Health Monitoring of Primary Vital Parameters Using Non-Invasive Device Implemented By Medical Internet of Things

Karthikeyan.R[1], SakthiSudhan.K[2], Pretha N[3]
[1, 2, 3] Dept of Electronics & Communication Engineering
[1, 2, 3] Dr.N.G.P. Institute of Technology, Coimbatore, India-641048

Abstract- *A genuine non invasive medical device that can measure pulse rate, blood oxygen saturation level, temperature, blood pressure, heart rate and ECG monitoring in a single device. The sensor module of the device is designed to send data to their mobile application with the help of IoT, so that they can able to view the result in mobile application. The sensors are interfaced in sensor interface circuit from which the data base can be collected and then given to the microcontroller through analog to digital converter. The device also helps in maintaining patients health record and in case of any critical situation the patient can use the buzzer which is in the device. To provide an integrated and compact device for various biomedical application. These six medical parameters result can be viewed on both mobile application of the patient and the physician. Furthermore number of patients result can be stored in cloud by using Thing speak unit for future reference. This innovative medical device would enable the user to wear at low cost device on home continuously when the need arises. This fast and interminable monitoring system has capacity to remediate the patient's life endowment by contributing a psychological empathizes.*

Keywords- Internet of Things (IoT), SpO_2 sensor, Thing speak unit, mobile application, Raspberry Pi3

I. INTRODUCTION

There are many models of device available in market for measuring various medical parameter. They differ in size, cost and quality. As the number of diseases is getting increased day by day and hence continuous monitoring of some physical parameter is mandatory. However the conventional methods used to measure these parameters are bulky and require the presence of physician to make sense of raw values. Most importantly heart, SpO_2 related attacks happens at small hours and nocturnal monitoring is not possible in the conventional methods.

Wearable Health Devices (WHD) plays human vital record during daily life time with the bounty of calumniate distress and interference with the ordinary human action. There is a opulent necessary for predominantly monitor patient with health issues of heart diseases are major cause of death around the world, which can be easily monitored with the following proposed device. Wearable devices are currently at the heart of just about every discussion related to IoT.
The requirement of self health monitoring and preventive medicine is increasing due to projected dramatic increase in number of elderly people. This is possible by constantly monitoring health indicators in various areas and in particular the wearable devices are considered to carry out the task. These wearable devices and mobile application now have been integrated with telemedicine and telehealth efficiently. IoT has a key to convert reactive form of diseases diagnosis process existence in present days into proactive form in future.

By exploiting the IoT uncovering major challenges such as interoperability, security, privacy and standardization in health trackers a personalized, remote and complete biological monitoring device will be possible in place which offers intelligent actionable services on device management and control. It focuses on the basic physiological medical parameter which is very essential for everyday life of human routines.

II. RELATED WORKS

Hayder Ozkan et al [1] implemented a wearable Tele-ECG and heart rate (HR) monitoring system that has a novel architecture and can be remote monitored. Holter based ECG is designed to evaluate average correlation of recorded ECG, from which HR can be calculated. The data are sent from (patients) smart phone through Bluetooth Low Energy (BLE) to consultant. When HR is above normal range it can be intimated to physician via Short Message Service (SMS). This is spontaneous and long lasting tele-monitoring system that has a capacity to improve patients life by replenish a psychological assuage.

Deepak Mishra et al [2] proposed a simple and non-contact measurement of SpO2.It uses only a single light source and so it does not affect the accuracy of results. By using this it can be measured in fingers and ear-lobes. The result obtained by this is only the initial proof-of-concepts. This overcomes the disadvantage of using multiple light source of different wavelength. And further it also tells polarisation image maintain great dormant in facilitating cost effective, stiffened integrated device for bio-medical application.

Chengyu Liu et al [3] developed a wearable and IoT technologies enable real time and ECG monitoring system. It has a novel structure consisting of sensing layer, network layer, cloud saving and application layer. A lightweight QRS detector is developed for accurate QRS complexes and also has high computation efficiency.

IoT driven smart vest can be employed for massive monitoring population during daily life. This has a advantage of providing comfort on cloth, replaced by using dry electrode, cloud platform for big data analysing and processing.

Xuan Liu et al [4] proposed had overcome the technical issues in spectroscopic Optical Coherence Tomography (OCT).This system uses spectral normalisation technique to eliminate spectral modulation induced by the wavelength and to reduce the spectral speckle noise due to highly scattering blood. With the help of SO2 dependent spectroscopic information from 1D and 2D OCT images, that could be used to find SO2 level .In real time it can be implemented by using dynamic focusing and extensive averaging.

Hsin-Yi Tsai et al [5] proposed a non-contact skin oxygen-saturation viewing systemfor predicting human tissue oxygen saturation. These provide analysis of Skin Oxygen Saturation Imaging (SOSI) and totalise skin tissue saturation. This also provides comparison between for measurement by using SOSI and transcutaneous oxygen pressure (TcPO2). This quickly measures SpO2 level (10 s). The Near Infrared (NIR) is used here. SOSI can also be used to find shallow layers of any human tissue.

III. PROPOSED APPROACH

The core technologies of health care system is to develop a device that have the capacity to measure various medical parameters at door step with good accuracy along with minimum expenditure of cost and hardware requirement. This innovative system is to put forward a smart patient health monitoring system that uses sensor to monitor the patient health and uses internet to view the result concurrently. Our system uses temperature and Humidity Sensor (DHT11), ECG board (AD8232), pulse sensor rate. These sensor are connected to Raspberry Pi through sensor interface circuit.

In this project we offer a modern day, sensor technology and IoT based solution for monitoring the health parameters integrated with a alert system which is automated during emergencies. It is demonstrated through a defined architecture design, including hardware and software dealing with sensors, mobile application for further diagnosis and storage. With the help of improved technology have been developed greatly and are considered reliable tools for long-term health monitoring systems. These are applied in the observation of a large variety of health monitoring indicators in the environment, vital signs and fitness. The Internet of Things (IoT) is a new concept, providing the possibility of healthcare monitoring using wearable devices. The IoT is defined as the network of physical objects which are supported by embedded technology for data communication and sensors to interact with both internal and external objects. With IoT, multiple monitoring devices can be connected thus enabling real-time monitoring of patients. Along with this, these devices can transmit data from patient to physician thus, reducing the time needed for patient care in the hospitals. This can reduce the need for doctors attention and can improve the level of care provided at the same time. This will also provide real time information which will help in providing evidence based medications.

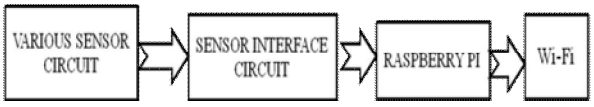

Figure 1 General Block of Proposed System

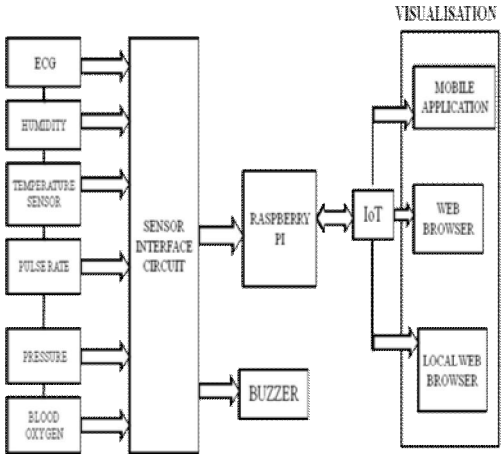

Figure 2 Proposed System

The ECG uses three electrode (leads) that had to be placed on arms and legs respectively. Eventually, electrodes were invented that could be placed directly on the patient's skin.

The leads are argument that can able to view heart at different angles. The augmented aVR, aVL, aVF are amplified because the is to small to be useful when negative electrode is Wilson terminal. Together the leads I ,II, III augmented limb leads aVR, aVL, aVF form the basis of the hexaxial reference system, which is used to calculate the heart electrical axis in the frontal plane.

The pulse rate is measured by IR transmitter and receiver. Infrared transmitter is a type of LED which emits infrared rays generally called as IR Transmitter. Similarly IR Receiver is used to receive the IR rays transmitted by the IR transmitter. One important point is both IR transmitter and receiver should be placed straight line to each other. The IR transmitter and receiver are placed in the pulse rate sensor. When measuring the pulse rate, the pulse rate sensor has to be clipped in the finger. Then the final square wave signal is given to raspberry pi.

This circuit is designed to measure the Humidity. In this circuit for the Humidity measurement which are connected in the resistor bridge network. Then the final TTL pulse is given to microcontroller in order to monitor the respiration rate.
DHT11 can be used to measure temperature. In this first configuration DHT11 is powered and connect the output directly to analog to digital converters. In the second utilize all the sensor resources and can measure the full range temperature from -55 to 150 degree centigrade. This configuration is little complex but yields high results.

IV. MATERIALS AND METHODS

1. ADS1115: The chip can be configured as 4 single-ended input channels, or two differential channels. It includes a programmable gain amplifier, up to x16, to help boost up smaller single/differential signals to the full range. ADC is liked because it can run from 2V to 5V power/logic, can measure a large range of signals and its super easy to use.

2. AD8232: The AD8232 is an integrated signal conditioning block for ECG and other biopotential measurement applications. It is designed to extract, amplify, and filter small biopotential signals in the presence of noisy conditions, such as those created by motion or remote electrode placement. This design allows for an ultralow power analog-to-digital converter (ADC) or an embedded microcontroller to acquire the output signal easily. The AD8232 can implement a two-pole high-pass filter for eliminating motion artifacts and the electrode half-cell potential. This filter is tightly coupled with the instrumentation architecture of the amplifier to allow both large gain and high-pass filtering in a single stage, thereby saving space and cost. An uncommitted operational amplifier enables the AD8232 to create a three-pole low-pass filter to remove additional noise. The user can select the frequency cutoff of all filters to suit different types of applications. To improve common-mode rejection of the line frequencies in the system and other undesired interferences, the AD8232 includes an amplifier for driven lead applications, such as right leg drive (RLD). The AD8232 includes a fast restore function that reduces the duration of otherwise long settling tails of the high-pass filters. After an abrupt signal change that rails the amplifier the AD8232 automatically adjusts to a higher filter cutoff.

3. PULSE RATE CIRCUIT: The heart beat rate is measured by IR transmitter and receiver. Infrared transmitter is one type of LED which emits infrared rays generally called as IR Transmitter. Similarly IR Receiver is used to receive the IR rays transmitted by the IR transmitter. One important point is both IR transmitter and receiver should be placed straight line to each other. The IR transmitter and receiver are placed in the pulse rate sensor.

4. DHT11 SENSOR: DHT11 sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature. The humidity sensing capacitor has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels. The IC measure, process this changed resistance values and change them into digital form. For measuring temperature this sensor uses a Negative Temperature coefficient thermistor, which causes a decrease in its resistance value with increase in temperature. To get larger resistance value even for the smallest change in temperature, this sensor is usually made up of semiconductor ceramics or polymers.

5.RASPBERRY PI : Raspberry pi is a single computer board with credit card size, that can be used for many tasks that your computer does, like games, word processing, spreadsheets and also to play HD video. It was established by the Raspberry pi foundation from the UK. It has been ready for public consumption since 2012 with the idea of making a low-cost educational microcomputer for students and children. The main purpose of designing the raspberry pi board is, to encourage learning, experimentation and innovation for school level students. The raspberry pi board is a portable and low cost. Maximum of the raspberry pi computers is used in mobile phones. In the 2st century, the growth of mobile computing technologies is very high, a huge segment of this being driven by the mobile industries. The 98% of the mobile phones were using ARM technology.

6. MPX2050: The MPX2050DP is a dual-port on-chip temperature compensated and calibrated silicon Pressure Sensor. The MPX2050 series device is silicon piezoresistive pressure sensor provides a highly accurate and linear voltage output, directly proportional to the applied pressure. The sensor is a single, monolithic silicon diaphragm with the strain gauge and a thin-film resistor network integrated on-chip. The chip is laser trimmed for precise span and offset calibration and temperature compensation.

***7.MAX30100*:** The MAX30100 is an integrated pulse oximetry and heart-rate monitor sensor solution. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart-rate signals.

The MAX30100 operates from 1.8V and 3.3V power supplies and can be powered down through software with negligible standby current, permitting the power supply to remain connected at all times. Complete Pulse Oximeter and Heart-Rate Sensor Solution Simplifies Design.

V. RESULT AND DISCUSSION

1. POSITION OF ELECTRODES AND AD8232: The following figure describes the placing of electrode in human Right and Left hand . The Red and Black electrode in right hand and Blue electrode in Left hand.

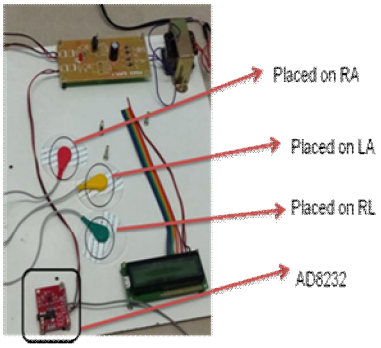

Figure 3 Position of all Sensors and Raspberry Pi

2. PLACING OF ALL SENSORS

The figure explains the placing of Raspberry Pi, Pulse Rate Sensor, ADS1115, Power supply on the Board

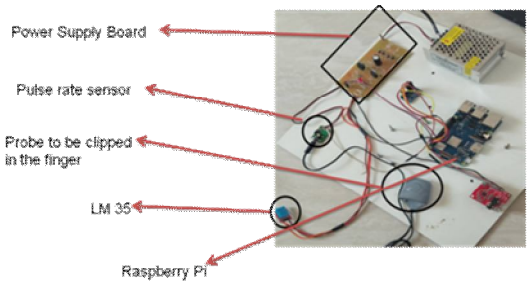

Figure 3 Position of all Sensors and Raspberry Pi

3. ELECTRODES ON HAND

The figure explains the placing of all three electrodes on Right and Left Arm

Figure 4 Electrodes on hand

OUTPUT OF ALL PHYSIOLOGICAL PARAMETERS

The figure shows the Snapshot of Temperature, Humidity, ECG and Pulse Rate.

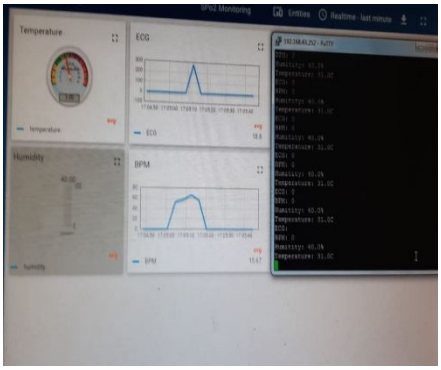

Figure 5 Output of Physiological parameters

VI. CONCLUSION

The various physiological parameters is measured by using different type of sensors that vary accordingly to their application. This is very efficient as they are light weight and reduces the mobility of patients to the hospitals and it mainly

helps in elderly people to wait in hospital for measuring these basic physiological parameters by enhancing that in doorstep. Based on the result obtained can be easily monitored by both patients and the corresponding physician. This system is very helpful in monitoring different parameters in a single devices. The parameters that include temperature, ECG, pulse and humidity is monitored continuosly and on daily basis when the need arises. The advantage of this system are

- Single device multiple parameters
- Cost is comparatively low
- Provides doorstep measuring of various physiological parameters

REFERENCES

[1] Ozkan, H., Ozhan, O., Karadana, Y., Gulcu, M., Macit, S., & Husain, F. (2019). A Portable Wearable Tele-ECG Monitoring System. IEEE Transactions on Instrumentation and Measurement

[2] Mishra, D., Priyadarshini, N., Chakraborty, S., & Sarkar, M. (2017). Blood oxygen saturation measurement using polarization-dependent optical sectioning. IEEE Sensors Journal, 17(12), 3900-3908.

[3] Liu, C., Zhang, X., Zhao, L., Liu, F., Chen, X., Yao, Y., & Li, J. (2018). Signal quality assessment and lightweight QRS detection for wearable ECG SmartVest system. IEEE Internet of Things Journal, 62), 1363-1374.

[4] Liu, X., & Kang, J. U. (2010). Depth-resolved blood oxygen saturation assessment using spectroscopic common-path Fourier domain optical coherence tomography. IEEE Transactions on Biomedical Engineering, 57(10), 2572-2575.

[5] Tsai, H. Y., Huang, K. C., Chang, H. C., Yeh, J. L. A., & Chang, C. H. (2014). A noncontact skin oxygen-saturation imaging system for measuring human tissue oxygen saturation. IEEE Transactions on Instrumentation and Measurement, 63(11), 2620-2631.

[6] Mendelson, Y., & Kent, J. C. (1989). Variations in optical absorption spectra of adult and fetal haemoglobins and its effect on pulse oximetry. IEEE Transactions on Biomedical Engineering, 36(8), 844-848.

[7] Pang, G., & Ma, C. (2014). A neo-reflective wrist pulse oximeter. IEEE access, 2, 1562-1567.

[8] Tekeste, T., Saleh, H., Mohammad, B., & Ismail, M. (2018). Ultra-Low Power QRS Detection and ECG Compression Architecture for IoT Healthcare Devices. IEEE Transactions on Circuits and Systems I: Regular Papers, 66(2), 669-679.

[9] Satija, U., Ramkumar, B., & Manikandan, M. S. (2017). Real-time signal quality-aware ECG telemetry system for IoT-based health care monitoring. IEEE Internet of Things Journal, 4(3), 815-823.37

[10] Woods, J. C., & Walinjkar, A. (2017). ECG classification and prognostic approach towards personalized healthcare.

[11] Murali, D., Rao, D. R., Rao, S. R., & Ananda, M. (2018, September). Pulse Oximetry and IOT based Cardiac Monitoring Integrated Alert System. In 2018 International Conference on Advances in Computing, Communications and Informatics (ICACCI) (pp. 2237-2243). IEEE.

[12] Kansara, R., Bhojani, P., & Chauhan, J. (2018, January). Designing Smart Wearable to measure Health Parameters. In 2018 International Conference on Smart City and Emerging Technology (ICSCET) (pp. 1-5). IEEE.

[13] Revathi, K., Samydurai, A., Kumar, N. S., & Keerthana, K. (2019, March). Health Trackers in Current Market: A Systematic Review, Trends and Challenges. In 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS) (pp. 251-256). IEEE.

[14] Revathi, K., Samydurai, A., Kumar, N. S., & Keerthana, K. (2019, March). Health Trackers in Current Market: A Systematic Review, Trends and Challenges. In 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS) (pp. 251-256). IEEE.

[15] Pinto, S., Cabral, J., & Gomes, T. (2017, March). We-care: An IoT-based health care system for elderly people. In 2017 IEEE International Conference on Industrial Technology (ICIT) (pp. 1378-1383). IEEE.

[16] Suyun, J., Guoqiang, L., & Hui, X. (2011, August). Special testing equipment for pressure distribution of human. In IEEE 2011 10th International Conference on Electronic Measurement & Instruments (Vol. 1, pp. 176-179). IEEE.

[17] Kokalki, S. A., Mali, A. R., Mundada, P. A., & Sontakke, R. H. (2017, September). Smart health band using IoT. In 2017 IEEE International Conference on Power, Control, Signals and Instrumentation Engineering (ICPCSI) (pp. 1683-1687). IEEE.

[18] Kansara, R., Bhojani, P., & Chauhan, J. (2018, January). Designing Smart Wearable to measure Health Parameters. In 2018 International Conference on Smart City and Emerging Technology (ICSCET) (pp. 1-5). IEEE.

[19] Vippalapalli, V., & Ananthula, S. (2016, October). Internet of things (IoT) based smart health care system. In 2016 International Conference on Signal Processing, Communication, Power and Embedded System (SCOPES) (pp. 1229-1233). IEEE.

[20] Lampe, B., Mau, T., Morehead, S., Turner-Bandele, N., Krishnan, S., & Dezfouli, B. (2018, October). Halo: A Personal IoT Air Monitor. In 2018 IEEE Global Humanitarian Technology Conference (GHTC) (pp. 1-7). IEEE.

[21] Hooshmand, M., Zordan, D., Del Testa, D., Grisan, E., & Rossi, M. (2017). Boosting the battery life of wearables for health monitoring through the compression of biosignals. IEEE Internet of Things Journal, 4(5), 1647-1662.
[22] Gope, P., & Hwang, T. (2015). BSN-Care: A secure IoT-based modern healthcare system using body sensor network. IEEE Sensors Journal, 16(5), 1368-1376.
[23] Alam, M. G. R., Abedin, S. F., Moon, S. I., Talukder, A., & Hong, C. S. (2019). Healthcare IoT-based Affective State Mining Using a Deep Convolutional Neural Network. IEEE Access.
[24] Ravi, D., Wong, C., Lo, B., & Yang, G. Z. (2016). A deep learning approach to on-node sensor data analytics for mobile or wearable devices. IEEE journal of biomedical and health informatics, 21(1), 56-64.
[25] Haghi, M., Thurow, K., & Stoll, R. (2017). Wearable devices in medical internet of things: scientific research and commercially available devices. Healthcare informatics research, 23(1), 4-15.
[26] Patii, N., & Iyer, B. (2017, May). Health monitoring and tracking system for soldiers using Internet of Things (IoT). In 2017 International Conference on Computing, Communication and Automation (ICCCA) (pp. 1347-1352). IEEE.
[27] Kulkarni, C., Karhade, H., Gupta, S., Bhende, P., & Bhandare, S. (2016, January). Health companion device using IoT and wearable computing. In 2016 International Conference on Internet of Things and Applications (IOTA) (pp. 152-156). IEEE.
[28] Son, L. P., Thu, N. T. A., & Kien, N. T. (2017, October). Design an IoT wrist-device for SpO2 measurement. In 2017 international conference on advanced technologies for communications (ATC) (pp. 144-149). IEEE.