A Study on Different Approaches for ECG Signal Enhancement

Bhanu Priya
Department of Electronics & Communication Engineering, Sat Priya Group of Institutions, Rohtak, Haryana, India

Isha
Assistant Professor, Department of Electronics & Communication, Sat Priya Group of Institutions, Haryana, India

Abstract – ECG Signal is the extracted heart signal used to perform the cardiac disease identification. But as the signal is captured, it can include different noise forms in the signal. To perform the effective decision making and recognition, it is required to improve the signal strength and reduce the noise. In this work, a study on some of the common approach for noise reduction over the ECG signals. The paper has analyzed the DWT, Spectral subtraction method and LPC method for noise reduction.

Index Terms – ECG, LPC, Spectral Subtraction, DWT

1. INTRODUCTION

ECG is one of effective and specialized form of energy used to perform the communication. This is the only media form that cannot be travelled in vacuum. The ECG waves are divided in two broader categories called transverse wave and longitudinal waves. The transverse wave perform up-down vibration whereas the longitudinal perform back and forth vibration. Another division of ECG signal is based on the frequency, such as human ECG frequency is between 100Hz to 4500 Hz. The ECG is the most interactive way to communicate between the humans. This communication can either direct or distance through some electronic medium. Because of this lot of research is been done in area of ECG and the hearing science. It defines the dynamics and processes respective the production and perception f ECG. There are number of ECG processing techniques to acoustic signal by using the knowledge offered by researchers in the hearing science field.

To provide the effectiveness of ECG Signal there are different work defined to ease and speed to representing and processing the ECG data that can be contributed to develop the effectiveness of the ECG. These approaches are basically used to resolve the issues associated with ECG. The ECG processing is further been defined under 5 different areas called ECG encoding, ECG synthesis, ECG recognition, speaker recognition and spoken language translation. Encoding of ECG basically define the process to perform encoded transmission over the channel. The ECG media is popular because of different communication medium and different encoding mechanisms. These encoding mechanisms include the Autistic FeedBack Cancellation of ECG Signal so that effective transmission will be performed and the bandwidth utilization will be done significantly. ECG encoding is the essential process used by most of ECG Signal so that the secure communication will be achieved over the network. The storage of the ECG messages in mailbox is one of the major application of encoding process. The encoding of the signal is been used to store the maximum data with occupying the lesser space. The telephone answering machine also uses the encoding process to store the heavy messages with minimum space allocation in the memory.

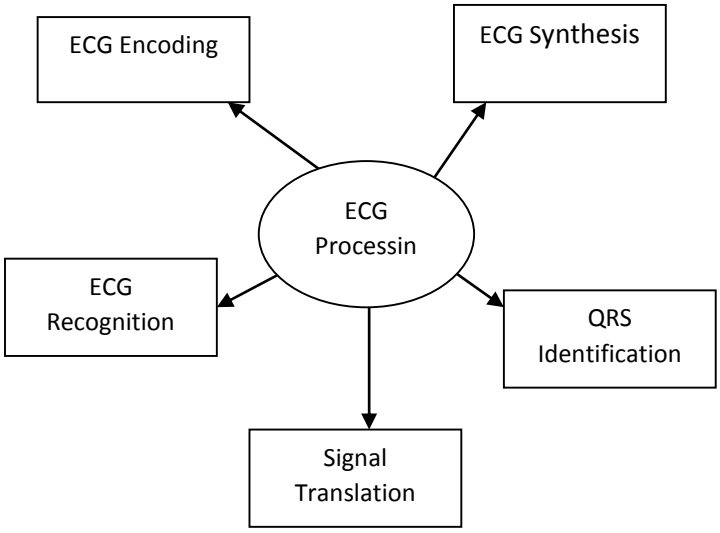

Figure 1 : Type of ECG Processing

ECG synthesis is the important aspect of ECG processing used to convert the information from one form to other. It is basically to perform the secure and effective way to convey the information reliability over the network. There are number of input mediums for the ECG such as using mic, auto generated ECG, ECG captured from telephone lines etc. But to perform the communication, it is required to convert this ECG signal to some standard form so that the communication will be done reliably, such kind of ECG signals having the lesser chances of distortion during the communication. ECG recognition is one of the major aspect of the ECG processing to verify the identity

of a person or the speaker. It is basically used in authentication applications where the presence of the person is required. The advantage of ECG recognition is to compare the ECG information, it is basically used by many automatic teller machines that read the user spoken information and take the relative decisions based on selected options. The ECG recognition is basically the message authentication driven from the ECG signal. This work basically depends on the extraction of the message from the ECG signal. The ECG commander is such an application based on ECG recognition. Speaker recognition is the biometric authentication scheme in which the password authentication is achieved by using the speaker ECG. Speaker recognition is the process to identify the speaker by analyzing the ECG or ECG features such as vocal characteristics. The language translation is the process to recognize the conversion of the ECG from one language to other. It is basically the approach to define the globalization. This translation depends on ECG recognition, ECG synthesis and natural language processing with long term goals.

The ECG Autistic FeedBack Cancellation is the major requirement for any of the ECG processing application as it basically reduces the size of the ECG. The presented work is focused on same Autistic FeedBack Cancellation approach. The work is divided in two main layers, first to enhance the ECG by reducing the ECG noise and other to perform the ECG Autistic FeedBack Cancellation. In this section, all aspects of ECG and ECG Signal are discussed. In section 2, the work already done by earlier authors is defined on ECG Autistic FeedBack Cancellation. In section III, the proposed work is been defined along with algorithm. In section IV, the results driven from the existing work is defined. In section V, the conclusion driven from the work is defined.

2. EXISTING WORK

In this section, the work done by earlier researchers in the area of ECG Autistic FeedBack Cancellation is been defined. H.B. Kekre[1] has defined work on sppech Autistic FeedBack Cancellation by using Vector Quantization. The author has defined a performance parameter called Fractional Change analyzer. The author has performed the effective Autistic FeedBack Cancellation and also performed the analysis under different parameters such as mean absolute error, SNR evaluation, Autistic FeedBack Cancellation ratio analysis etc. The another work on ECG Autistic FeedBack Cancellation is presented by shiv kumar[2] by achieving the high Autistic FeedBack Cancellation ratio up to 50%. The author performs the signal encoding with ECG Autistic FeedBack Cancellation. The author adapted the transparent Autistic FeedBack Cancellation for high quality of ECG. The analysis of the work is done by performing the frequency analysis and the distortion analysis over the signal. The work is been defined for high quality ECG Signal that is been used for the internet based communication. A DWT based work is been adapted by M.A. Najih[3] to perform the ECG Autistic FeedBack Cancellation. The author used the wavelet filters and to identify the best filter for ECG processing and to provide the low bit rate and to reduce the complexity over the signal. Author has defined his work under 5 different filters called DWT, thresholding, quantization, Huffman encoding and reconstruction of signal. Author [4] also performed the comparative analysis of DWT approach with other filtration approaches under different parameters such as Autistic FeedBack Cancellation ratio, bit error rate etc.

In year 2011, V.Radha[5] has defined the comparative analysis on different Autistic FeedBack Cancellation techniques. These techniques are implemented on Tamil ECG Datasets. The Autistic FeedBack Cancellation defined in this work is been implemented by using LPC, DCT and DWT approaches. High quality ECG is been taken for the Autistic FeedBack Cancellation and the results driven by the author shows that the effective Autistic FeedBack Cancellation ratio is been achieved. Jean-Marc Valin[6] performed a work, on High-Quality ECG and Audio Codec. Author propose a codec that simultaneously addresses both these requirements, with a delay of only 8.7 ms at 44.1 kHz. It uses gain-shape algebraic vector quantization in the frequency domain with time-domain pitch prediction. Author demonstrates that the proposed codec operating. Another DWT based Autistic FeedBack Cancellation approach is been adapted by Hatem Elaydi[7]. This is a lossy Autistic FeedBack Cancellation scheme that is often used to compress information such as ECG signals. This paper presents a new lossy algorithm to compress ECG signals using Discrete Wavelet Transform (DWT) Techniques to solve the limited bandwidth problem facing the Palestinian cellular company, Jawwal. The performance of the DWT for ECG Autistic FeedBack Cancellation is very good compared with other techniques such as μ-law ECG coder. In Year 2009, Katrina L. Neville[8] defined the on the DWT on ECG under different coefficient vectors. The work is focused on the analysis of effects of wavelet Autistic FeedBack Cancellation. This work includes the Autistic FeedBack Cancellation of ECG data using wavelet Autistic FeedBack Cancellation techniques and the effect such Autistic FeedBack Cancellation has on the ECG data. Two wavelet Autistic FeedBack Cancellation techniques are utilised, these are: thresholding, where small coefficients in a wavelet decomposition are set to zero and the second method is using low-subband filtering of the coefficients. Two methods of error analysis are also used to determine the quantitative effect these Autistic FeedBack Cancellation methods have on the ECG. KT Talele[9] propose a simple ECG Autistic FeedBack Cancellation algorithm using subband division and ADPCM algorithm. Although ECG data are stored in a semiconductor memory device, its capacity and the available network capacity are limited. Therefore, it is necessary to compress the data as much as possible. In Year 2012, Smita Vatsa[10] has defined a ECG Autistic FeedBack

Cancellation work based on DCT and DWT. The main objective of work is to achieve the Autistic FeedBack Cancellation with encoding approach. Objective of ECG Autistic FeedBack Cancellation is to enhance transmission and storage capacity. In this paper Discrete wavelet transform and Discrete cosine transform based ECG Autistic FeedBack Cancellation techniques are implemented with Run length encoding, Huffman encoding and Run length encoding followed by Huffman encoding. In Year 2012, M.Suman[11] has defined the performance analysis on compressed ECG signal and its enchancement. This paper deals with multistage vector quantization technique used for coding of narrow band ECG signals. The parameter used for coding of ECG signals are the line spectral frequencies, so as to ensure filter stability after quantization.

3. RESEARCH METHODOLOGY

In this present work, an intelligent hybrid approach is defined to perform the Autistic FeedBack Cancellation. The hybridization of the approaches is performed by using Spread Spectrum, LPC and the DWT approach. The intelligent work is about to perform the ECG filtration to remove the unwanted noise contents from the ECG so that the ECG will be more effective as well as the size will be reduced. In this work, at the first layer the combined Spread Spectrum and LPC will be used to estimate the noise and to remove it from the ECG file. Just after this the DWT will be used to perform the ECG Autistic FeedBack Cancellation respective to ECG contents. The reduction will be performed to obtain the linearity over the signal so that minimum distortion will occur. While performing the Autistic FeedBack Cancellation an analytical measure will be implemented to control the error ratio. If the ratio will be increased from this value, the Autistic FeedBack Cancellation will be stopped.

The complete work is divided in three main stages. In first stage, the spectral spectrum analysis is been defined to perform high level filtration. In second layer, LPC is been defined to perform the low level filtration and to remove the noise over the signal. In third layer, DWT based approach is been used to achieve the ECG Autistic FeedBack Cancellation. In this section, these three approaches are been defined in detail.

Here figure 2 is showing the Autistic FeedBack Cancellation model. In which, at existing stage, the noise reduction over the signal is been performed and at next level Autistic FeedBack Cancellation is been achieved by using DWT approach. These three layers are been explained here in detail

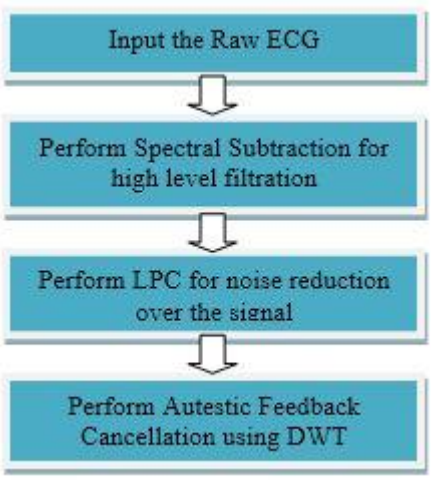

Figure 2 : Presented Model

3.1. Layer 1

Spectral subtraction is an effective signal restoration approach based on the magnitude spectrum of signal. The approach is been defined to remove the additive noise over the signal. It can perform the high level filtration, by identifying the average noise over the signal. Once the noise is been analyzed over the signal, the direction subtraction of the noise from the signal is done. The effectiveness of this algorithm is based on the estimation of noise spectrum. Once the estimation is done, the updating of signal is been done and elimination of the signal. The work also includes some assumption that the noise is stationary and it will not be changed significantly. The restoration of the signal under the time domain is been defined to estimate the signal magnitude and adjust it with phase change to control the signal noise. Once the adjustment of signal is done, the discrete Fourier transformation is been performed. In general case only the magnitude change is done and no change to the phase is done by this approach.

The work has defined signal y(n) , the discrete noise corrupted input signal, is composed of the clean ECG signal s(n) and d(n) the uncorrelated additive noise signal, then it the noisy signal can be represented as:

$$y(n)=s(n)+d(n) \quad (1)$$

This assumption is based on the fact that s(n) , is stationary, but ECG is not a stationary signal. The processing, is carried out on a short-time basis (frame-by- frame), therefore, a time-limited window (n w multiplies the original ECG, noisy ECG signal as well as the noise. Thus, the windowed signals can be represented as:

$$yw(n)=sw(n)+dw(n) \quad (2)$$

Finally the noise computation over the signal is been evaluated by using FFT. After the estimation of signal, the reduction of noise from the signal is done to derive the reconstructed signal. This signal is noise free.

3.2. LPC

LPC is the ECG analysis and ECG synthesis approach for the modeling of vocal signal as linear. The signal uses the IIR based filtration for the system transfer. The work is based on the vocal pole parameters for the filtration. The parameters included in this work include p that defines the number of poles, G represents the filtration gain and a[k] represents the pole determination parameters. The frequency of signal is represented by Fo, pitch of signal is represented by 1/Fo. The ECG generated here is defined the filtration model with periodic impulse train.

4. CONCLUSION

In this paper, hybrid model is presented to ECG signal Autistic Feedback Cancellation. The paper includes the ECG signal analysis at the earlier stage. The method includes three different layers for image filtration and Autistic Feedback Cancellation. At each level the effectiveness of signal improved.

REFERENCES

[1] Chien-Chih Yu," A Web-Based Consumer-Oriented Intelligent Decision Support System for Personalized E-Services", 1-58113-930-6/04/10
[2] Marta Zorrilla," A Decision Support System to improve e-Learning Environments", 978-1-60558-990-9/10/03
[3] Salma Mahgoub," Interactive Case Based Learning in Teaching Decision Support Systems and Business Intelligence", 978-1-4503-1314-8/12/10.
[4] Mohammed N. A. Abdelhakim," A Web-Based Group Decision Support System for the Selection and Evaluation of Educational Multimedia", 978-1-59593-783-4/07/0009
[5] Suresh Kalathur," Enriching Student Experience with Student Driven Content while Teaching an Online Data Mining Class", SIGITE'08, 978-1-60558-329-7/08/10
[6] Eitel J.M. Lauría," Mining academic data to improve college student retention: An open source perspective", LAK'12, 978-1-4503-1111-3/12/04
[7] Evis Trandafili," Discovery and Evaluation of Student's Profiles with Machine Learning", BCI'12 978-1-4503-1240-0/12/09
[8] S Shirgaonkar," Overview of Real Time Decision Support System", International Conference and Workshop on Emerging Trends in Technology (ICWET 2010)
[9] Andrej Kristofic," Improving Adaptation in WebBased Educational Hypermedia by means of Knowledge Discovery", HT'05, 1595931686/05/0009
[10] Yiming Ma," Targeting the Right Students Using Data Mining", 1-58113-233-6/00/08
[11] Pearl, J. & Russell, S. (2000). Bayesian networks, Technical Report Tech. Rep. R-216, Computer Science Department, University of California, Los Angeles.
[12] Pearl,J. Causality: models, reasoning, and inference, Cambridge University Press, New York, 2000. ISBN-13: 978-0521773621.
[13] Rok Rupnik, "DMDSS: Data Mining Based Decision Support System to Integrate Data Mining and Decision Support", Int Conf. Information Technology Interfaces ITI 2006, June 19-22, 2006
[14] Sudheep Elayidom , "Applying Data mining techniques for Placement chance prediction", International Conference on Advances in Computing, Control, and Telecommunication Technologies, IEEE 2009
[15] Changjiang Li, "The Application Research of OLAP in College Decision Support System", Second International Conference on MultiMedia and Information Technology, IEEE 2010.
[16] Nguyen Thi Ngoc Hien, "A Decision Support System for Evaluating International Student Applications", SEE/IEEE Frontiers in Education Conference, IEEE 2007.
[17] Diego Garc a-Saiz, "Comparing classication methods for predicting distance students' performance", JMLR: Workshop and Conference Proceedings 17 (2011)
[18] S. B. Kotsiantis, "efficiency of machine learning techniques in predicting students' performance in distance learning systems", Recent advances in mechanics and related fields university of Patras 2003