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Enhanced ECG Signal Compression using DWT and Hard & Soft Threshold Method

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ABSTRACT: Wireless body area network has a wide range of applications but still ,the main problem which prevails is the problem of battery exhaustion. In this work, the researchers are compressing the ECG signal by the use of DWT along with hard and soft threshold. By making the use of hard and soft threshold the network becomes more energy efficient. The performance of the network also improves as the length of the signal to be transmitted is reduced. As a result, when the transmitted signal has the reduced number of bits to be transmitted, the energy consumed reduces further improving the QoS parameter of the network. The simulation shows considerable improvements in energy, throughput, and delay by improving energy ,throughput, and delay by 180%, 200% and 140% (approximately) respectively.

KEYWORDS: ECG signal, Hard Threshold ,Soft Threshold, Digital Wavelet Transform**.**

I. INTRODUCTION

A body area network will be a network that has sensors located close to a person's body that monitor vital signals of the human body and more intelligent nodes are capable of handling more advanced signal processing, The most obvious application of BAN is discussed in the medical field, and BAN has many recreational uses. With these convenient ways, elderly people can track their health conditions without having to visit their doctors' offices often. Meanwhile, their doctors can still access the data and advise their patients based on this data. Yu (2009) hopes that the work of the feasibility study may shed some light on the general questions that arise in the BAN medical application. The rest of the report is organized as follows. Section II introduces the requirements of medical applications and BAN.

Over the last decade, wavelet transform, especially discrete wavelet transform, has emerged as a powerful and robust tool for analyzing and extracting information from then-stationary signals such as speech signal and ECG signal due to the time-varying nature of these signals as discussed by Ranjeet. , Kumar, and Pandey (2011). Non-stationary signals are characterized by a number of abrupt changes, transitory drifts and trends. Wavelet has a localization feature along with its time-frequency resolution, which is suitable for analyzing non-stationary signals such as speech and electrocardiogram (ECG) signals given by Nave and Cohen (1993). Recently, several other methods have been developed based on wavelet or wavelet packets to compress the ECG signal

The lessening of the bits to speak the same amount of information is called signal compression. By and large, this must be done while saving the important attributes of the waveform. In principle, signal compression is the procedure where the excess data contained in the flag is identified and disposed of. For example Biomedical Signal Compression. Flag coding that permits a lessening of the aggregate number of bits need to represent a signal without unimportant mutilation.

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A compression of the signal in one area brings about an extension of the other and the other way around. For ceaseless signs, If x (f) is the Fourier transform of x (t), then 1 / k × X (f / k) is the Fourier transform of x (kt), where k is the parameter controlling the growth or withdrawal. On the other hand, the faster an event (which is compressed by time), the higher the frequency. In the event of an event slowing down (which will be extended by time), it must be made from low frequency. This example is the case for two extremes. That is, if the time area signal is compressed so far it becomes a drive; the comparing recurrence range is extended so far that it turns into a steady esteem. In a similar manner, if the time area is extended until the point when it turns into a consistent esteem, the recurrence space turns into an expanded signal.

Discrete signs act in a comparable manner; however, there are a couple of more points of interest. The principal issue with discrete signs is associating. Envision that the beat is compressed a few times more than it appeared. The recurrence range is extended by an equivalent factor, and a few of the mounds are pushed to frequencies past 0.5. The subsequent associating breaks the basic extension/withdrawal relationship. This sort of associating can likewise occur in the time area. Envision that the recurrence range is compacted significantly harder, bringing about the time space motion in venturing into neighboring periods.

Another issue is to characterize precisely compressing or extend a discrete flag. As appeared in Fig. 10-12a, a discrete flag is packed by compressing the fundamental change that the examples lay on, and after that resampling, the new nonstop change is to locate the new discrete signal. In a similar manner, this same procedure for the development of discrete sign is appearing in the original signal. At the point when a discrete signal is compressed, occasions in the flag, (for example, the width of the beat) occur over a less number of tests.

About hard and soft threshold

Researchers apply rigid and soft threshold techniques to signal treatment when noise reduction or predetermination of observations is required. In a hard threshold, nodes transmit data if the perceived feature is in the range of interest and this reduces the number of transmissions. Author Bhattacharya (2010) argues that the value of this threshold is conservative in most cases, so that the researcher chooses to be more or less level than what the application has to offer. On the other hand, in soft threshold mode, any small change in the value of the sensory feature is transmitted. The authors Refai, Alawne, and Batiha (2014) have shown that there is only a difference between rigid and smooth thresholding mechanisms in the choice of linear transformation on the empirical wavelet coefficients. Nodes constantly absorb their environment and store the perceived value for transmission. The node transmits the perceived value if one of the following conditions is satisfied:

(a)Sensed value > hard threshold (HT).

(b)Sensed value > hard threshold >= soft threshold (ST).

II. LITERATURE SURVEY

Yu et. al. [7] suggested that the ECG signals have very important information regarding the health condition of the human health of the patient. Since the ECG signal is very long the need is to compress the signal to have minimum power dissipation during the transmission of the signal from the source to sink in the Wireless body area network. This work proposes the compression of ECG signal using the 2D wavelet transforms. The result shows the proposed scheme enhances the performance of the network in term of compression ratio. Also, some improvement is observed in PRD that is Percent root mean square difference and NCC that is normalized cross correlation coefficient.

Li et. al. [8] described a method in which the paper proposes the scheme which enables us to compress the ECG signal using the SVD method that is the singular value decomposition method. This technique uses the truncation method to compress the ECG signal giving excellent compression ratio. In this scheme, the two-dimensional signal is compressed using the zero padding method and an average period signal of the variance function. MIT-BIH arrhythmia ECG signal is evaluated using compression of ECG signal.

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Ranjeet et. al. [9] in this paper has proposed a BSBL technique that is Block sparse Bayesian learning. The main benefit of the proposed work is that it is very energy efficient, highly compressive and has minimum reconstruction rate. BSBL has explored the quality of signal compression of ECG signal very efficiently in its handling and directionality. The results show that the technique achieves 75% compression with negligible loss.

Nave et. al. [10] told that a multi-lead ECG signal compression is proposed in this paper which uses Predictive coding along with the Set Partitioning in Hierarchical Trees (SPHIT). The signal is formulated using the linear prediction between beats. Then the predictive coding is done. The main advantage of the predictive coding is to minimize the amplitude variance of 2D ECG signal. The experiments show that the signal performs better than its competitors.

Bhattacharya et. al. [11] proposed a new algorithm J-MRA that is joint multi resolution analysis. Seeing from the signal's point of view, this technique helps to represent thesignal in a minimum number of samples. The result had been formulated from 10 sample processing of the ECG signal. The results depict that the proposed technique proves to be better than its competitors. Results clearly indicated the better performance in energy consumption and bandwidth par amends.

Al-Refai et. al. [12] tended to the issue of compacting Electrocardiogram (ECG) signals utilizing the idea of versatile examining. The idea of versatile testing identifies with ideal estimation of wavelet parameters that best speaks to a given sign. These wavelet parameters are evaluated by limiting the least mean square mistake between the first and approximated signal. Such a streamlining approach is executed inside the edge work of neural organizes by utilizing wavelet nonlinear works in its neurons. The researchers apply this strategy for the pressure of ECG signals. The experimental details of ECG compression are provided. For these experiments, the standard ECG database that was created by the American Heart Association (AHA) is used

III. PROBLEM FORMULATION

Digital Wavelet Transform (DWT) based ECG compression technique is used as a signal compression technique. DWT is general wavelet transform algorithm which is well suited for data compression. In DWT technique a threshold value is settled according to theneed of theuser and signal compression ratio and on the basis of athreshold, samples are taken from thesignal. By the use of this wavelet transform here ECG signal is compressed and transmitted to another end for further processing. To improve the signal compression ratio and energy efficiency of the DWT compression the researchers need to enhance its energy efficiency in Wireless body area networks. As of now, the signal is compressed but the authors are proposing to choose between the right time of taking to observation and the value of thesignal that is yet to be compressed.

IV. PREVIOUS ECG COMPRESSION TECHNIQUES

The authors Singh, Kaur, and Singh (2015) proposed that principal target of any compression strategy is to achieve extreme compression ratio while saving the huge flag morphology highlights with least percentage of root mean square difference. To accomplish better execution different pressure methods are proposed in writing and talked about in present segment.

Direct Time-Domain Technique

Direct strategies depend on the extraction of a subset of huge examples. Direct time-space ECG pressure procedures have productive execution as far as preparing velocity and CR. These strategies investigate the redundancies present straightforwardly in the ECG tests. Direct pressure procedures can be founded on three draws near: resilience correlation Compression, differential beat code regulation (DPCM), and entropy coding.

Transform-Domain Techniques

Change based ECG pressure procedures are performed by the use of thelinear symmetrical change to ECG tests. These unique examples of ECG are exposed to a change and the pressure is performed in the totally new space like Fourier

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change (FT), DCT and wavelet and so forth. These methods present higher CR than direct procedures and are unfeeling toward clamor present in ECG signals.

Parameter Extraction Techniques

These are irreversible procedures which hold the specific attributes or parameters of the ECG signals. The parameter extraction strategy depends on prevailing aspect extraction from crude ECG signal; models incorporate neural based or syntactic techniques, top picking, and straight expectation technique.

2D Compression Techniques

Most conventional techniques of compression listed above, a1D representation of ECG signals has been adopted. These techniques explore the sample-to-sample (intra-beat) correlations properties for ECG compression. However, since the ECG signals have both intra-beat as well as beat-to-beat (inter-beat) correlations, a2D representation of ECG may produce better compression performance

V.PROPOSED WORK

In this work,the researchers have shown the improvement by the use of soft and hard threshold in the cross layer interaction. The researchers have done sampling on the basis of signal values importance and also done the compression using the DWT compression. The researchers have calculated the criticality of the observation using hard and soft thresholds thereby deciding whether to sample or not. In this code first,if it is assumed that the network is a homogeneous network in which all the nodes are of same type and specification. No super node is present. Those super nodes generally have only one distinct property which makes them different from other nodes that are their ability to have more energy or a bigger battery. Since they have much more energy they are very beneficial for the network. These nodes are used primarily for the becoming the cluster heads because of the more stored energy in them and once the energy in them becomes equal to the energy in another node there is no such difference left in them and the other nodes. But since the researchers are not concerned with the comparative performance but the overall network efficiency,the researchers are considering it to be a homogeneous network.

Since the decision, that is about the health of the patient is dependent on some peaks or dips of the ECG signal, the researchers decided to find a way-out for somehow only sampling the most important peaks and dips in the signal and also the frequency at which they occur was given equal importance.

At the start, the nodes are given their full able energy with special nodes having higher energy levels only if they are there but in our case,the researchers do not have any special nodes. In anormalscenario, the signal is formed using the electrical impulses from thehuman body which is then converted to the final ECG signal. The signal contains the entire received sample which is then compressed using DWT and then transmitted. Therefore transmission of the relevant and the irrelevant data happens. No doubt the data is compressed and the energy of transmission is saved in the process but still, the room for improvement is there if the researchers only transmit the relevant data and this fact has influenced the implementation of this work greatly.

The simulation is carried out for 100 hundred rounds for the determination the lifetime of the network. Now as the researchers have included very fine methods in the DWT compression, the researchers propose the improvement using the hard and the soft threshold.

Since the observations are of prime importance in WSN, the researchers are giving stress on the need of transmitting a particular observation. The hard threshold is decided on the basis of the application needed. It is s fixed threshold above or below or in therange of which the observation will be transmitted. The soft threshold is which determines the difference in the consequent transmitted observation is big or small enough for the observation to be transmitted. By reducing the number of observation transmitted the energy consumption and thereby network life is improved. In our case if the observation is above or below the hard threshold then only it is sampled and also it is sample given the

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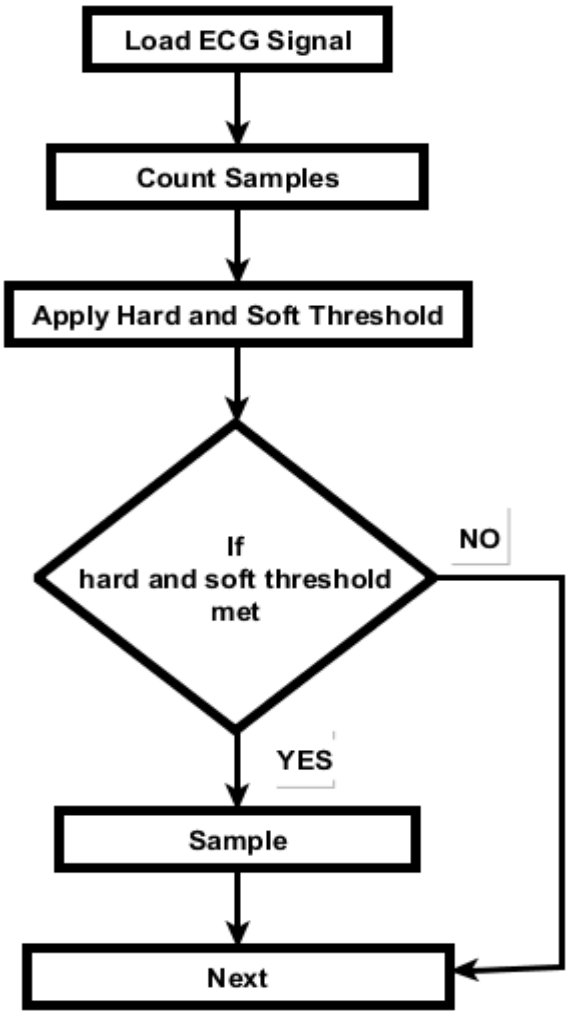
continuous peak is at least more or the dip is at least less than by at least the soft threshold. At last, the signal is compressed which indicates the saving of transmission energy.



VI.RESULTS

Figure 1 shows the comparison of energy which depicts the better performance of proposed method. As the total number of observations to be sent as a signal is comparatively less the transmission energy is reduced.

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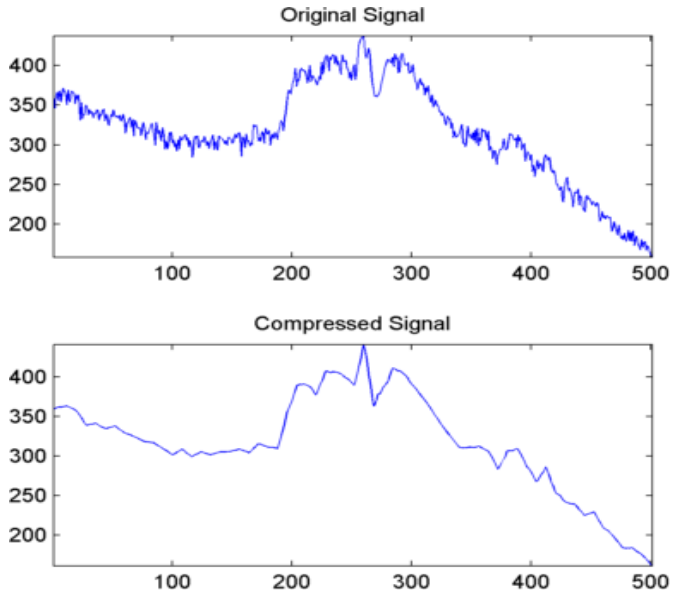

Figure 2 shows the performance of Throughput in the previous method and the proposed work. Since the network energy is maintained in an appropriate manner, the energy spent is less which causes more nodes to be available for communication, hence improving throughput.

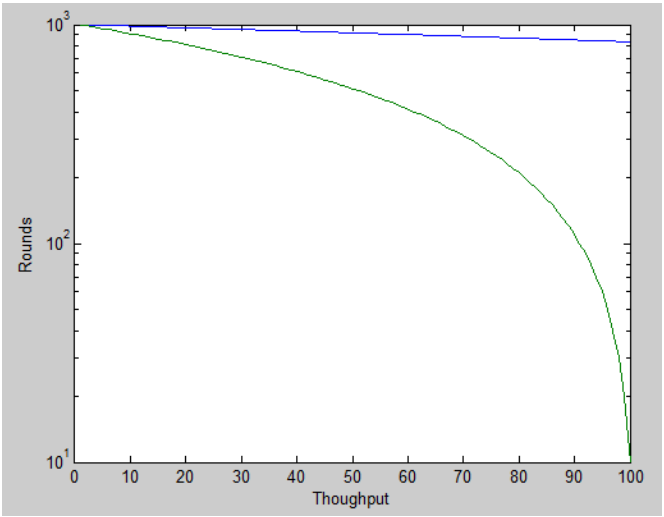

Figure 3shows that the Delay proves to be better in the case of proposed work because of the improved throughput, the successive packets that reach the destination take much lesser time in between them to reach the destination.

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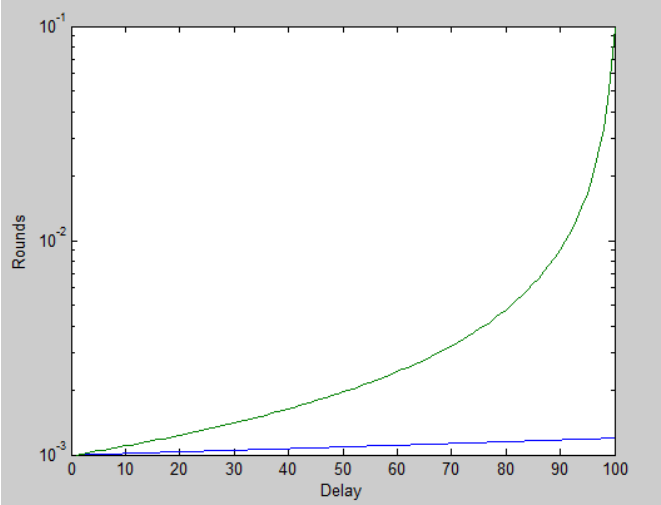

PARAMETER	DWT	DWT with HT &ST
ENERGY(MILLIJOULES)	49	85
THROUGHPUT(BITS/SECOND)	450	900
DELAY(MILLISECONDS)	850	650

Above table represents the results obtained from the simulation. The Energy left among the previous DWT and current DWT with hard and Soft Threshold is better in the case of current scenario by almost and margin of 180%. Similarly in case throughput and delay also the results are better by 200% and 140% approximately.

VII. CONCLUSION

The simulation of the sampling of the ECG signal with the use of hard and soft thresholds has improved the performance of the network a lot both in terms of energy efficiency as well as the Quality of service. The network outperforms the simulation when only the DWT was used to compress the signal because in that only the final formulated signal was compressed. But in the work proposed in this paper, the formulationofthefinal signal is also controlledas it is governed by the soft and hard threshold.

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