International Journal of Reconfigurable and Embedded Systems (IJRES)
Vol. 12, No. 1, March 2023, pp. 51~59
ISSN: 2089-4864, DOI: 10.11591/ijres.v12.i1.pp51-59

Development of electrocardiogram intelligent and wearable monitoring system-assisting in care

Manjunathan Alagarsamy[1], Jemin Vijayaselvan Mariyarose[2], Nithya Devi Shanmugam[3], Joseph Michael Jerard Vedam[4], Mary Dallfin Bruxella Joseph[5], Kannadhasan Suriyan[6]
[1]Department of Electronics and Communication Engineering, K. Ramakrishnan College of Technology, Trichy, India
[2]Department of Computer Science and Engineering, R.M.K. College of Engineering and Technology, Thiruvallur, India
[3]Department of Electronics and Communication Engineering, Dr.N.G.P. Institute of Technology, Coimbatore, India
[4]School of Computing and Information Technology, REVA University, Bengaluru, India
[5]Department of Computer Science and Information Technology, Kalasalingam Academy of Research and Education, Krishnankoil, India
[6]Department of Electronics and Communication Engineering, Study World College of Engineering, Coimbatore, India

Article Info

Article history:

Received May 21, 2022
Revised Aug 7, 2022
Accepted Oct 17, 2022

Keywords:

Arduino
Electrocardiogram
Monitoring system
Point of care devices
Wearable devices

ABSTRACT

The primary factor contributing to the high mortality rate in our country is coronary heart disease, which affects almost 50% of people from rural regions. Internet of things (IoT) contributes effectively to the development of point of care (POC) gadgets that support the medical upkeep of an expanding agricultural population. An electrocardiogram test is crucial for analysing cardiac disorders. Therefore, we must develop a POC piece of hardware to assess the health of the heart in an affordable manner and to design it for the patients without interfering with their daily regular procedure in order to monitor the patient's coronary heart disease. As a result, we must design an uninterrupted workbench, which consists of three main integrated parts. The first is a mobile Bluetooth low energy device that has 5-lead electrocardiogram (ECG) surveillance equipment and the smallest form factor. The smart phone Android application that inherits, resolves, and maps the data sent from the ECG device comes next. The patient's information and report details are then compiled on a cloud server for the doctor's future attribution needs.

Corresponding Author:

Manjunathan Alagarsamy
Department of Electronics and Communication Engineering, K. Ramakrishnan College of Technology
Trichy, Tamil Nadu, India
Email: manjunathankrct@gmail.com

1. INTRODUCTION

In this post, we focus on a straightforward answer to the growing problems in rural regions. The biggest problem is the infrastructure's deterioration and the dearth of qualified medical personnel. In addition to this, those living in rural areas are experiencing a severe economic crisis and lack access to any kind of health insurance [1]. Later, the issue is that several lethal illnesses are on the increase, and that coronary heart disease may contribute to nearly 2 million deaths annually. Early medical evaluation and ongoing health validation are required for these sorts of disorders [2]. Accordingly, remote monitoring and telemedicine may be a humane answer to this two-growing issue in rural places. The main point of this concept is that it enables medical administrators and patients to both profits from the trip time by providing appropriate patient healthcare monitoring without relocating from their current location. A digenetic hardware system is created that is best suited for collecting data from an electrocardiogram (ECG) machine. It is integrated with smart phones, and with the use of the cellular network, the data are converted and sent to a distant server [3]. In this article, we'll develop a system that effectively monitors the health care and surveillance systems utilising a 5 lead ECG instrument and a Bluetooth transgressor that uses the least amount of energy [4]. Additionally, an Android application has been created that uses cellular networks to send the data collected from patients to a cloud server. A website is developed to show the reading to the doctor and to provide the patient with advice as well. Additionally, tests are performed to evaluate the product's quality [5].

2. PROPOSED SYSTEM ARCHITECTURE

The computerised activity of the heart system is measured by a procedure called electrocardiography. Time is shown along the axis of abscissas, while voltage is plotted along the axis of coordinates for electrocardiogram signals. 12 electrodes are needed for an ECG procedure, which involves placing a 12-vibrating strip on the epidermis to record potentiality inequality between a few areas, such as the right leg or left leg, or the right arm or left arm, or any combination of these. All of these things have occurred due to advancements in detection technology and the absence of conventional electrocardiogram equipments. Due to this rise, we have been able to create a portable and wearable device that uses a 5-lead ECG and automatically analyses the waveform and heart rate of the cardio vascular system for extended periods of time [6]. The system comprises of one hardware component that collects information about the ECG measurement results and sends it wirelessly through a Bluetooth low energy device to a smartphone. Recognised information is gathered by an Android application that is installed on smart phones, and it is then wirelessly sent to a cloud server over a cellular network. Regardless of the physician's location, the online storage offered by this system may serve as a middleman between the physician and the patient who resides in a remote region. The medical professional may also access the health records using this system, and he or she is also able to provide any instructions to the patient living in a remote region. The system design is shown in Figure 1 throughout the whole system development process.

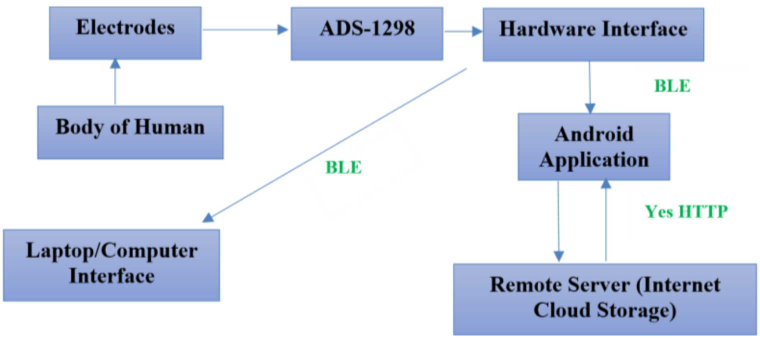


Figure 1. Architecture of the proposed system

3. ELECTRODE PLACEMENT

We had roughly 10 electrodes on hand while we were considering a common approach of obtaining the cardio vascular signal. These electrodes are positioned throughout the body in various places. Four electrodes are positioned in the limbs; three of the electrodes are used to measure the voltage signal, and the remaining electrode is utilised to reduce noise that is present in the right leg's right leg [7]. These in-leg electrodes have the ability to measure voltage signals and are utilised to create limb leads, which are electrical signals. Leads with four leads are known as limb leads. The six electrodes that are connected together in the chest are known as the chest leads. It may provide access to six additional leads overall. There is another current configuration that just makes use of 5 electrodes [8]. In our model, this configuration is used. The majority of the ECG signal will fall between 0.1 and 5 mV, or the week signal. However, it may have a significant DC offset of up to 300 mv. The main cause of noise may be patient movement, patient breathing during exhale and inhalation, as well as the power sources we employ in this setup [9]-[15].

4. DESIGNING OF HARDWARE

Figure 2 in the following paragraphs depicts the ECG module created specifically for our purpose. It consists of a CC2541-compliant Bluetooth low energy (BLE) device made by Texas instruments, an analogue front-end device (ADS1293), and a power supply component. A single board, measuring 35 to 38 mm, has all of them. A connector joins the wires of the 5-lead ECG cable. DB9 connection [16] is the connector used [25].

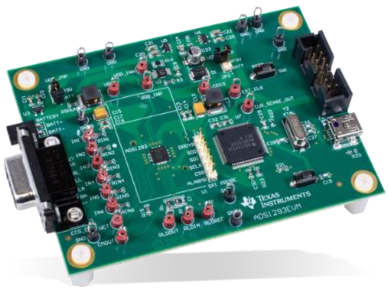


Figure 2. Module of electrocardiogram

4.1. Analog ADS 1293

The ADS1293 has all characteristics that are typical. Three low-power medical channels with high resolution digital ECG channels, portable sports, and simultaneous pace output capability are available for request. It also directs the development of numerous medical devices that are less expensive, smaller in size, and use less power [11], [12]. The integrated portion includes a high resolution channel possibly three that are particularly designed for a certain sampling rate, and the bandwidth is enabled in accordance with how the function will be carried out in relation to the power source. These stunning resolution bands are made up of digital filters R1, R2, and R3 plus a customizable decimation band. The bandwidth, noise, and data rate are changed as a result of the weakening of R1, R2, and R3 [13]. Due to restrictions on the band rate and noise level, it becomes quite helpful. Our project's R1, R2, and R3 values are 4, 8, and 64, and the sampling frequency, which is 50 samples per second, achieves a maximum bandwidth of 40 Hz. The 40 Hz bandwidth is utilised in medical offices and hospitals [14].

4.2. Bluetooth low energy CC2541

The CC2541 is designed to run system-on-chip gear that is appropriate for both low-energy Bluetooth sources and general applications. It allows for robust. Additionally, it makes it possible for radio frequency (RF) headphones to function with an 8051 MCU that is enhanced for Bluetooth low energy. The framework included a flash memory drive, 8 KB of RAM, and various other features. This CC2541 is utilised in systems with very low control use. The CC2541 is available in two variants, the CC2541F128 and F256, with flash memory capacities of 128 KB and 256 KB. These models mostly have 8 KB of SRAM. In our project, CC2541F256 is used.

4.3. Android application

The "SAI EGG" Android application was created for this project. The "SAI EGG" application shows the ECG data of the patients utilising Bluetooth low energy technology and sends the exact same result to the cloud through internet access. The waveform may be seen on the website. This use may be done for API level 23. However, the BLE with computer support is API 18. With the use of the programme, a doctor is able to browse a website and evaluate a patient's ECG who has difficulty with Medicare-related concerns.

The active class will process and get the patient id from the cloud where it has been saved when the programme is launched. Android projects are basically separated into three primary andrology active class, service class, and analysis class. The user's chosen device may be connected to, and nearby Bluetooth devices can also be found using this feature. The main control activity used to depart when a device is connected, allowing the user to view the patient's data and plot the ECG signal's waveform using the interface.

The information is saved in a service class that is specifically geared for electrocardiogram instruments in the end, and it sends the information to other classes once it has been converted from integer to string format. In the analysis class, there are five convolution techniques that use the information supplied in the main control activity's letter-font data. The following is a list of the analysis class output:

a. The beats per minute representation of the ventricular rate (BPM).
b. A millisecond representation of the QRS value.
c. A millisecond representation of the R-R time interval.
d. There are three different categories of heartbeat: (brady, achy, and normal).

The "BackGroundServices" class is started in order to do network activities, from which it communicates to the server and then receiver through this class. Additionally, it begs the "ConnectionUtil" to elicit a http-based connection so that it may beg and ripost to the cloud server. OkHttp is used to establish the http connection.

4.4. Storage server

As a storage server, WAMP server is used. The acronym WAMP stands for "Windows, Apache, MySQL and PHP area kind of server which is utilised for web development stage on Windows." The HTTP server included in the WAMP package runs the webserver within its own windows. PHP is a programming language, and MySQL is a highly fast database system that has the ability to transfer data from one database to another. Therefore, PHP design exploits as an intersection between client and database. The client has to transmit data to the database via an Android application, as per the data flow paradigm that is recommended. The user session is checked on the server. Only when the session state is in the present format and there is continuous communication between the server and client is the gathered data transmitted in a JSON format. The obtained data is then read and decoded in accordance with the key value pair format. The database receives and compiles the data that has been decoded from JSON. The information was obtained for the local host's three channels. The data has been moved from the Android device to the local network and is now being displayed by the PHP server. Finally, the table is modified in accordance with our needs, and at the terminal level, it is performed on the distant server.

4.5. Desktop application

An application for a home computer has been created to display the ECG signal of the individual to whom the instrument is fastened in Figure 3. Data communication is made possible by the usage of BLE wireless technology. Both hospitals and the healthcare system utilise this programme. The medical professional interconnects the BLE gadget with the EKG through the system.

The user interface for this application is being created using JavaFX. This Java programme is used for graphical design. Upon the BLE connection, a processor is employed to allow the home computer to communicate with the ECG monitoring equipment. This configuration deforms the BLE control layer and the host, initialises both in the CC2541 BLE dongle, and instals both the system profile and the application on the user's home computer. For communication between the dongle and the PC as well as via vendor-specific HCI instructions, virtual URT is employed.

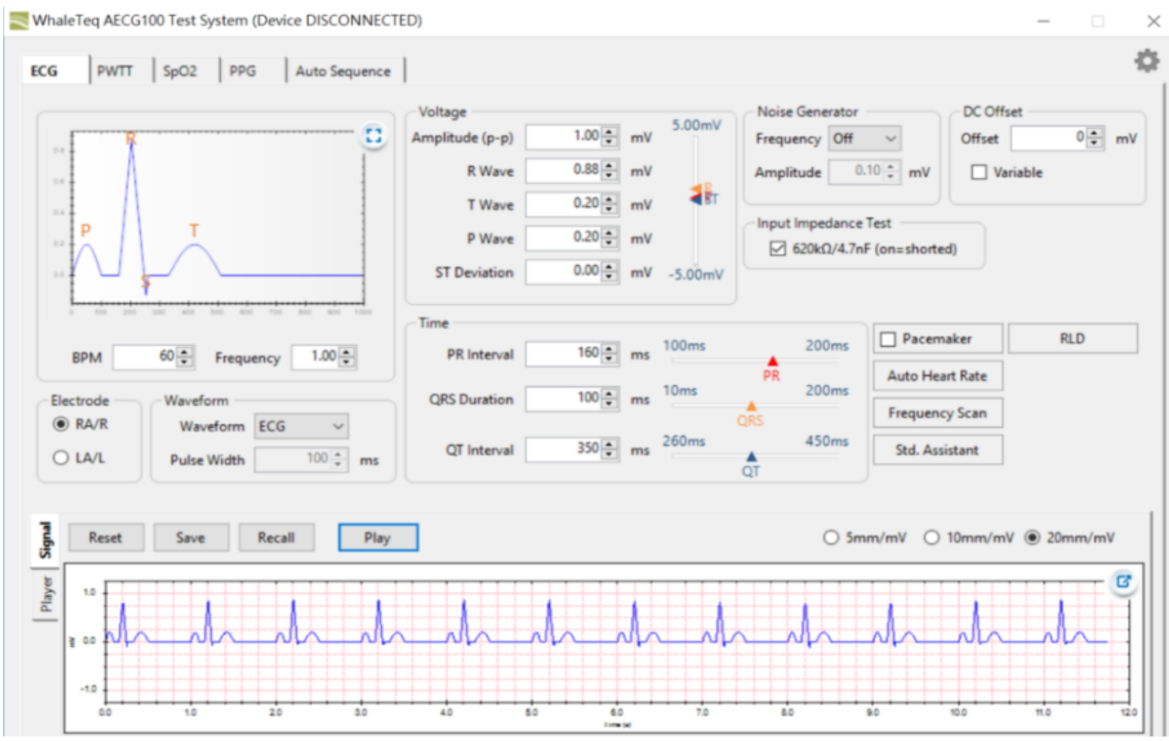
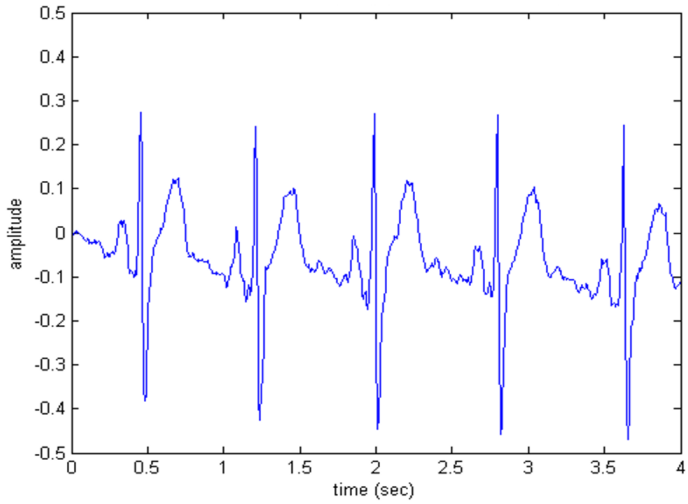


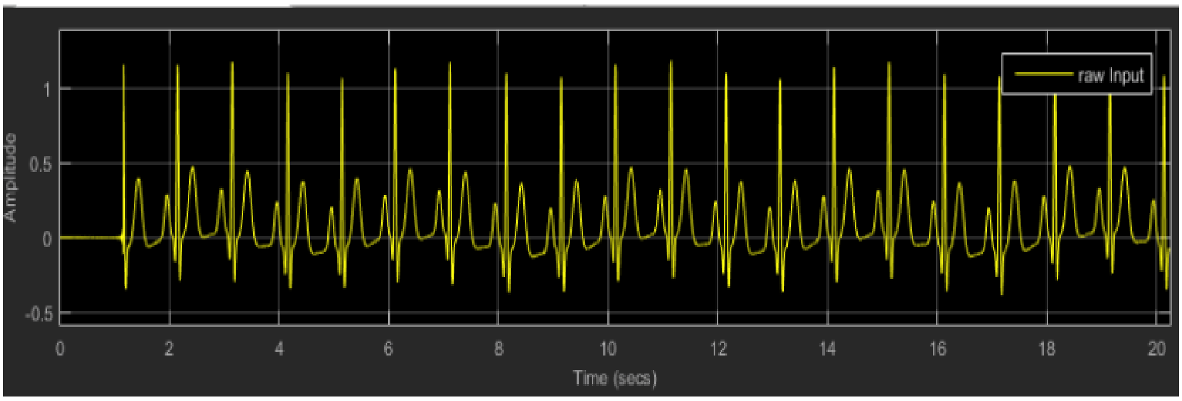
Figure 3. Graphical user interface developed for ECG interface

5. RESULTS AND DISCUSSIONS

Sri Sathya Sai General Hospital routed the preliminary endorsement procedure in accordance with the medical partitioner's requirements. Results of 16 patients' electrocardiograms were obtained using both a conventional machine and our equipment. The ECG recorded from the patient utilising our device, as well as via the GE MAC 600 and standard ECG equipment, are all taken into account in the Figure 4. Figure 4(a) depicts the ECG that was obtained with the suggested hardware. Figure 4(b) displays the obtained signal that was retrieved from the ECG. The outcomes produced by these two systems are relevant and are also examined by cardiac specialists.



(a)

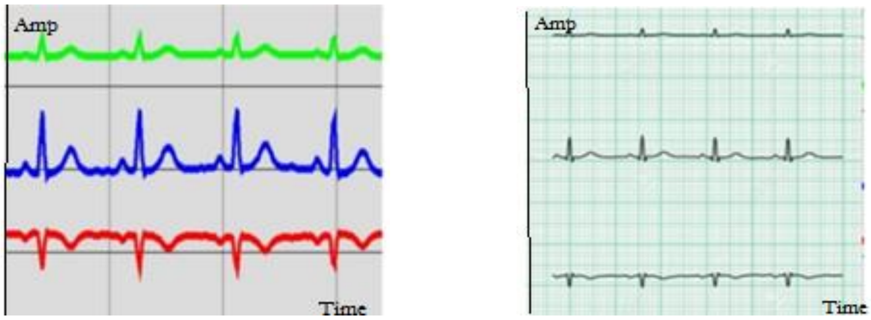


(b)

Figure 4. The signal acquired ECG from (a) the proposed hardware and (b) ECG device available in hospital

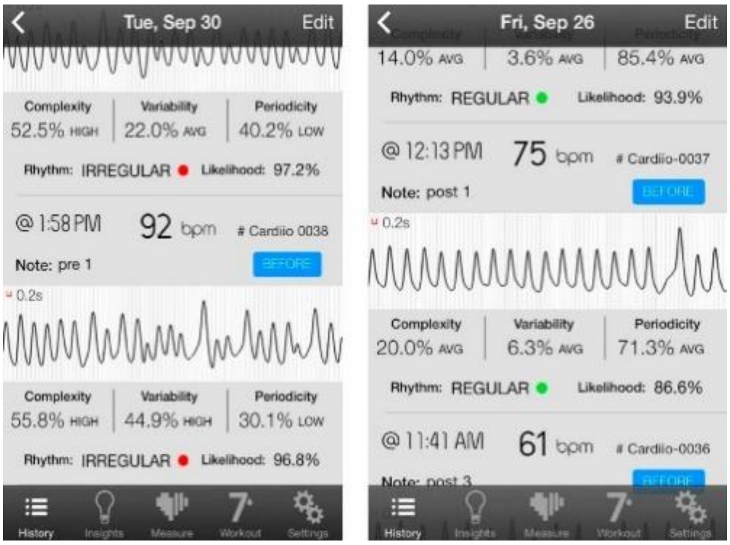
The ECG device is calibrated using the DATASIM 6100 simulator, and as a result, 15 different types of ECG data are sent to the ECG simulator via our ECG integrated component. Figures 5 show how we can use the NSR graph to reclaim information from both the desktop interface and the mobile app. Figure 5(a) displays an ECG obtained using a computer programme, and Figure 5(b) displays a signal captured using a mobile device for simulation.

We developed an algorithm to determine the ventricular rate of the heart and the QRScomplex-R time length are presented on a mobile application, which only requires 2 seconds of our time, after looking at the results of 15 various kinds of irregularities. The ECG data supplied in the online source is shown in Figure 6. As illustrated in Figure 6(a), the technique is also utilised to determine if the data collected is of "Sinus TACHYCARDIA", "Sinus BRADYCARDIA", or "NORMAL SINUS". Figure 6(b) depicts the internet page's depiction of the ECG signal.



(a) (b)

Figure 5. The signal acquired from acquisition of ECG through (a) laptop computer application and (b) the mobile application that could be processed for simulation



(a)

(b)

Figure 6. The signal acquired ECG from (a) mobile application and (b) Tachy

Rural residents who are far from medical facilities are in a worse situation since a delay in diagnosis or treatment might lead to fatalities. If these issues are identified and treated right on, they may be significantly minimised. Thanks to advancements in wireless communications and wearable sensor technology, real-time healthcare monitoring systems are now feasible. This study has proposed a real-time heart monitoring gadget for cardiac patients who reside in remote areas. The developed system consists of wearable sensors, an Android mobile device, and a web interface. The system is adaptable and can simultaneously extract heart rate, blood pressure, and temperature from a large number of individuals. The obtained data is transferred to an Android mobile device via Bluetooth low energy, where it is then forwarded to a web application for further processing. The patient's medical status is shown online together with personal information like age, gender, residence, and location after a computer application analyses the data it gets. A threshold-based warning system has also been created to alert doctors about abnormalities such arrhythmia, hypotension, hypertension, fever, and hypothermia is shown in Figure 7.

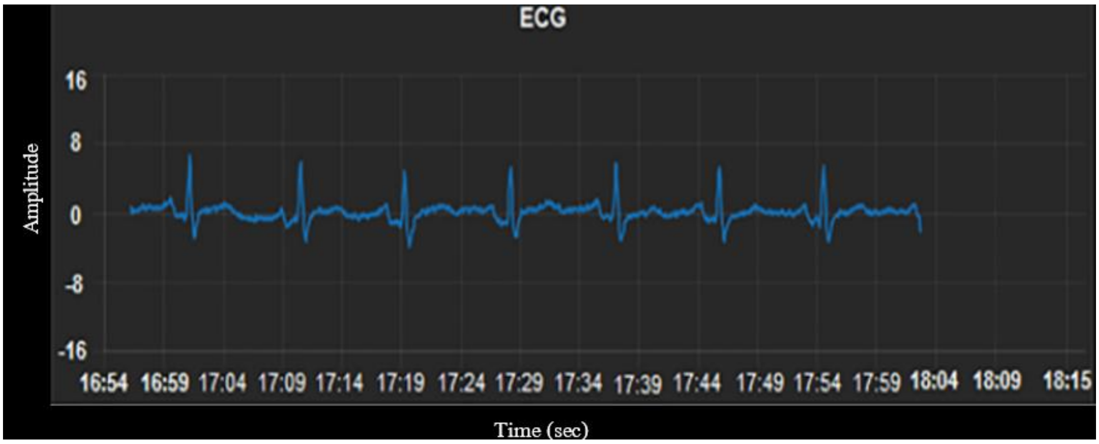


Figure 7. Display of ECG information on web site page

6. CONCLUSION AND FUTURE WORK

This study develops a diagnostic framework for remote monitoring that could spot underlying heart problems in real-time, avoiding potential heart illnesses and helping those recovering from cardiac conditions. With the help of the recommended real-time monitoring system, it is possible to concurrently measure a number of indicators, including heart rate, blood pressure, and body and skin temperature. By setting alerts based on higher and lower threshold values, these cardiac parameters help in the early detection of illnesses like arrhythmia, hypotension, hypertension, and hyperthermia. Similar to the monitoring systems now in use, the newly developed system has two interfaces, one for patients and one for clinicians. The patient interface is made up of wearable sensors that gather health information from users and transmit it through Bluetooth low energy to a listening port running Android.

REFERENCES

[1] A. Malaoui, "Low cost pedagogic device for practical works using embedded system," *2015 IEEE/ACS 12th International Conference of Computer Systems and Applications (AICCSA)*, 2015, pp. 1–8, doi: 10.1109/AICCSA.2015.7507160.

[2] A. Vishwanatham, C. Narendra, S. R. Abhishek, C. R. Ramakrishna, S. S. S. Sanagapati, and S. Mohanty, "Smart and wearable ECG monitoring system as a point of care (POC) device," *2018 IEEE International Conference on Advanced Networks and Telecommunications Systems (ANTS)*, 2018, pp. 1-4, doi: 10.1109/ANTS.2018.8710115.

[3] K. Karumbaiah *et al*., "ECG findings you do not want to miss!," *Cardiofel Newslet*, vol. 3, no. 9, pp. 40-44, 2020, doi: 10.13140/RG.2.2.12945.45925.

[4] N. Shalaby, H. Aguib, M. Badran, and K. Elkhodary, "A two-stage purkinje network for more accurate ECG representations," *Research square*, 2020, doi: 10.21203/rs.3.rs-37226/v1.

[5] J. Ngango and O. Omole, "Prevalence and sociodemographic correlates of cardiovascular risk factors among patients with hypertension in South African primary care," *Cardiovascular Journal of Africa*, vol. 29, no. 6, pp. 344-351, 2018, doi: 10.5830/CVJA-2018-038.

[6] N. Lowres *et al*., "Feasibility and cost-effectiveness of stroke prevention through community screening for atrial fibrillation using iPhone ECG in pharmacies," *Thrombosis and Haemostasis*, vol. 111, no. 06, pp. 1167-1176, 2014, doi: 10.1160/TH14-03-0231.

[7] A. K. Joshi, A. Tomar, and M. Tomar, "A review paper on analysis of electrocardiograph (ECG) signal for the detection of arrhythmia abnormalities," *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, vol. 03, no. 10, pp. 12466-12475, 2014, doi: 10.15662/ijareeie.2014.0310028.

[8] N. Bashi, M. Karunanithi, F. Fatehi, H. Ding, and D. Walters, "Remote monitoring of patients with heart failure: an overview of systematic reviews," *Journal of Medical Internet Research*, vol. 19, no. 1, 2017, doi: 10.2196/jmir.6571.

[9] M. Shrivastav, R. Shrivastav, J. Makkar, and M. Biffi, "Patient selection for ambulatory cardiac monitoring in the Indian healthcare environment," *Heart Asia*, vol. 5, no. 1, pp. 112-119, 2013, doi: 10.1136/heartasia-2012-010228.

[10] A. Saxena *et al*., "Prevalence and outcome of subclinical rheumatic heart disease in India: the RHEUMATIC (rheumatic heart echo utilisation and monitoring actuarial trends in Indian children) study," *Heart*, vol. 97, no. 24, pp. 2018-2022, 2011, doi: 10.1136/heartjnl-2011-300792.

[11] M. Linzer, "Clinical guideline: diagnosing syncope: part 2: unexplained syncope," *Annals of Internal Medicine*, vol. 127, no. 1, 1997, doi: 10.7326/0003-4819-127-1-199707010-00014.

[12] M. J. Reed, D. E. Newby, A. J. Coull, K. G. Jacques, R. J. Prescott, and A. J. Gray, "Role of brain natriuretic peptide (BNP) in risk stratification of adult syncope," *Emergency Medicine Journal*, vol. 24, no. 11, pp. 769-773, 2007, doi: 10.1136/emj.2007.048413.
[13] M. J. Reed, D. E. Newby, A. J. Coull, K. G. Jacques, R. J. Prescott, and A. J. Gray, "The risk stratification of syncope in the emergency department (ROSE) pilot study: a comparison of existing syncope guidelines," *Emergency Medicine Journal*, vol. 24, no. 4, pp. 270-275, 2007, doi: 10.1136/emj.2006.042739.
[14] S. Yin *et al*., "Wearable physiological multi-vital sign monitoring system with medical standard," *IEEE Sensors Journal*, vol. 21, no. 23, pp. 27157-27167, 2021, doi: 10.1109/JSEN.2021.3123084.
[15] M. Ramkumar, C. G. Babu, K. V. Kumar, D. Hepsiba, A. Manjunathan, and R. S. Kumar, "ECG cardiac arrhythmias classification using DWT, ICA and MLP neural networks," *Journal of Physics: Conference Series*, vol. 1831, no. 1, 2021, doi: 10.1088/1742-6596/1831/1/012015.
[16] M. Ramkumar, C. G. Babu, A. Manjunathan, S. Udhayanan, M. Mathankumar, and R. S. Kumar, "A graphical user interface based heart rate monitoring process and detection of PQRST peaks from ECG signal," in *Inventive Computation and Information Technologies. Lecture Notes in Networks and Systems*, S. Smys, V. E. Balas, K. A. Kamel, and P. Lafata, Eds. Singapore: Springer, 2021, pp. 481-496, doi: 10.1007/978-981-33-4305-4_36.
[17] A. Manjunathan, E. D. K. Ruby, W. E. Santhkumar, A. Vanathi, P. Jenopaul, and S. Kannadhasan, "Wireless HART stack using multiprocessor technique with laxity algorithm," *Bulletin of Electrical Engineering and Informatics (BEEI)*, vol. 10, no. 6, pp. 3297-3302, 2021, doi: 10.11591/eei.v10i6.3250.
[18] J. Chelliah, M. Alagarsamy, K. Anbalagan, D. Thangaraju, E. S. Wesley, and K. Suriyan, "Automatic wireless health instructor for schools and colleges," *Bulletin of Electrical Engineering and Informatics (BEEI)*, vol. 11, no. 1, pp. 278–285, 2022, doi: 10.11591/eei.v11i1.3330.
[19] K. Suriyan, N. Ramaingam, S. Rajagopal, J. Sakkarai, B. Asokan, and M. Alagarsamy, "Performance analysis of peak signal-to-noise ratio and multipath source routing using different denoising method," *Bulletin of Electrical Engineering and Informatics (BEEI)*, vol. 11, no. 1, pp. 286-292, Feb. 2022, doi: 10.11591/eei.v11i1.3332.
[20] M. Ramkumar, A. Lakshmi, M. Pallikonda Rajasekaran, and A. Manjunathan, "Multiscale Laplacian graph kernel features combined with tree deep convolutional neural network for the detection of ECG arrhythmia," *Biomedical Signal Processing and Control*, vol. 76, 2022, doi: 10.1016/j.bspc.2022.103639.
[21] T. Pechprasarn and S. Pongnumkul, "Estimation of respiratory rate from smartphone's acceleration data," *2013 10th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology*, 2013, pp. 1-5, doi: 10.1109/ECTICon.2013.6559610.
[22] B. Jeon, J. Lee, and J. Choi, "Design and implementation of a wearable ECG system," *International Journal of Smart Home*, vol. 7, no. 2, pp. 61-70, 2013.
[23] J. Malmivuo and R. Plonsey, *Bioelectromagnetism – Principles and Applications of Bioelectric and Biomagnetic Fields*, Oxford University Press, 1995.
[24] J.G. Webster, *Medical Instrumentation application, and design*, John Wiley, 1998.
[25] P. Kakria, N. K. Tripathi, and P. Kitipawang, "A real-time health monitoring system for remote cardiac patients using smartphone and wearable sensors," *International Journal of Telemedicine and Applications*, vol. 2015, pp. 1–11, 2015, doi: 10.1155/2015/373474.

BIOGRAPHIES OF AUTHORS

Manjunathan Alagarsamy received the Engineer degree in Electronics and Comunication Engineering from Dr. Navalar Nedunchezhiyan College of Engineering in 2010. He received the Master degree in Embedded System Technologies from Raja College of Engineering and Technology, Madurai, Tamil Nadu, India in 2013. He is currently working as an Assistant Professor in the Department of Electronics and Communication Engineering at K. Ramakrishnan College of Technology, Trichy, India. His area of interests includes embedded systems, image processing, sensors and interfacing networks and internet of things. He has published 13 articles in peer reviewed International journals and presented 6 papers in International conferences. He can be contacted at email: manjunathankrct@gmail.com.

Jemin Vijayaselvan Mariyarose received the Bachelor degree in Information Technology from Sun College of Engineering and Technology 2010. He received the Master degree in Computer Science and Engineering from University College of Egineering, Nagercoil, Tamil Nadu, India in 2013. He is currently working as an Assistant Professor in the Department of Computer Science and Engineering at R. M. K. College of Engineering and Technology, Puduvoyal, Chennai, India. His area of interests includes image processing, sensors and interfacing networks and computer vision. He has published 3 article in peer reviewed International journals and presented 3 papers in International conferences. He can be contacted at email: vmjemin@gmail.com.

Nithya Devi Shanmugam received the Bachelor of Engineering degree from Sasurie College of Engineering, Vijayamanagalam in 2009, Master of Engineering from Anna University Regional center, Coimbatore 2013. She is pursuing PhD degree in Testing of Low power VLSI digital circuits from Anna University, Chennai. She is an Assistant Professor at Dr. N.G.P. Institute of Technology, Coimbatore since 2016 and earlier she had gained her experience from Info Institute of Technology, Coimbatore. She has totally 13 years of teaching experience. She has authored 8 research publications both international and national journals and presented 11 papers in international conferences. Her areas of interest include Testing of VLSI digital circuits, artificial intelligence, signal processing and VLSI for wireless communications. She is a life member of professional bodies like ISTE, IETE and IAENG. She can be contacted at email: ndsnithya88@gmail.com.

Joseph Michael Jerard Vedam received the Bachelor of Engineering degree in Electronics and Comunication Engineering from Mookambigai College of Engineering in 1991. He received the Master of Engineering degree in Computer Science & Engineering from NIT, Trichy in 1997. He receieved the Doctorate in Computer Science & Engineering (Cloud Computing Security) from Karagam Academy of Higher Education, Coimbatore in 2019. He is currently working as Professor in the School of Computing & Information Technology, REVA University, Bangalore. His area of interests includes cloud computing, internet of things, machine learning and big data analytics. He has published 6 articles in peer reviewed International journals and presented 2 papers in International conferences. He can be contacted at email: Jerard.vedam@gmail.com.

Mary Dallfin Bruxella Joseph an academician having more than 14 years of teaching experience currently working as an Assistant Professor in the Department of Computer Science and Information Technology in the Kalasalingam Academy of Research and Education (Deemed to be University), Krishnankoil, Tamil Nadu. She has completed B.Sc (Maths) in Bharathidasan University, M.C.A. in Bharathidasan University, M.Phil and Ph.D. in Periyar University in the year 1999, 2002, 2007 and 2021 respectively. Her area of research is machine learning. She has secured University Rank in B.Sc(Maths) Programme under Bharathidasan University. She has published 10 research articles in various SCI/Scopus Indexed Journals/UGC CARE Journals. She has presented nearly 16 papers in the International and National conferences/Seminars. Recently she published a patent in her research area in the year 2020. She can be contacted at email: jdallfin@gmail.com.

Dr. Kannadhasan Suriyan is working as an Assistant Professor in the department of Electronics and Communication Engineering in Study World College of Engineering, Coimbatore, Tamil Nadu, India. He is Completed the Ph.D in the field of Smart Antenna for Anna University in 2022. He is Twelve years of teaching and research experience. He obtained his B.E in ECE from Sethu Institute of Technology, Kariapatti in 2009 and M.E in Communication Systems from Velammal College of Engineering and Technology, Madurai in 2013. He obtained his M.B.A in Human Resources Management from Tamil Nadu Open University, Chennai. He has published around 45 papers in the reputed indexed international journals indexed by SCI, Scopus, Web of science, Major indexing and more than 146 papers presented/published in national, international journal and conferences. Besides he has contributed a book chapter also. He also serves as a board member, reviewer, speaker, session chair, advisory and technical committee of various colleges and conferences. He is also to attend the various workshop, seminar, conferences, faculty development programme, STTP and Online courses. His areas of interest are smart antennas, digital signal processing, wireless communication, wireless networks, embedded system, network security, optical communication, microwave antennas, electromagnetic compatability and interference, wireless sensor networks, digital image processing, satellite communication, cognitive radio design and soft computing techniques. He is Member of IEEE, ISTE, IEI, IETE, CSI, IAENG, SEEE, IEAE, INSC, IARDO, ISRPM, IACSIT, ICSES, SPG, SDIWC, IJSPR and EAI Community. He can be contacted at email: kannadhasan.ece@gmail.com.