Abstract

This paper highlights on the issue or the major limitations of Wireless Sensor Networks that are battery operated with limited battery powers. This study deals with overcoming this limited battery using Compressive Sensing and PEGASIS protocol. The study concentrates on Wireless Body Area Networks (WBAN) where wireless sensors are used to capture potential data from human body and sends it to the medical room in case of emergency. These captured data are huge and complex images like ECG, Scanning etc., and these data has to be exchanged across the network efficiently without any break in the network that operates with limited battery power. To overcome the problem of battery power limitation this study proposes a compressive sensing PEGASIS based algorithm for efficient handling of the network without network breakages.

I. INTRODUCTION

There is a vast growth of technological advances recently in the area of wireless sensor networks and in particular with wireless body area networks which has become a mandatory part of the medical science that helps doctors to provide emergency services to their patients...
instantly from remote locations. For this remote monitoring of patients to happen real time the entire network requires uninterrupted data exchange that are complex data objects in terms of text, images and videos that needs to be exchanged across the network efficiently. One such area in WBAN is the long-term and ubiquitous real-time ECG monitoring that is becoming increasingly popular [1]. Though these areas have started gaining momentum, such systems face a large number of constraints, such as limited memory, limited energy, and limited computation and communication capabilities. In WBAN energy requirement is necessary for sensing, wireless communication and data processing. The actual limitation of this body area network is the cost to wirelessly transmit data which is on the higher side and demands some data reduction strategy at the sensor node. Compressed sensing (CS) is one suitable approach to lower energy consumption and complexity in WBAN. Their results show that CS outperforms state-of-the-art wavelet transform-based compression methods in terms of energy efficiency. This paper discusses on employing combination of compressed sensing and energy efficient PEGASIS protocol for efficient data handling in WBAN.

II. WBAN AND ITS LIMITATIONS

Wireless body area networks (WBANs) are a subset of Wireless Sensor Networks and provide support for telemedicine or remote healthcare monitoring. WBANs are biomedical carriers capable of carrying biomedical data to facilitate early diagnosis and treatment in a continuous health monitoring system by using various biomedical wireless sensors used for the human body. A remote data center operates in co-ordination with these sensors to process the bio-medical signals through cellular network. Some of the major limitations posed by this WBAN are its power consumption and sampling rate. Compressed sensing (CS) is a signal acquisition/compression methodology which gives an alternative to traditional signal acquisition along with PEGASIS protocol for improving on the factor of minimizing energy utilization.

III. COMPRESSIVE SENSING

The traditional method of reconstructing images from the measured data follows Shannon sampling theorem. The sampling rate must be twice as that of the highest frequency [2]. Similarly, the fundamental theorem of linear algebra suggests that the number of collected measurements or samples of a discrete finite-dimensional signal should be at least as large as its dimension for reconstruction. This underlying principle was followed to most of the recent technology such as medical imaging, analog to digital conversion, audio and video. Compressive sampling or Compressive sensing or parse recovery provides a new approach to data acquisition that overcomes this common thinking. Compressive sensing is a new type of sampling theory which predicts certain signals or images which can be recovered from what was previously believed to be highly incomplete information. Algorithms such as l1-minimization can be used for recovery. Compressive sensing has many potential applications in signal processing and imaging. Compressive sensing is a new framework for sensor design and signal acquisition [3]. It also performs sensing with
image compression thereby helps in image size reduction with improved quality.

The major advantage of Compressive Sensing is that it enables a large reduction in the computation costs and sampling for sensing signals which has a compressible representation. Nyquist Shannon sampling theorem states that in order to capture an arbitrary band limited signal, certain minimum number of samples are required. Using compressive sensing it is possible to gradually reduce the number of samplings to be stored, when the signal is sparse in a known basis. In other words using compressive sensing one can recover certain images and signals from fewer measurements or samples using traditional methods. Compressive Sensing relies on two principles sparsity that pertains to the signals of interest and incoherence that pertains to the sensing modality.

Sparsity provides the idea that in the continuous time signal, information rate may be much smaller than its bandwidth, or that a discrete-time signal depends on a number of degrees of freedom that is comparably much smaller than its finite length. Incoherence expresses the idea that the objects having a sparse representation must be spread out in the domain they are acquired and extends the duality between time and frequency [4]. In recent years, compressed sensing has been widely used in the areas of computer science, applied mathematics, and electrical engineering.

IV. ENERGY EFFICIENT ALGORITHM

Energy conservation has become a major concern that needs to be addressed by many sectors over the world. There are many Federal programs that provide incentives to save energy and promote the use of renewable energy resources. There is a high time demand from Individuals, companies, and organizations seeking energy efficient products as the energy cost to run equipment has grown to be a major factor that overruns the total setup cost. Energy consumption is very critical to all electronic gadgets in terms of both cost and availability. Electricity costs impose a substantial strain on the budget of data and computing centers. Google engineers, maintaining thousands of servers, warned that if power consumption continues to grow, power costs can easily overtake hardware costs by a large margin. Energy has become a leading design constraint for computing and digital devices. Hardware engineers and system designers explore new directions to reduce the energy consumption of their products. Energy efficiency is one of the easiest and most cost effective ways to combat climate change clean the air we breathe, improve the competitiveness of our businesses and reduce energy costs for consumers. The Department of Energy is working with universities, businesses and the National Labs to develop new, energy-efficient technologies while boosting the efficiency of current technologies on the market [5].

V. IMPORTANCE OF ENERGY OPTIMIZATION IN WBAN

WBAN consist of miniature sensors that are able to sense and communicate with other devices. These wireless sensors will be in the form of wearables like rings and watches. These wireless sensors will detect changes in human body and passes information to the
measuring device. These measurements can be displayed in the monitor as like scanning machine and even this reading can be transmitted to a mobile app with the help of Bluetooth and the patient with high risk can be monitored frequently and the results can be stored in other device for future references. When more devices are involved in WBAN, there should not be any interruption between the communications of nodes. To avoid interruption and network traffic, energy saving of the resources is must.

VI. PEGASIS PROTOCOL

Power-Efficient Gathering in Sensor Information Systems (PEGASIS) is a clustering and chaining protocol that is focused around the chain structure formation for efficient data exchange. Each node communicates only with a close neighboring node and takes turns by transmitting to the base station, thus the amount of energy spent per round get reduced. The main aim of this protocol is to extend the lifetime of a network by achieving a high level of energy efficiency and uniform consumption of energy across all network nodes. PEGASIS reduce the delay that data incur on their way to the sink. The PEGASIS protocol achieves about 90-100% to improvement when compared to the LEACH protocol [6].

6.1 Working of PEGASIS Protocol

PEGASIS, convention is focused around the chain structure. Chain is a collection of nodes belonging to a cluster and each chain can have one and only group head. The group head takes the complete control of nodes in the chain through accepting and sending messages between nodes that fit in with the chain. The bunch head devour expansive vitality as the chain keeps expanding. In PEGASIS, information exchange takes place with the nearest neighbor policy thereby transmission across the chain to base station is taken care by the group head thereby spare the battery for WSN and expanding the lifetime of the system [7].

6.2 Application Of Pegasis Protocol With Compressive Sensing

![Figure 1. Application of PEGASIS Protocol with Compressive Sensing](image)

6.2.1 WBAN

WBAN is the Wireless Body Area Network. In today’s technological world with technology developments on the verge and technological gadgets thronging the market, health issues and concerns have become a greater mystique. In such a prevailing situation it is necessary
that the technology world should come out with a better or improved health monitoring system that is capable of handling the monitoring gadgets and the communication gadgets with minimum resource utilization and that has led to the development of WBAN, a health monitoring system. The wireless body sensors sense the body and pass the signals to the personal devices.

6.2.2 Personal devices (WBAN Gateway)
The personal devices or otherwise called the gateway of WBAN. Personal devices are the components that are use to receive signals from body sensors. The personal devices are then connected to internet through which signals are passed to medical network. It can be anything like computer, watches that are connected internally with WBAN. The signals provided by Body sensors are internally stored in personal networks and the networks transfer the signals to medical network that is external network through internet.

6.2.3 Medical Monitoring Center
Medical networks are nothing but doctors, emergency vehicle or the medical case history storage device. When the signals from WBAN are normal then they are stored in case history storage. If any abnormalities found in WBAN then alert signals are passed to doctors or to the emergency vehicle.
Along with this basic setup the compressive sensing and PEGASIS algorithm can be implemented over the wireless area network to improve upon faster and effective data transmission and energy efficiency and this architecture could offer better performance than any other system that solely works with either compressive sensing or PEGASIS protocol.

VII. PERFORMANCE OF PEGASIS PROTOCOLS
In the given Figure 2, where communication overhead is measured in joules, the overhead incurred by LEACH is significant with the increase in number of nodes and thereby affects the energy consumption, security, communication stability and the quality of service in large networks. On the other hand, the overheads are very small. Therefore the performance of PEGASIS is better than LEACH.

![Figure 2. Performance of PEGASIS is better than LEACH.](image-url)
As shown in the Fig. 3 PEGASIS achieves around 2x the number of rounds compared to LEACH at all values of number of nodes deployed in the network. This shows that as compared to LEACH, PEGASIS offers better stability and lifetime in large networks.

VIII. CONCLUSION
This paper makes a detailed study on the WBAN architecture and the implementation of compressive sensing and PEGASIS protocol for enhanced data delivery with the available battery power. The paper also makes a comparative study of LEACH and PEGASIS protocol and the study proves that the PEGASIS protocol performs better in handling energy factor and sets the network work for longer hours without any network failure. In future this work can be extended to implement the model of WBAN with compressive sensing and PEGASIS protocol.

IX. REFERENCES
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