International Engineering Journal For Research & Development

Vol.5
Issue 5

E-ISSN NO:-2349-0721

Impact factor : 6.549

ANALYSIS OF HEART SOUND FOR AUTOMATED DIAGNOSIS OF CARDIAC DISORDERS

[1]Pranali K. Jawale, [2]Dr. A. N. Cheeran, [3]Vaibhav Awandekar

Electrical Department Veermata Jijabai Technological Institute Matunga, India[1], Electrical Department Veermata Jijabai Technological Institute Matunga, India[2] , Sr. R & D Engineer A3 Remote Monitoring Technologies Pvt. Ltd. India[3]

pranali.jawale18@gmail.com[1] , ancheeran@ee.vjti.ac.in[2] , Vaibhav.awandekar@a3rmt.com[3]

ABSTRACT

Healthcare monitoring system have received substantial attention of researchers in the past few years. The most important aim was to invent a dedicated patient monitoring system in order to make it possible for healthcare professionals to supervise their patients from a remote distance. The most commonly used technique to identify or assess the cardiac disorders is body Auscultation. This is an inexpensive and highly effective method, but presence of professional doctors is always necessary for this method to understand heart sound for diagnosis of cardiac disorders. This work aims to provide the basic distinction between healthy and unhealthy heart sounds. some of the unique features of heart sound are to be taken into considerations to automate the identification of cardiac disorders. The experimental results should specify enough differentiation between healthy and unhealthy patient's data that is heart sounds for automated assessment of cardiac disorders using various signal processing algorithms.

Keywords—auscultation; digital stethoscope; signal processing; cardiac disorders; heart sound, Lub, Dub

INTRODUCTION

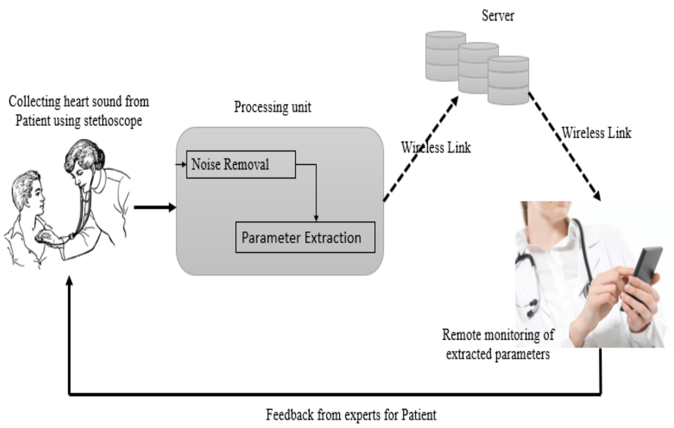
Information and communication technology have been an important factor in the development in each part of human life in the past few decades. Advancements in the technology have contributed in various fields like consumer electronics, communication systems, production and distribution automation, monitoring systems, and navigation systems. Several improvements in technology have made it possible to monitor and treat patient(s) from a remote location [1]. Fast growth in healthcare facilities and inexpensive wireless communication has huge assistance in reducing the problems associated with medical facilities. Tele-health and telemedicine are now getting more deeply embedded in providing everyday health care, distance education and also health care management [2]. Many people in rural areas are now getting benefited with medical services which they might never have experienced without having travelled a lot of distance or overcoming other transportation obstacles [3]. Information technology can be used to provide healthcare services at remote locations and it is termed as Tele-healthcare. It comprises medical services like monitoring patients which are at indoor or outdoor locations [4]. Constant monitoring of vital parameters is the main thing that the doctors are actually interested in so that the doctors can know the history of patient and the change in the state of patient on a day today basis. When these findings and data points are available, then action can be taken much earlier to improve a medical disorder for the patient under observation [5].In Analysis of Heart Sound for Automated Diagnosis of Cardiac Disorders, Anushikha Singh et al [6] have discussed the basic investigation and comparison of heart sounds which are taken from healthy and unhealthy subjects for automated screening of cardiac disorders. Few attributes are measured from heart sound such as probability distribution for amplitude and frequency contents, these attributes are quantified using signal processing algorithms and passed for automated diagnosis of heart related issues. Mohan Mishra et al [7] showed the processing of heart sounds in wavelet domain for automating cardiac disorders screening. In this work, first wavelet domain is used to transform the heart sound signal and then differentiation between heart sounds recorded from healthy and anomalous patients is performed on the basis of extracted parameters. K. Hassani et al [8] presented an algorithm for segmentation of heart sound. This algorithm which uses homomorphic filtering producing time-domain intensity envelopes of heart sound, automatically segregates the heart sound into its distinct component parts. This algorithm divides the sound into four overlapping parts. In [9], Yi-Li Tseng et al presents detection of presence of third and fourth heart sound named as S3 and S4 using an adaptive method based on time-frequency analysis, which forms rare peaks of the heart sound. The authors have made use of Hilbert-Huang Transform (HHT) to examine the heart sound signal during diastolic periods. Maximal instantaneous frequency and its amplitude were plotted in the form of a discrete plot and points were clustered. S3 and S4 were identified by observing the clusters of points. Period definition and iteration tracking further enhanced the performance of the method. In [10], Jayshril S. Sonawanel et al present a well-organized system for detecting heart disease in advance. 13 clinical features are given to the system as input and Learning Vector Quantization algorithm is used to train the network. This system tells if a particular patient's data indicates any signs of heart disease. An algorithm for classifying heart sounds into two groups (Normal and Murmur) is proposed in [11]. Some of the factors that have an impact on this classification and which in turn assist for selecting some optimal findings are used in the development of this algorithm. Amy Hamidah et al [12] explained a methodology in order to detect various parts of heart sound which include primary sounds (named as S1 and S2), extra sounds (which are named as S3 and S4), murmur, and other abnormal sounds (split, click, and ejection click). Signal envelop is calculated using Shannon's energy formula and it is considered to be the starting part of the detection process. Some of the signal characteristics such as peak frequency, peak duration, peak interval, total power and amplitude are extracted from various segments of each signal. These signal characteristics are used by the process for further classification part.

This work aims to develop a portable, simple to use and handle, real time wireless telemedicine system which has the-capability to acquire, process and send vital parameters to-doctors in real time. One of the objectives of the presented system is to integrate wireless (Bluetooth Enabled) stethoscope with the system and to develop an algorithm to accurately calculate the heart rate of a patient from acquired heart sound signal. Most important goal of this work is to propose an algorithm for automated diagnosis of cardiac and respiratory disorders by analyzing the heart sound and lung sound without involving any professionals. Web servers will be allocated for accumulating the collected reports so that the information is accessible to doctors at any time when needed from any place.

This paper is organized as follows. The proposed system flow and the tools used are discussed in the section II. Experimental results and discussions are presented in section III. The summery and future work remarks are provided in section IV.

PROPOSED METHODOLOGY

Proposed System Block Diagram



Fig, 1 Proposed system block diagram

Schematic representation for the wireless patient monitoring system is shown in fig, 1. The system architect is three-tier comprising, a patient interface, that is, a digital stethoscope, Processing Unit for noise removal and parameters extraction, and a web portal for doctors. In the first stage of proposed system, digital stethoscope that is Food and Drug Administration i.e. FDA cleared is used. This stethoscope is also CE marked. Clinicians at over 4,000 hospitals use this stethoscope which enables user to capture and visualize the heart sound. It also provides facility for saving or securely sharing sounds for a second opinion so as to have multiple opinions on the same case. This interface is Bluetooth enabled for wireless connectivity. The second stage comprises of an application developed at the processing unit which is used to obtain patient's information from records. The stethoscope transmits information that is real time data in the form of heart sounds to one of the application that has been incorporated with the device through Bluetooth Low Energy. The data is processed at processing unit for parameter extraction and decision making. The processed data is transmitted to the doctor via server. Requests to extract data available from SQLite internal database is initiated by the web portal in the third stage of the system and this data is transferred to online MySQL via GPRS/3G or Wi-Fi. One of the advantages of the system is that medical history for any patient who is registered with the system is always saved on the server and this information can be retrieved at any time from any place by the doctor. This can be useful for generating various reports, notifications or reminders for specific activity to doctors as well as patients if required. For the processing and analysis of heart sound, interactive programming language, Python is used.

RESULTS AND DISCUSSIONS

Fig. 2 shows the recording of a heart sound collected using digital stethoscope. Sampling frequency used for collecting the samples is 4000 Hz. These samples are then down sampled to 1000 Hz. Resampled signals undergo denoising process which involves wavelet transform using haar window. Waveform after denoising process are shown in Fig. 3.

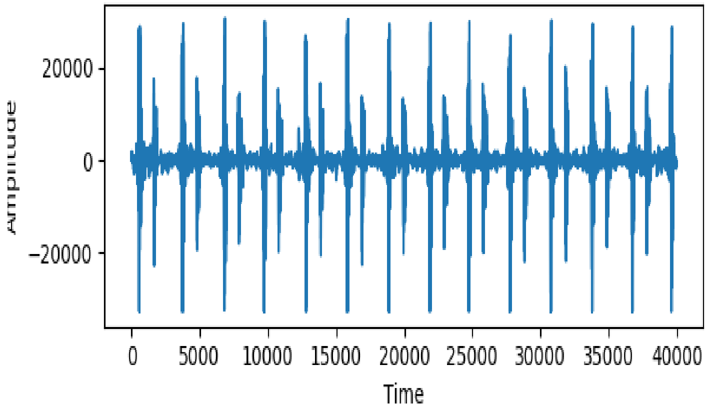


Fig. 2 Sample data collected using Digital Stethoscope

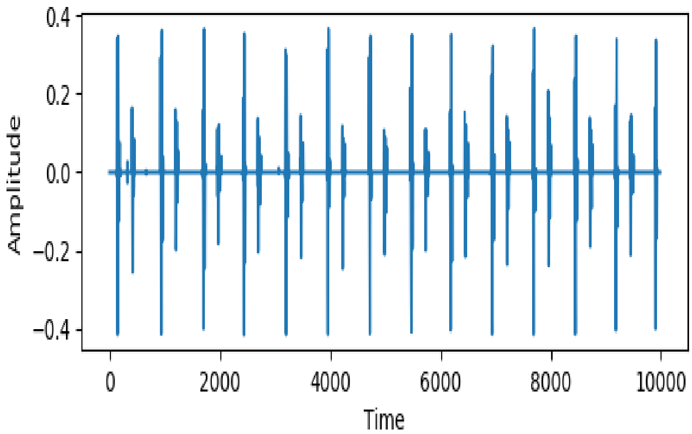


Fig. 3 Sample data collected after resampling and denoising

Finally, to separate the heart sound in its two main components i.e. "Lub" and "Dub", first the processed data is normalized using the standard normalization formulae. The peaks in the normalized signal represent beats of the heart sound. These peaks are separated into two different classes namely Lub and Dub based on the distance calculations. Fig. 4 shows the normalized heart signal with peak detection where the orange symbol denotes lub and green one denotes that the peak is dub.

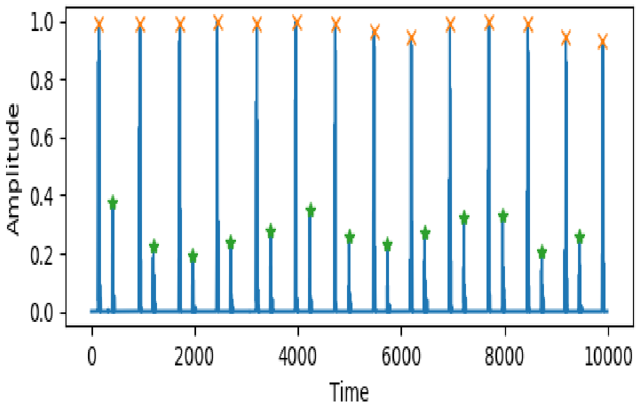


Fig. 4 Lub-Dub detection in sample recording

As explained earlier, above figure shows the separation of heart sound into two main components. But sometimes it may happen that some of the peaks are missed out in the process of acquiring data or while processing it. In order to take care of this possibility, algorithm has been designed is such a way that person who is monitoring the results will be notified with message on the screen saying that "Attention", This method may have skipped one or more peaks". Fig. 5 illustrates this scenario in detail.

As shown in Fig. 5 one of the dubs is missed out by the algorithm and one lub is also misinterpreted as dub. To notify this issue to the user screen is prompted with the earlier mentioned message as shown in Fig. 6. In such cases where the error is notified, another method called energy calculation is automatically called for further discrimination of peaks between two principle components of heart sound.

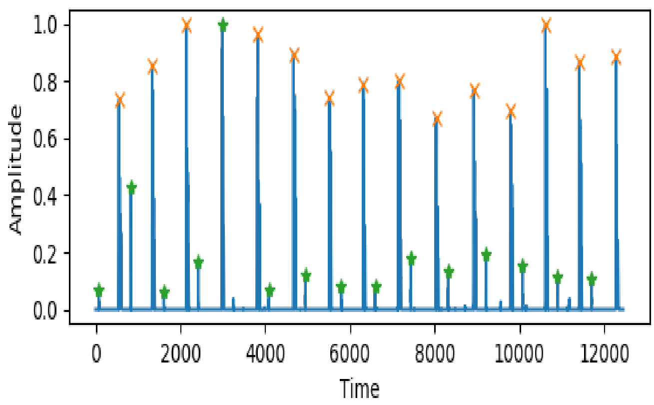


Fig. 5 Improper Detection of peaks

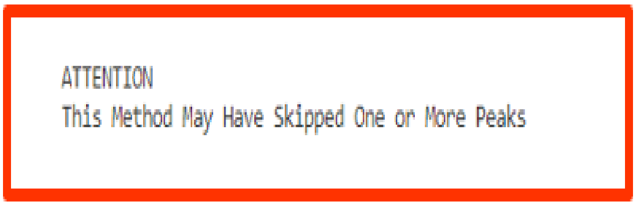


Fig. 6 Notification of error on the screen

Fig. 7 shows the energy envelope of the recorded sound signal which is calculated using Shannon energy formula. The peaks are discriminated using the fact that energy contained in respective lub and dub have distinguishable difference. Comparing the energies of respective peaks, they are classified as lubs and dubs. Red dots in the above figure denotes the lubs of the heart sound whereas black square denotes the dubs of the heart sound.

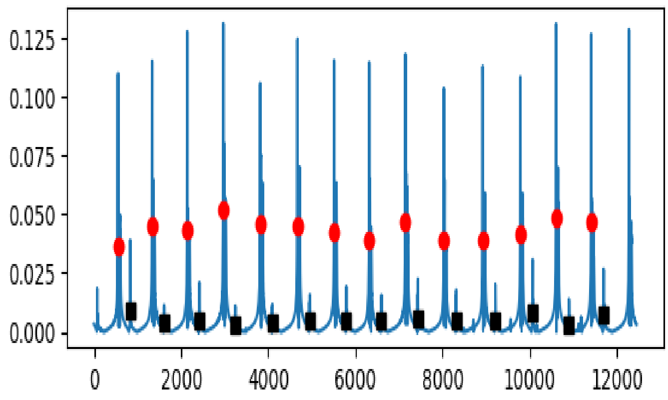


Fig. 7 Energy envelope with proper peak detection

Fig. 8 shows the graphical user interface that is developed in order to provide the ease of handling the system to the user. It has entry fields to enter the details of patient as shown in above figure. Various options are made available to the user in order to use the system. Acquisition button allows the user to record the heart sound of the patient for 10 seconds. After 10 seconds, system will show an indicative message on the screen saying that the data collection has been successfully completed. There are options to play and view the recording so that if user is not satisfied with data acquisition, delete button will delete the recording from the memory and new once can be again taken by the same process. Parameter extraction button, as of now, allows the user to calculate the heart rate for patient and display it onto the screen.

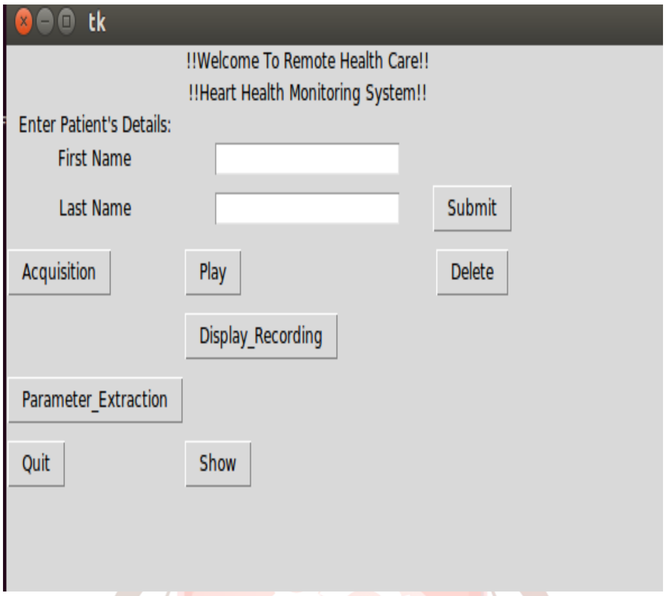


Fig. 8 Graphical User Interface

CONCLUSION AND FUTURE WORK

Due to insufficient availability and facilities and also due to the increasing cost there is an increase in the rate of cardiovascular diseases in the adults and the older population which has become a severe issue. Worse affected population are the ones who are situated or located at a faraway place since they cannot avail the medical facilities. Due to this there can be a delay in diagnosis and the required treatment on the affected patients which can lead to death. Treatments should be given to the affected as early as possible. New emerging technologies like improvements in wireless communications and wearable sensor technology have enhanced the development of the healthcare monitoring systems in real-time for remote areas.

Based on the existing healthcare systems and related work done in the field of telemedicine, a real time wireless patient monitoring system has been developed. Along with low complexity and low power consumption, the system is highly portable for health care monitoring of patients. The patients can be diagnosed from any location, that is the system can be used for remote home monitoring. This will not only reduce the treatment cost but also the treatments can be done without availing expensive medical facilities.

This paper talks about the segmentation of heart sound into its two principle components named as Lubs and Dubs. In order to ensure the proper segmentation, various approaches have been taken into account as discussed in the previous sections. Once the segmentation is done, heart rate can be easily calculated from the list of peaks found. A Bluetooth based digital stethoscope is integrated with the Linux system and graphical user interface is designed for the ease of user to use the system. Future aim of this work is to concentrate on detecting an abnormality in the heart sound if any and its related diseases. This will be used to intimate the patient about the heart condition so that he/she can take proper precautions or medication.

REFERENCES

[1] Roy, Soumya, and Rajarshi Gupta. "Short range centralized cardiac health monitoring system based on zigbee communication." In Global Humanitarian Technology Conference-South Asia Satellite (GHTC-SAS), 2014 IEEE, pp. 177-182. IEEE, 2014.

[2] Kakria, Priyanka, N. K. Tripathi, and Peerapong Kitipawang. "A real-time health monitoring system for remote cardiac patients using smartphone and wearable sensors." International journal of telemedicine and applications 2015 (2015): 8.

[3] V. Prasad and G. Phade, “Design of Electronic Stethoscope and Heart Rate Monitor for Remote Area Application,” International Journal of Computer Applications, vol. 137, no. 10, pp. 33–36, Mar. 2016.

[4] Shaikh, Rubina A. "Real time health monitoring system of remote patient using ARM7." Control and Automation (IJICA) ISSN(2012): 2231-1890.

[5] Sunehra, Dhiraj, and Pini Ramakrishna. "Web based patient health monitoring system using Raspberry Pi." In Contemporary Computing and Informatics (IC3I), 2016 2nd International Conference on, pp. 568-574. IEEE, 2016.

[6] A. Singh, M. K. Dutta, and C. M. Travieso, “Analysis of Heart Sound for Automated Diagnosis of Cardiac Disorders.,” 2017 International Conference and Workshop on Bioinspired Intelligence (IWOBI), 2017.

[7] M. Mishra, A. Singh, M. K. Dutta, and A. R. Munoz, “Automatic screening of cardiac disorders using wavelet analysis of heart sound,” 2017 4th IEEE Uttar Pradesh Section International Conference on Electrical, Computer and Electronics (UPCON), 2017.

[8] K. Hassani, K. Bajelani, M. Navidbakhsh, D. Doyle, and F. Taherian, “Heart sound segmentation based on homomorphic filtering,” Perfusion, vol. 29, no. 4, pp. 351–359, Feb. 2014

[9] Y.-L. Tseng, P.-Y. Ko, and F.-S. Jaw, “Detection of the third and fourth heart sounds using Hilbert-Huang transform,” BioMedical Engineering OnLine,vol.11,no.1,p.8,2012

[10] J. S. Sonawane and D. R. Patil, “Prediction of heart disease using learning vector quantization algorithm,” 2014 Conference on IT in Business, Industry and Government (CSIBIG), 2014.

[11] F. Chakir, A. Jilbab, C. Nacir, and A. Hammouch, “Phonocardiogram signals classification into normal heart sounds and heart murmur sounds,” 2016 11th International Conference on Intelligent Systems: Theories and Applications (SITA), 2016.

[12] A. Hamidah, R. Saputra, T. L. R. Mengko, R. Mengko, and B. Anggoro, “Effective heart sounds detection method based on signals

characteristics,” 2016 International Symposium on Intelligent Signal Processing and Communication Systems (ISPACS), 2016