computer engineering and technology (IJARCET), 2015.
9. C. L. Priya, D. Gowthami and S. Poonguzhali, "Lung pattern classification for interstitial lung diseases using an ANN-back propagation network," *2017 International Conference on Communication and Signal Processing (ICCSP)*, Chennai, 2017, pp. 1917-1922.
10. Rajasekaran. S, Kumaran.P, Premnath.G, Karthik.M, "Human health monitoring using wireless sensor network (WSN)", International Journal of application or innovation in engineering and management(IJAIEM), 2013.
11. Dr. V. K. Bairagi, S. Kakade, P. Lokhande, D. Shende, "GSM based patient monitoring system", International Journal of advanced research in computer science, 2017.
12. S.Poonguzhali, Advanced Fetal Essential Parameters Observation Using WSN, International Journal of Pharmacy & Technology, Issue No.8, pp 421629-216342016 IJPT.
13. Priya, C. Lakshmi, D. Gowthami, and S. Poonguzhali. "Lung pattern classification for interstitial lung diseases using an ANN-back propagation network." 2017 International Conference on Communication and Signal Processing (ICCSP). IEEE, 2017.
14. Sivasangari. A and Martin Leo Manickam. J (2014) " A Light Weight Cryptography Analysis for Wireless Based Healthcare Applications " , Journal of Computer Science, , ISSN : 1549-3636 , Vol.10,No. 5, pp.2088-2094