IP Addressable Cloud Based Real Time ECG Health Monitoring System Using Bio-Wireless Sensor Node

Cheppala Reena Ratan[1], Sri D. Kishore[2]
[1]M.Tech ,Embedded Systems
[2]Associated Professor, Dept of ECE
[1, 2] Adityaa College of Engineering&Technology,Surampalem

Abstract- *The continuous real time remote health monitoring is a challenging task in bio-medical engineering. The existing remote health monitoring systems use wireless bio-information node (w-bin) to monitor the individual health parameters like heartbeat, temperature, etc. This paper presents a novel, low cost, low power cloud based ECG monitoring system using single system on chip (soc) and directly uploads its data to cloud without using any intermediate embedded servers. The developed system is named as "IP addressable cloud based real time ECG health monitoring system using Bio-Wireless Sensor Node". The proposed system make use of Texas Instruments CC3200 ARM Cortex M4 processor comes with integrated Wi-Fi which allows direct connectivity with the cloud based web portals. The proposed algorithm is an effective solution to plot ECG graph on the cloud. This system scales down the cost and power requirement for remote health monitoring by making use of advanced system on chip (soc), Internet of Things (IoT) and cloud technologies. Using Bio-Wireless Sensor Node, it is possible to send other human vitals (like temperature) to the cloud. With the help of IoT technology, the uploaded real time sensor data can be monitored from anywhere, anytime and by anyone with proper security credentials on the cloud. TI Exocite cloud server is used to connect with CC3200 ARM Cortex M4 processor using API.*

Keywords- CC3200, Cloud server, ECG Monitoring, SoC, WBAN

I. INTRODUCTION

Generally in personal health monitoring systems body sensor network (BSN) plays a very key role for bio medical information transfer to health care monitoring systems [1]. These body sensor networks inter connects different Body Information Nodes (BIN) and collects the information through wireless medium. Till now each bio Analog Sensor Interface use a separate wireless BIN to measure and transfer the data to the wireless sensor network servers. Typically a BIN was implemented with SOC comprises of analog amplifier, sampler, filter and RF transmitter to digitize and transmit the signal [2]. Three problems were identified in the existing BIN of BSN. First, if the number of sensors increases for health monitoring of a patient, the number of BINs will increase. So that hardware, cost, power consumption increases for monitoring a single patient health. Secondly, a separate high performance wireless sensor network server should be implemented to receive all these BIN's information [3]. Lastly, if the number of patients increases, the number of nodes increases, which in turn put a lot of load on to the server unless the communication between server and BIN implemented with proper protocol. Figure1 shows the existing system architecture.

In this paper, a solution is provided to avoid problems discussed above. In order to reduce the hardware, cost and power consumption all the body sensors of a patient is interfaced to a single node (referred as Multiple sensor node) and this node is comprised along with RF transmitter with low power. One of the challenging thing in this prototype is send and plot the real-time ECG wave on the cloud. With the advent of internet of things (IoT) technology, all these multiple sensor nodes are identified with a separate IP address. So that all these multiple sensor nodes can be communicate via IP based wireless networks. Therefore no separate network protocols and portable servers to be maintained which in turn reduce cost of implementation of the health care system in hospitals.

With the advent of miniaturization technology, a lot of chip companies have been implementing microcontroller along with RF technology for the development of IOT. The Texas Instruments is one of the companies who develop such microcontrollers (named simple link wireless MCUs – CC3200) as SoC with a size 9mmx9mm. In this project, this SoC is used as multiple sensor nodes for developing the application as per requirement. A cloud based application is developed to monitor and display the information coming from Multi sensor node [5].

The rest of the paper is organized as follows. Section II describes the related work of this paper. Section III presents the architecture of proposed system for personal health monitoring. Section IV presents the implementation of the proposed system. Section V presents the results of this paper. Section VI provides the conclusion of the paper.

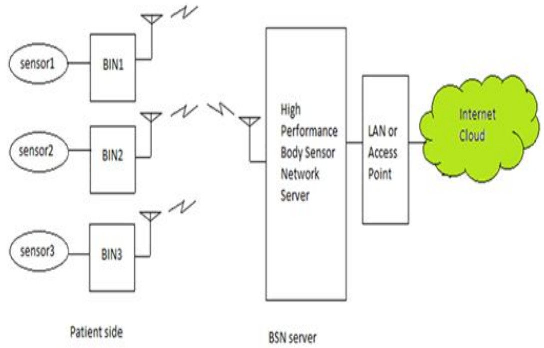

Figure 1: Existing System architecture. .

II. RELATED WORK

The present research on personal health monitoring focusing on IoT architectures in healthcare environments often use ZigBee, Wi-Fi, and RFID technologies. For example, Wu et al. [7] propose a healthcare management platform based on ZigBee WSN for safety monitoring capabilities. In another effort, Tsirbas et al. [8] present a RFID-IPv6 based scenario in a healthcare environment. Their platform utilizes the combination of RFID technology and IPv6 with Virtual MAC address Generator. None of these discussed platforms consider the characteristics of health data such as streaming nature of ECG and EMG data which plays a critical role in healthcare systems. Kirbas et al. [6] describe a web-based remote monitoring interface called HealthFace for medical healthcare systems based on wireless body area sensor network. Healthface can be accessed everywhere, anytime via IP based devices without any special programs or requirements for web-browsers.

III.SYSTEM ARCHITECTURE

The proposed system personal health monitoring is shown in figure 2

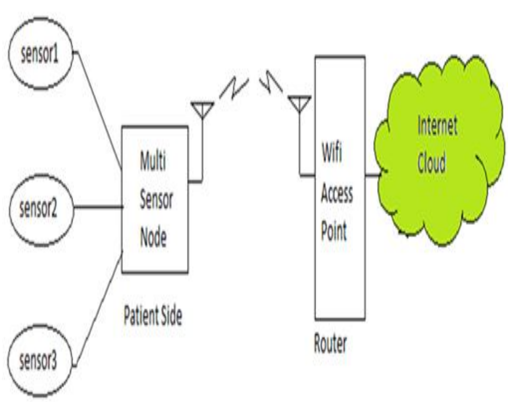

Figure2: Proposed system architecture

The proposed system is a single System on Chip (SoC) and Wi-Fi connectivity can be used to monitor all the normal human vitals and directly send such information to web services without using any personal servers. The recent advancements in Wi-Fi technology will allow the Wi-Fi devices to operate with low power. So by using this IP based multiple sensor node instead of multiple BIN's will reduce the cost and power requirement for remote heath monitoring systems. Because of the Internet of Things, the multiple sensor data from proposed device can be viewed from anywhere and anytime.

The proposed system consists of i) Analog Sensor Interface circuit which converts human vital to electrical signals and amplify them. ii) Analog to digital converter converts analog electrical signals to digital. iii) The host processor or controller processes the digital data and convert it internet data packets. And iv) the wireless transceiver module allow the device to get connect to router.

The proposed system uses web based applications to analyze, visualize and storage the real time data for personal health monitoring system. Cloud based patient's medical data storage is the upcoming challenges. In this paper, the results have been presented on the cloud services. The visualization methods in cloud services that make the patient's medical data accessible to all in a readily digestible format.

IV. SYSTEM IMPLEMENTATION

The proposed system block diagram is shown in figure 3

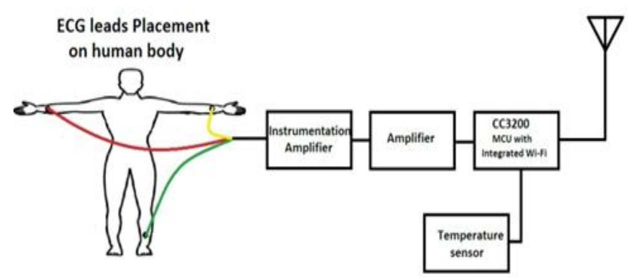

Figure 3: Block diagram of proposed system

The working of the proposed system implementation is divided into three parts. Since the embedded processor used in this device run with Real Time Embedded Operating System. The following sections will be executed as an independent parallel task in the processor itself using real time operating system.

1) Analog Sensor Interface
2) Signal Processing
3) Interfacing with Communication devices

4) Cloud Interface

1) Analog Sensor Interface:

The Analog Sensor Interface will provide the interface mechanism for different sensing units like ECG, temperature, blood pressure, etc. At this stage, the physicals human vital are converted into electrical signals. Amplification circuits used to boost up the analog signal level which is to be detected by the processor. A 3-lead ECG and temperature sensor were interface to this multiple sensor node. In this paper, the waveform of ECG taken from the CAD based Digital CRO tool and waveforms software.

The below figure shows the ECG Waveform.

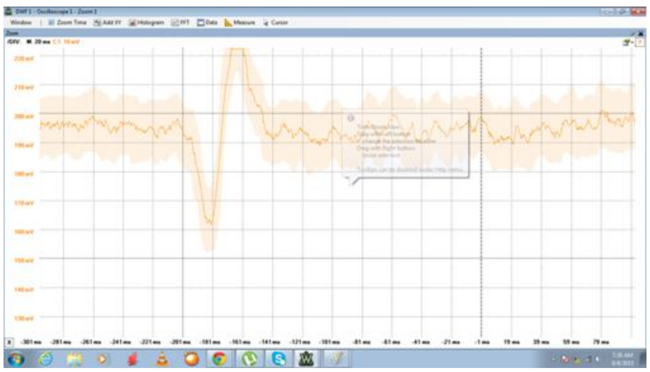

Figure4: QRS wave of the human wave recorded using Analog discovery tool

The figure 4 shows the ECG Waveform plotted using CAD digital CRO. From the figure 4, the QRS wave (highest frequency component) time interval is 60ms, i.e the frequency is 17Hz. Therefore from the nyquist rate, the sampling rate should be twice that of the actual signal (35 samples per 60ms). For 60ms duration there would be 35 samples, For 1sec duration, it will be 580 samples.

2) Signal Processing:

At this stage, processor ARM Cortex M4 CC3200 will convert the analog electrical signals into digital using in-built Analog to Digital converter (ADC). Before converting digital, the analog electrical signal should be cut down into pieces called samples. The number of samples per second is depending up on the maximum frequency component in the signal. For example, the ECG signal is sampled at 500 samples per second. In order to achieve different sample rates for different signals like ECG, blood pressure and respiratory, the processor internally uses timers. After sampling, these samples are converted into digital numbers. Again depend up on the vital parameter, processor will apply FIR filter to remove unwanted (noise) content in the signal. Finally, all the data collected from the different sensors gather and stored in a buffer, which is to be send to the Web services.

3) Interface with Communication devices:

The ARM processor CC3200 itself consists of inbuilt Wi-Fi mechanism. Programmatically, it is possible to connect the routers with this processor. By the way CC3200 will also consume less power while communicating with router.

4) Cloud Interface:

Once, the device connected to the communication router. Therefore all the ECG data will be converted into internet packets and uploaded to internet. All the Human vital information need to be converted into java script object notation (JSON) format before send it to the cloud services.

At the cloud server, a GUI is prepared using JavaScript to monitor the ECG graph.

V. RESULTS

As mentioned above, the system architecture is constructed using single Wi-Fi integrated SoC cloud based portal services. A snap shot of the implemented system architecture is shown in the figure 5. In the figure 5, a 3-lead ECG real time data is captured by the CC3200 and sent to the IoT enabled cloud services. The plotted results are shown on the laptop and smart phone.

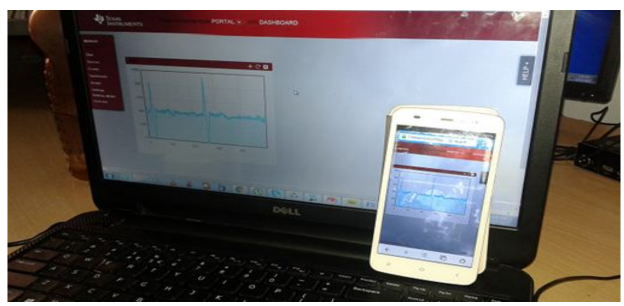

Figure5: ECG from both laptop and smart phone using cloud services

In this paper, IoT enabled personal health monitoring is presented by using proposed multiple sensor node with real time ECG monitoring. This will reduces the power and space occupied by the conventional health care system using multiple body information nodes.cases there could be chances where your paper receives number of critical remarks. In that cases don't get disheartened and try to improvise the maximum.

After the successful review and payment, IJSART will publish your paper for the current edition. You can find the payment details at: http://www.ijsart.com/publication-charges/

VI. CONCLUSION

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

APPENDIX

Appendixes, if needed, appear before the acknowledgment.

VII. ACKNOWLEDGMENT

The preferred spelling of the word ―acknowledgment‖ in American English is without an ―e‖ after the ―g.‖ Use the singular heading even if you have many acknowledgments.

REFERENCES

[1] X. Y. Jing, F. Wu, Z. Li, R. Hu and D. Zhang, "Multi-Label Dictionary Learning for Image Annotation," in IEEE Transactions on Image Processing, vol. 25, no. 6, pp. 2712-2725, June 2016.
[2] V.Gazis, M.G¨ortz, "A Survey of Technologies for the Internet of Things", IEEE journal, pages 1090 – 1095, DOI: 10.1109/IWCMC.2015.7289234
[3] J.Jara, M.A.Zamora, & A.F.G. Skarmeta, "Intra-mobility for Hospital Wireless Sensor Networks Based on 6LoWPAN", 2010 6th International Conference on Wireless and Mobile Communications, page numbers 389–394. DOI:10.1109/ICWMC.2010.54
[4] T.N.Gia,T.N.Kumar, "Customizing 6LoWPAN Networks towards Internet of Things Based Ubiquitous HealthcareSystems", Publisher :IEEE , Place of conference-Tampere DOI:10.1109/NORCHIP.2014.7004716.
[5] J. Neuhaeuser, "collecting and disturbing wearable sensor network" 35th Annual International Conference of the IEEE EMBS Osaka, Japan, 3 - 7 July, 2013
[6] G.Almashaqbeh, T.Hayajneh and V.Vasilakos, "A Cloud-based Interference-aware Remote Health Monitoring System for Non-hospitalized Patients" IEEE-conference DOI:978-1-4799-3512-3.
[7] Kirbas and C.Bayilmis "HealthFace: A web-based remote monitoring interface for medical healthcare systems based on wireless body area sensor network", vol. DOI:10.3906/elk-1011-934., 2010.
[8] M. Wu, and W. Huang., "WSN-based Health Care Management Platform for Long-Term Care Institutions", J. Converg. Inform. Technol. (JCIT) Vol 7, Num 7, April 2012.
[9] H. Tsirbas, K. Giokas, and D. Koutsouris, ""Internet of Things", an RFID – Ipv6 Scenario in a Healthcare Environment": MEDICON 2010, IFMBE Proceedings 29, pp. 808–811, 2010..
[10] B.Lin , Y.Chen , "Comparision Between Json And Xml In Applications On Ajax" IEEE-confernce 2012 DOI: 10.1109/Csss.2012.297 978-0-7695-471