International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 06 | June 2021 www.irjet.net p-ISSN: 2395-0072

A Survey on Measuring Heart Rate of a Patient

Mothukuri Dushyanth Babu[1], Anil Bezawada[2], Idupulapati venkata sai eshwar[3]

[1-2]Student, Dept. of Electronics and communication Engineering,S R M , Guntur, Andhra Pradesh, 522501, INDIA
[3]Student, Dept. of Electronics and communication Engineering,koneru lakshmaiah Education foundation, Guntur, Andhra Pradesh, 522502, INDIA

Abstract *- In recent days due to COVID-19 health awareness had woken up many minds across the world. As a result, people understand about various types of diseases and their symptoms. Analyzing the disease affected by patient is the major and preliminary step of doctors for having the perfect medication to get cured. Here I have mentioned about, different types of heart rate measurements such as by using invasive/non-invasive electrodes, wearable sensors, ECG(Electrocardiogram), plethysmograph, etc... So, one of the major problems is heart rate monitoring, more than conventional methods there are other methods for finding the heart rate of a patient easily. This helps in worse condition of a patient when he/she was under fire injury with 2nd /3rd degree burns or under a heavy injury. Photo plethysmograph, plethysmograph, contactless heartbeat monitor are the better alternatives for measuring heart rate when compared to traditional techniques like ECG(Electrocardiograph), wearable sensors, and GSM techniques integration with wearables. Non- contact measuring of heart muscle activity through bioelectric signals passing by electromagnetic waves for calculation are some other techniques used for heart rate measurement. This survey paper discusses all the relevant papers (given in references) used for heart rate measuring techniques.*

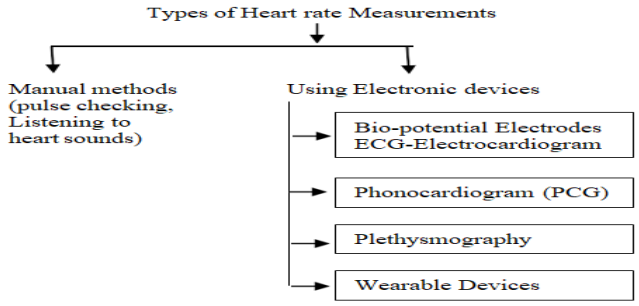
Keywords **- ECG(Electrocardiogram), plethysmography, photoplethysmography, Phonocardiogram, wearable sensors, pulse sensor, heart rate measurement, GSM techniques.**

1.INTRODUCTION

As the days pass by the values for medical and medical diagnosis have been raised to the sky. And the importance of self-diagnosis during lockdown gained its own priority in the diagnosis of health through different wearable devices. Health assessing devices ruling the market because of the massive increase of cost price of health check-up by hospitals, and poor availability of hospitals in and around regions, population are the effective reasons for increasing usage of health self-assessing sensors.

For example, we consider our daily healthcare. There are several parameters that need to be seen they are BP (blood pressure), Heartbeat monitor, body weight, etc [1]. For heart disease prevention, day-to-day monitoring of the heart is simply effective and helpful. As this paper discusses only different kinds of measuring techniques, we go one by one in brief. Measuring heart rate includes two types. They are invasive and non-invasive. An invasive measurement includes piercing your skin at the measurement part and the non-invasive doesn't require piercing your skin for measurement. For example, X-RAY, CT SCAN, MRI SCAN, etc. Electrocardiograph (ECG) is one of the techniques purely involves in measuring heart rates.

Plethysmograph is a new technique that combinedly takes respiration and heart activity. Wearable sensors such as pulse sensors and other sensors included for heart rate monitoring. 12-Lead system, III, IV lead system of measuring heart rate measurement [2]. All these techniques are used only for acquiring signals from the patient body. Based on mathematical studies these acquired signals are converted conveniently for analyzing patient health conditions. Based on signal analysis patient heart condition will be understood by the doctor [3]. The technology improvement has massive in the world. Through these advanced instruments and measuring techniques, doctors and researchers can predict the heart condition of the fetus. Thus, fetal heart and health problems could be cured and estimated within the mother's womb [4]. This also includes a low noise ratio and other factors in the recording of signals. Fault prediction and calculations may result in false estimation of the health condition of patients[6]. From formal or manual methods this measurement of heart rate has taken biggest evolution change in the medical Industry[7].



FFig.1. Block Diagram of Types of heart rate measurements

2. LITERATURE SURVEY

2.1 Manual methods

At the first, Heart rate measurements are done very manually. These manual methods involve in checking pulse at your wrist by placing two fingers between the bone and the tendon over your radial artery. This radial artery is located on the thumb side of your wrist. As shown Fig.2. B. With some mathematical calculation we count the beats per minute. As we know manual methods involves in inaccuracy due to human observational errors. To be advanced, we can even measure heart rate by placing your finger on the carotid pulse which is located at the side of your neck. As shown in Fig. 2. A. When all above fails, place your ear on the patient body and listen to heart beats. And start counting them for a minute. Generally, it is preferred to have 3-5 readings. If you feel that the recorded readings are inaccurate, ask your neighbor to conduct experiment. Through mathematical analysis such as using mean, median, Average, Mean deviation, Average deviation we can rectify the errors in measurements.

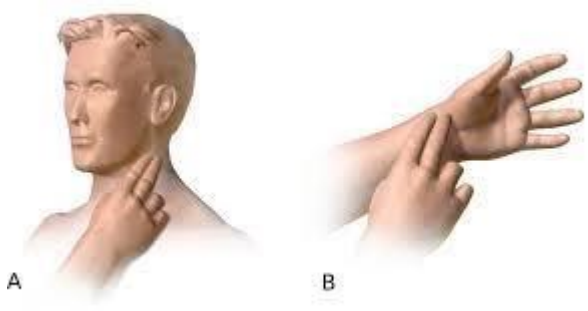


Fig. 2. Manual method for measuring heart rate

2.2 Using Electronic Devices

Recording of an electrical activity associated with the functioning of heart is known as Electrocardiogram (ECG). The obtained electrical pulse is fig 1. It is a quasi-periodical, rhythmically repeating signal synchronized by the function of the heart, which acts as a generator of bioelectric events.

An electrocardiogram (ECG or EKG, from the German "electrocardiogram") is a medical test used to evaluate and diagnose possible cardiac problems.

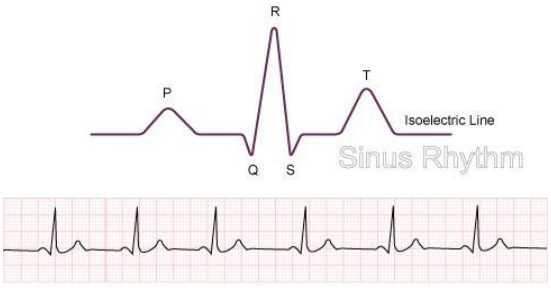


Fig. 3. Electrical signal rhythm of heart

2.3Phonocardiogram

Phonocardiograph (PCG) is the study of different sounds of heart produced. Fig. 2. It is the graphical representation of sounds of heart produced.

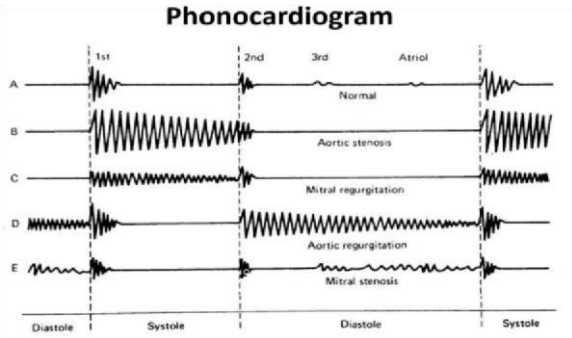


Fig. 4. Phonocardiogram signals graphical representation.

This helps in analyzation of different heart problems such as Systole problem, Diastole problems, Arrythmia, Tachycardia, Bradycardia etc., with the help of graphical representation.

Mathematically, there are two approaches for estimating heart rate from obtained signals.

2.4 Frequency domain analysis:

In this technique widely used models for estimating heart rate are Fast Fourier transform (FFT), and Short-term FFT.

2.5 Time-series domain analysis

In this technique several methods of heart rate measurement techniques involved, that is, peak detection, pattern matching etc

2.6 ECG LEADS

The limb leads, of which there are six (l, Il, Ill, aVF,aVR and aVL), have the exploring electrode and the reference point placed in the frontal plane. These leads are excellent for detecting vectors traveling in the frontal plane. The chest (precordial) leads (VI, V2, V3, V4, V5 and V6) have the exploring electrodes located anteriorly on the chest wall and the reference point located inside the chest.

Hence, the chest leads are excellent for detecting vectors traveling in the horizontal plane. Only three leads, namely leads l, Il and Ill (Einthoven's original leads) are derived by using only two electrodes. The remaining nine leads use a reference which is composed of the average of either two or three electrodes Leads l, II, Ill, aVF, aVL and aVR are all derived using three electrodes, which are placed on the right arm, the left arm and the left leg.

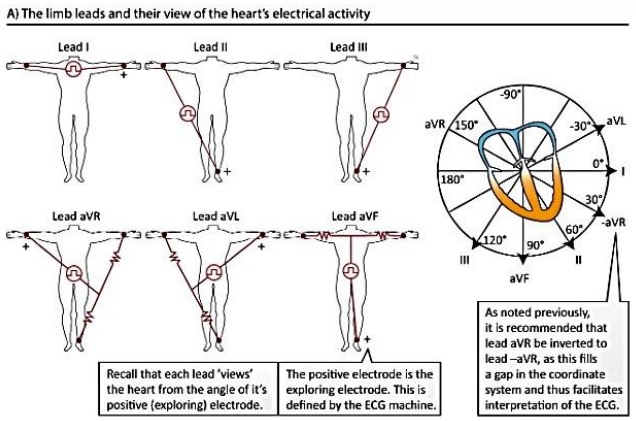


Fig. 5. Different kinds of Lead system for heart measuring of a patient

2.7 Plethysmography

A Plethysmograph is an instrumental device which helps in measuring the change in volume within any organ of human body. This technique has given the rise to new advancements in measuring heart rates. Heavy usage of digital devices made the doctors to estimate accurate conditions of patient.

2.8 Working principle

The amount of change in volume of blood through the heart helps in estimation of function of heart.

At the birth, this technique is used for estimating the working of human respiration system. So, as this technique is obeying all the requirements of measurements of heart rate of a patient this principle is adopted in the heart rate measurements.

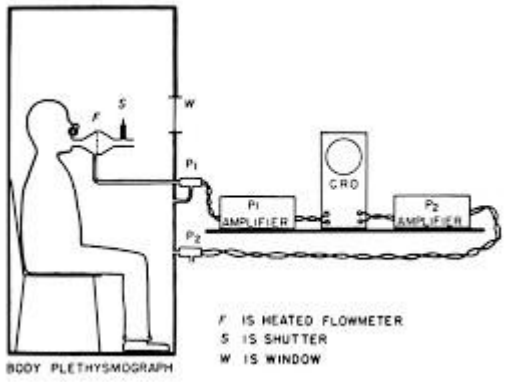


Fig. 6. Typical block diagram for plethysmograph

As said, Plethysmograph involves in adoption of large no: of digital devices such as Amplifier Circuits, CRO's, Digital recorders, etc., The above block diagram Fig. 6. explains the of birth of plethysmograph with the circuitry implemented.

2.9 Photoplethysmography

Photoplethysmography is the advancement made in Plethysmography technique. This method involves in usage of optical techniques which helps in simple detection volume in changes of blood through circulatory. Based on this this technique many optical devices have evolved with digital circuitry. These devices are simple and low cost. Devices like Blood pressure monitor, pulse rate monitor, pulse oximeter and some other devices makes use of photoplethysmography working principle.

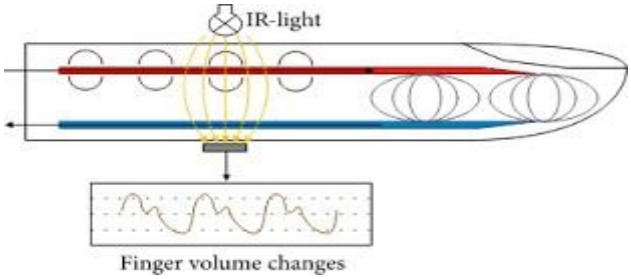


Fig. 6. Typical block diagram of photoplethysmography.

The above Fig. 6., shows the application of photoplethysmography which involves in measurements of blood pressure device. Photoplethysmography uses the different light rays such as IR-rays, UV-rays, etc., depending on the application different kinds of light rays are utilized.

E.Wearables Devices using wearable sensors such as patch sensor and pulse sensors we measure heart rates. This helps in early prediction of heart attacks. Because continuous monitoring of heart rate makes this efficient. Use of digital sensors makes prediction and analyzation easy.When it comes to heart rate monitoring, wearable fitness devices

and wrist-worn heart rate monitors now flourish in a market of fitness enthusiasts who have an insatiable desire to include technology in all aspects of their daily life.

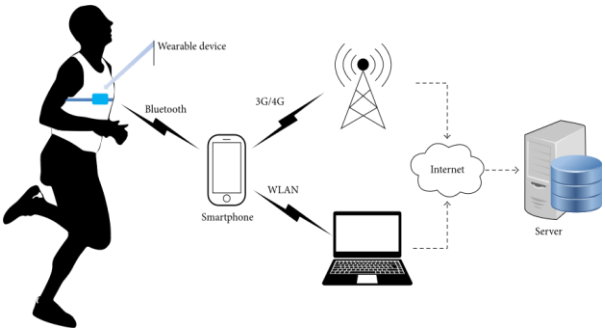


Fig. 7. Systematic procedure of using wearable sensors.

The main objective of this study Fig. 7., was to evaluate the precision of five popularly used optical-based heart rate monitoring devices. Four of these monitors are worn on the wrist; Apple Watch, Fitbit Blaze, Garman Forerunner 235, TomTom Spark Cardio and the Scosche Rhythm+ is worn on the forearm. Many devices are here for helping the people to continuously monitor and predict their life health. Thus, wearables help in making life easier for assessing their own health. However, there will be nothing accurate and precise wearables due Gross errors, Systematic errors, and Random errors. Systematic errors like instrumental errors results in major defects of instruments. With perfect calibration these devices work perfectly with patients or users. Also, before going to actual diagnosis using wearables for self-assessment of health issues is advisable. Likewise, the above structure discusses the different analysis helps in measuring heart rate of a patient.

3. Comparative Analysis

Besides every usage their needs an advancement in which requirement hides. As manual methods and old ECG methods needs no comparison with the new and advanced digital instruments. So, we look at a TABLE I which helps better view of understanding more standard techniques for measuring heart rates of a patient. The best way to analysis the pros and cons of any measurement techniques is to build a difference table. The below table is constructed by showing some common and usable differences between the Plethysmograph techniques,

Photoplethysmography techniques, Wearable devices. This helps in better understanding of the above-mentioned devices. This comparison table is the overview of above discussed techniques in measurement of heart rates of a patient. This analysis helps in manufacturing more advanced instruments and predictive devices in measuring heart rates of a patient in different patient perspective conditions. Patient perspective conditions are the conditions which makes doctors difficult in using certain old techniques in measuring heart rates of a patient. Patient might be injured in fire accident or road accident the techniques used in measuring heart rate of that particular patient should help him in terms of convenience and comfort.

TABLE I. Comparative Table for Advanced Heart Measuring techniques

S:no	Plethysmograph	Photo Plethysmography	Wearables
1	High cost	Low cost	High cost
2	High Accuracy	High Accuracy	High Accuracy
3	Medium Circuitry	Low Circuitry	Concise Circuit
4	Not easily movable	Easily movable and wearable	Easily movable and wearable
5	High Lifetime	Low Lifetime	Low lifetime
6	Not so easy for estimating heart rate of a patient	Very easy in estimating heart rate of a patient	Easy measurement heart rate of a patient
7	High Maintenance	Medium Maintenance	Low Maintenance

This above table is the comparison of advancements in heart rate measurements and discusses the economic, error, etc., which helps doctors to use preferred technique at a preferred condition of a patient.

4. Conclusion

This paper briefly discussed the evolution started in the measurement of heart rates by using different reference papers. The only idea is to give the knowledge on different methodologies involved in the measuring heart rates of a patient. The evolution starts from the manual method of

measuring heart rates to advanced techniques and involves in usage of Digital devices.

But still advancements are needed in measuring techniques of heart rate for a patient. It depends on usage and convenience of user depends on designer work. Instrument design should be done in a such a way that it should be comfortable in usage and should give desired results.

4.1 *Advancements Required.*

1. The devices should be user friendly and easily accessible.
2. Devices should be Using IC technology needs frequent cooling techniques, this should be considered as a severe issue and necessary actions to be taken.
3. Devices which result in electronic wastes are not to be encouraged.
4. Heart rate measurement devices should be easily carriable. Because in Ambulances there might not be required space to adjust the instrument.
5. Contactless measuring instruments need to be highly calibrated and should be more advanced.
6. Errors need to be reduced in calculation and measurements.

This predictive analysis and rectification help in much more advancements in future technologies.

Another advancement in photoplethysmography is LIDAR technology where a patient is sitting in a room using IR rays' temperature of the patient will be measured. In the same way using LIDAR (Light Detection and Ranging) the heart movements and working is observer by a thermographic image. This helps in having Non-Contact Photoplethysmography. This technique of measuring heartbeat is still in progress and readily available.

REFERENCES

[1] Agrawal, A., & Gawali, D. H. (2017). Comparative study of ECG feature extraction methods. 2017 2nd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT)

[2] M. Malik et al., "Heart Rate Variability - Standards of Measurement, Physiological Interpretation, And Clinical Use," Vol. 17, pp. 354-381, European Heart Journal (1996).

[3] M.N. Fiamma, Z. Samara, P. Baconnier, T. Similowski, and C. Straus, "Respiratory inductive plethysmography to assess respiratory variability and complexity in humans," Respiratory Physiology & Neurobiology, vol. 156, no. 2, pp. 234–239, May 2007.

[4] Kranjec, J., Begus, S., Drnovsek, J., & Gersak, G. (2014). Novel Methods for Noncontact Heart Rate Measurement: A Feasibility Study. Vol. 18, pp. 325-451, Aug 2019.

[5] Kok Beng Gan; Zahedi, E.; Ali, M.A.M. (2009). "Transabdominal Fetal Heart Rate Detection Using NIR Photopleythysmography: Instrumentation and Clinical Results".

[6] Idupulapati Venkata Sai Eshwar, Mothukuri Dushyanth Babu, Anil Bazawada, "Barrier Succeeding Miniature and AutonomousRobot," International Journal of Innovative Science and Research Technology,Volume 6, Issue 6, June – 2021,pp: 222-225.

[7] Idupulapati Venkata Sai Eshwar, Anil Bazawada Mothukuri Dushyanth Babu, "Relay Based Water Level Indicating And Controlling System Using Arduino," International Research Journal of Engineering and Technology (IRJET) Volume 8, Issue 6, June 2021,pp: 2846-2851.

[8] Keshavamurthy, T. G.; Eshwarappa, M. N. (2017). [IEEE 2017 Second International Conference on Electrical, Computer and Communication Technologies (ICECCT) - Coimbatore, Tamil Nadu, India (2017.2.22-2017.2.24)] 2017 Second International Conference on Electrical, Computer and Communication Technologies (ICECCT) - Review paper on denoising of ECG signal. , pp 1–4.

[9] Gao, Wei; Nyein, Hnin Y. Y.; Shahpar, Ziba; Tai, Li-Chia; Wu, Eric; Bariya, Mallika; Ota, Hiroki; Fahad, Hossain M.; Chen, Kevin; Javey, Ali (2016). [IEEE 2016 IEEE International Electron Devices Meeting (IEDM) - San Francisco, CA, USA (2016.12.3-2016.12.7)] 2016 IEEE International Electron Devices Meeting (IEDM) - Wearable sweat biosensors. , pp 6.6.1–6.6.4.

[10] Jayanth, S.; Poorvi, M. B.; Shreyas, R; Padmaja, B.; Sunil, M. P. (2017). [IEEE 2017 International Conference on Inventive Systems and Control (ICISC) - Coimbatore, India (2017.1.19-2017.1.20)] 2017International Conference on Inventive Systems and Control (ICISC) - Wearable device to measure heart beat using IoT. , pp 1–5

[11] J. B. Bathilde, Y. L. Then, R. Chameera, F. S. Tay and D. N. A. Zaidel, "Continuous heart rate monitoring system as an IoT edge device," 2018 IEEE Sensors Applications Symposium (SAS), 2018, pp. 1-6, doi: 10.1109/SAS.2018.8336777.

[12] B. Ahn, Y. Noh and D. Jeong, "Smart chair based on multi heart rate detection system," 2015 IEEE SENSORS, 2015, pp. 1-4, doi: 10.1109/ICSENS.2015.7370628.

[13] P. Bansal, M. Malik and R. Kundu, "Smart heart rate monitoring system," 2018 IEEMA Engineer Infinite Conference (eTechNxT), 2018, pp. 1-4, doi: 10.1109/ETECHNXT.2018.8385347.

[14] T. J. Swamy and T. N. Murthy, "eSmart: An IoT based Intelligent Health Monitoring and Management System for Mankind," 2019 International Conference on Computer Communication and Informatics (ICCCI), 2019, pp. 1-5, doi: 10.1109/ICCCI.2019.8821845.

[15] S. L. Rohit and B. V. Tank, "Iot Based Health Monitoring System Using Raspberry PI - Review," 2018 Second International Conference on Inventive Communication and Computational Technologies (ICICCT), 2018, pp. 997-1002, doi: 10.1109/ICICCT.2018.8472957.

[16] A. D. Acharya and S. N. Patil, "IoT based Health Care Monitoring Kit," 2020 Fourth International Conference on Computing Methodologies and Communication (ICCMC), 2020, pp. 363-368, doi: 10.1109/ICCMC48092.2020.ICCMC-00068.

[17] N. Kumar, "IoT architecture and system design for healthcare systems," 2017 International Conference On Smart Technologies For Smart Nation (SmartTechCon), 2017, pp. 1118-1123, doi: 10.1109/SmartTechCon.2017.8358543.

[18] D. G. Kristiani, T. Triwiyanto, P. C. Nugraha, B. G. Irianto, Syaifudin and D. Titisari, "The Measuring of Vital Signs Using Internet Of Things Technology (Heart Rate And Respiration)," 2019 International Seminar on Application for Technology of Information and Communication (iSemantic), 2019, pp. 417-422, doi: 10.1109/ISEMANTIC.2019.8884312.

[19] M. Hamim, S. Paul, S. I. Hoque, M. N. Rahman and I. Baqee, "IoT Based Remote Health Monitoring System for Patients and Elderly People," 2019 International Conference on Robotics,Electrical and Signal Processing Techniques (ICREST), 2019, pp. 533-538, doi: 10.1109/ICREST.2019.8644514.

[20] N. Gupta, H. Saeed, S. Jha, M. Chahande and S. Pandey, "IOT based health monitoring systems," 2017 International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS), 2017, pp. 1-6, doi: 10.1109/ICIIECS.2017.8276181.

BIOGRAPHIES

Mothukuri Dushyanth Babu
B.Tech in Electronics and Communication Engineering, SRM University.

Anil Bezawada
B.Tech in Electronics and Communication Engineering, SRM University.

Idupulapati Venkata Sai Eshwar
B.Tech in Electronics and Communication Engineering, Koneru Lakshmaiah University.