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Data Modulation Techniques for Wireless Sensor Networks using Classification

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Abstract

Wireless sensor networks are the decentralized type of networks which sense data and pass this information to base station. The network is deployed on faraway places and due to the small size of the sensor nodes energy consumption, quality of service are some of the major issues of the network. In nutshell, sensor nodes have to perform sensing, data processing and communication in an isolate physical area. As battery is fixed and cannot be replaced, there must be best energy efficient routing algorithm required to be implemented in every sensor network to increase the network lifetime manifolds. The improved adaptive modulation technique will modulate the low frequency data into high frequency which leads to the reduction in bit error rate. In proposed algorithm, the SVM classifier is applied which will classify the data into two classes. For regression, classification as well as general pattern recognition, the SVM classifier is proposed. There are many solutions proposed for the same. But in this work, the adaptive modulation scheme is proposed that is based on PCA algorithm which selects best modulation signal to increase frequency of the data. Both, proposed and existing algorithms are implemented in MATLAB and results are analyzed in terms of various parameters.

INTRODUCTION

There are numerous nodes deployed within a specific area of a wireless sensor network. These nodes are deployed in order to monitor the surrounding area. In order to provide communication amongst the nodes, present in the network, the sensor hub exists in the network which consists of sensors, actuators, memory and processor. To transmit the data through sensor nodes different communication carriers such as, radio frequencies, infrared, and so on, can be utilized. There is no wired connection present within these networks [1]. A random interconnection set across the nodes to transfer messages, which thus provides an ad-hoc network environment within the networks. A hub cannot communicate directly with another because the signal strength is not enough to establish a connection so the information to be transferred passes through many intermediate nodes available in the network. This process is known as multi-hop communication. The battery present within the nodes of WSN is of smaller size. Also the nodes are located at really far distances where human is not able to reach. So the major concern within the WSNs is the usage of battery within them [2]. This also affects the overall lifetime of the nodes and thus the deployment of the network. The sizes of various constraints such as battery size, processors, information storing memory and so on are important within these networks. The consumption of energy is required to be advanced within the networks with the help of various optimization algorithms. Various time constraints are present within the detected routing information sent across the WSNs. Before any alterations, the information can be utilized by the network. To communicate information across the network, the energy consumed is more as compared to other executions. Thus, it is very imperative to address the energy conservation issue in the WSNs. The flexibility, which enables the WSNs to handle various issues arising when these networks are deployed in various applications, is the major reason due to which there is an increase in growth of demand of these networks [3]. The major issue that arises within the wireless sensor networks is the limited amount of lifetime of a battery of nodes present within the network. There are very limited constraints on the size of battery, processors, and memory present within the sensor nodes deployed within the network due to their small sizes. Thus, the major concern here is to upgrade the amount of energy being consumed by these networks. In order to combat this problem, regular time constraints are provided within the network so that collected data can be transmitted to the destination and can be utilized prior to any hazard. There is

higher consumption of power due to the communication of data within these networks in comparison the processing function in these networks [4]. Thus there is a need to address such issues. Clustering method is used in order to save the energy available within the sensor nodes. Each of the nodes present within the network can be divided into several smaller groups which are known as clusters, with the help of productive network organization. A cluster head is present within each cluster along with all other individual nodes. A two-level order is provided within the clustering method. In first level, the node, with higher energy level, is designated as the cluster head. The second part involves the nodes of these networks. The nodes are grouped into clusters through the clustering process. The cluster head is chosen here periodically in such a manner that all the other nodes can communicate with it as per their requirement. The data that is gathered from the numerous nodes by the cluster head, is further passed to the base station by it. In comparison to other nodes, the cluster heads pass information over large distances thus they consumed higher energy in comparison to other nodes [5]. Radio frequency based contactless automatic identification expertise is known as Radio Frequency Identification (RFID). The active and passive RFID are the two sources of power in RFID and out of these two, passive RFID gives more advantages than active RFID in terms of size, battery management, and tag cost, etcetera. To store or detect physical information for a long time period, RFID is produced that add fundamental function and enhance the nature of framework. The tag to tag communication accessibility performed using active RFID, is more advantageous than passive in terms of stability, sensing rate and sensing distance. The tags are controlled by reader and point-to-multipoint (P2MP) communication structure is achieved by RFID [6]. The tag should be able to operate in sleep whereas during active periods energy is consumed by radio module that results in decreased tag energy consumption. The contention is used to deliver ID to the reader and collection of command is transmited by reader to multiple tags. During data collection period, data is collected on tags by reader that uses their ID to detect it from tag ID collection period.

LITERATURE REVIEW

Peyman Neamatollahi et al. [7], have analyzed that energy of a network reduces too much extent by cluster head that is why they have proposed half clustering approach. In beginning of any upcoming round information of clustering, existing nodes are involved in some application. When required, a clustering takes place and a baseline case is made by utilizing half and half clustering calculation of distributed clustering protocol HEED (Hybrid Energy Efficient Distributed). The proposed protocol has been tested and compared, by performing different experiments in terms of network lifetime that declared it as 30% more efficient. This protocol executes clustering on demand which is the main reason behind its being more efficient than existing protocols.

Maciej Nikodem et al. [8], main focus is to enhance the network lifetime of wireless sensor networks for which they have used theoretical parts of clustering. The clustering networks are compared with non clustering networks in terms of network lifetime and results show that it gives enhanced lifetime in some specific application. The real life nodes abilities have been recorded and 1D and 2D networks are break down utilizing integer linear programming. The experiments have been conducted whose results shown that network lifetime can't be enhanced by only clustering that gives a need of additional strategies.

Dahlila P. Dahnil, et al. [9], concluded that in wireless sensor networks there is need of same clustering strategies and cluster heads election based on single criterion investigation. The adaptability, coverage, distribution, cluster size, head and generated head distribution are the terms that have been used to compare the performance of HEED, LEACH and Energy-based LEACH protocols. The lifetime of a network has been increased by cluster formation that has been concluded from drawn results. The impact of advanced nodes present in the network has been investigated in terms of network lifetime. In the presence of advanced nodes, network lifetime can be enhanced using new approach for electing cluster heads and in their proposal HEED and AE-LEACH protocols have been investigated. A critical change in lifetime of network has been seen by adding some advance nodes in a network and compared it with a network contains more homogeneous nodes [10].

Ewa Hansen, et al. [11], have analyzed that for energy effective infrastructure development, use of wireless sensor network has become imperative. In cluster based sensor network, the distance between clusters' heads should be minimum that helps in reducing energy consumption and increases network lifetime. The cluster heads separation consumed some amount of sensor network energy that has been determined through performed simulation. The given separation distance between different existing cluster heads has been utilized to gives more detailed impact on energy consumption. When distance between different cluster heads is minimum enhanced performance has been achieved by wireless sensor network.

T. Shankar, et al. [12], recommended the use of neural networks for selecting cluster head in wireless sensor network for making it more energy efficient. A wireless sink backbone has been formed by cluster heads or exceptional nodes in routing based on cluster. The data is forwarded to sink after being gathered through cluster heads and same abilities has been gained by each nodes present in a homogeneous networks. In order to save energy, there is a need to reduce data redundancy. Every node's energy has been spared after deploying every node as a temporary cluster heads.

Matthias R. Brust, et al. [13], explained that clustering is a procedure of creating hierarchical networks. The cluster head is chosen by all available sensor nodes in a cluster. The wireless sensor networks and ad hoc networks are dynamic in nature due to this selection of a cluster head is the main issue. The productive information dissemination, sporadic or failure node mobility resilient and robust cluster head candidate selection for a new topological criterion has been proposed. The cluster selection in this proposed methodology is done by maintaining a strategic distance from the fringe nodes due to its mobility. So, a new cluster head is selected after re-clustering that is wastage of energy and time. Experiments have been conducted to check performance of present cases and static topologies.

PROPOSED WORK

Adaptive PCA is a dimensionality reduction technique that normally used for data aggregation. The data, collected by the sensor nodes, is of very low frequency due to which the network interferences affect the quality of sensed data. Adaptive PCA algorithm is applied in this work will select the carrier signal according to the type of data i.e. whether it is of high or is of low frequency. The selected data will be modulated using the PCA algorithm which is the principle component analysis technique that selects the best data according to selected component. The PCA algorithm is used to perform two tasks. The first task is to reduce the energy consumption of the nodes at the time of data aggregation in the network and second task is to reduce the bit error rate of the nodes in the network. To perform these two tasks, PCA algorithm consists of two sub algorithms, event checker and data accuracy checker algorithm. In the event checker algorithm, the data sensed by the sensor nodes need to transmit to the base station. In proposed algorithm the SVM classifier is applied to classify the data into two classes. For regression, classification and general pattern recognition, the SVM classifier is proposed. Due to its high generalization performance, without requiring any previous knowledge to add in it, this classifier is considered as a better option as compared to other classifiers. Performance is even better when the dimension of the input space is extremely high. In order to differentiate between the two classes of the training data, the SVM requires identifying the best classification function.

Proposed Algorithm:

Input: Sensor Nodes, sensed data (d)

Output : Transmit high frequency data

STEP 1. Deploy the sensor networks with the finite number of sensor nodes

STEP 2. Divide whole network into fixed size clusters and select cluster head in each cluster

STEP 3. The cluster heads in each cluster will be selected on the basis of energy and distance

STEP 4. Calculate the accuracy of sensed data (αi)

STEP 5. If all αi of Si >=desired of data (αi)

Then

Packet type ==low frequency

Else

Packet type==high frequency

STEP 6. If (Packet type==low frequency)

Then

Insert high frequency carrier signals

Else

Low frequency carries

STEP 7. End

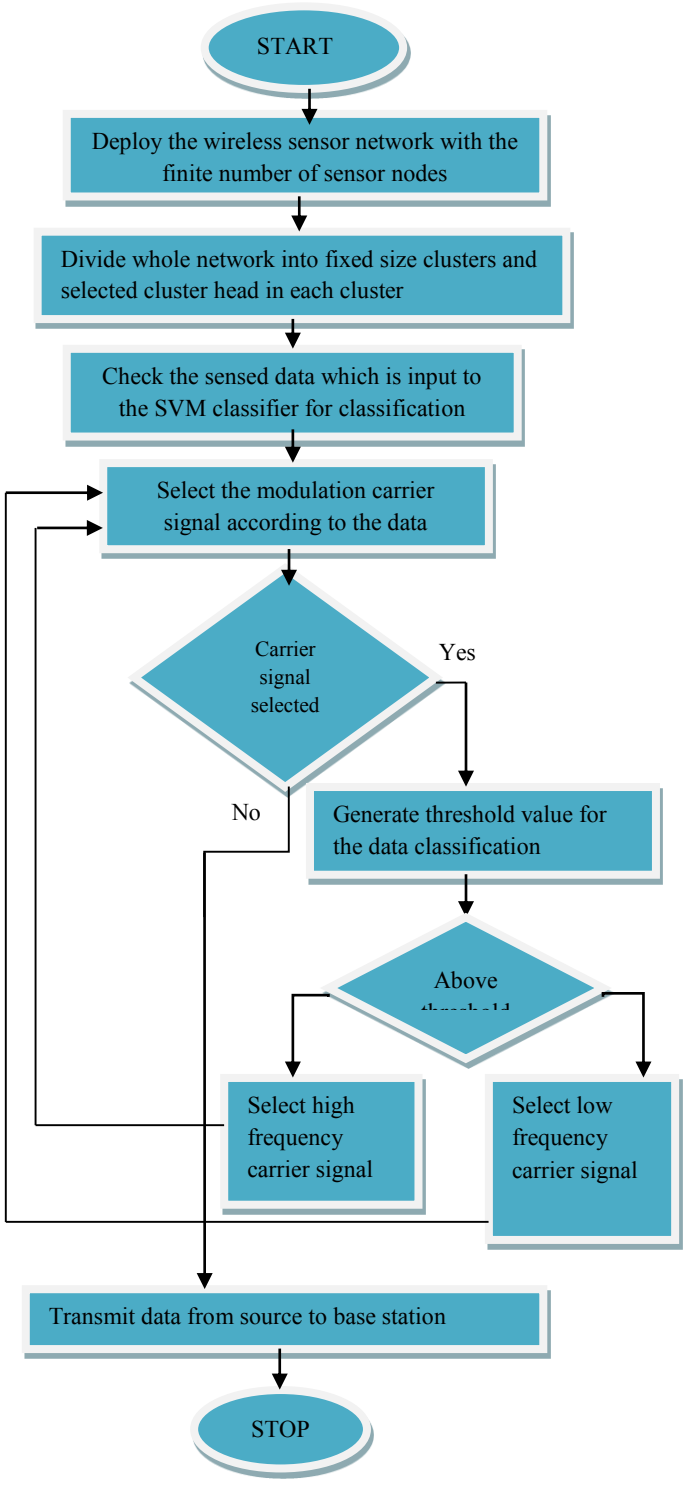

Figure 1: Flowchart of Proposed Algorithm

EXPERIMENTAL RESULTS

The proposed algorithm has been implemented using MATLAB and comparisons, amongst proposed and existing algorithm, have been drawn on the basis of several parameters.

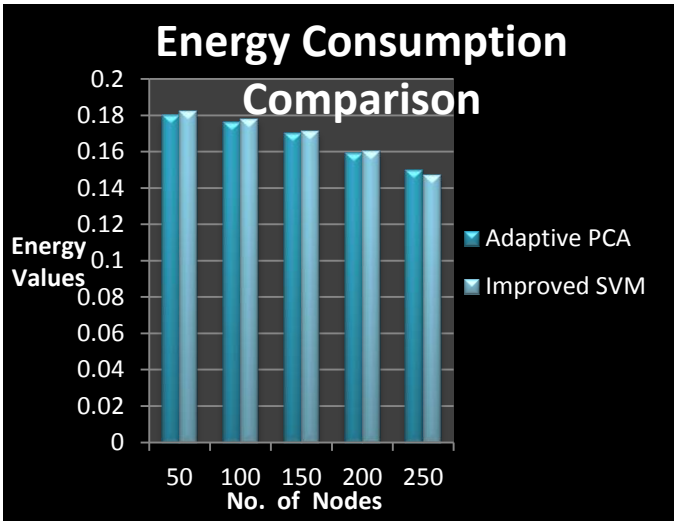

Figure 2: Energy Consumption Comparison of Adaptive PCA and Improved SVM

In figure 2, graph shows the remaining energy corresponding to the number of rounds. Algorithm is defined in terms of remaining energy and it has been analyzed that more energy is remaining by using Improved SVM as compared to Adaptive PCA. Thus energy consumption is lower in Improved SVM Technique but consumption increases as we added more number of nodes. But, as a whole, it provides more energy efficient solution than Adaptive PCA.

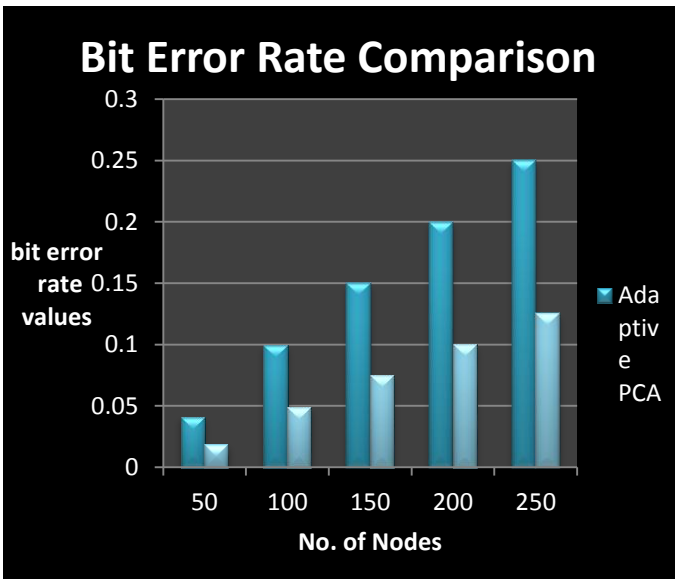

Figure 3: Bit Error Rate Comparison of Adaptive PCA and Improved SVM

In figure 3, graph shows the bit error rate with respect to the number of rounds. On the x-axis, number of rounds are shown and on the y-axis, bit error rate is represented. By analyzing the facts, it can be inferred that bit error rate is lower in case of Improved SVM Technique as compared to PCA.

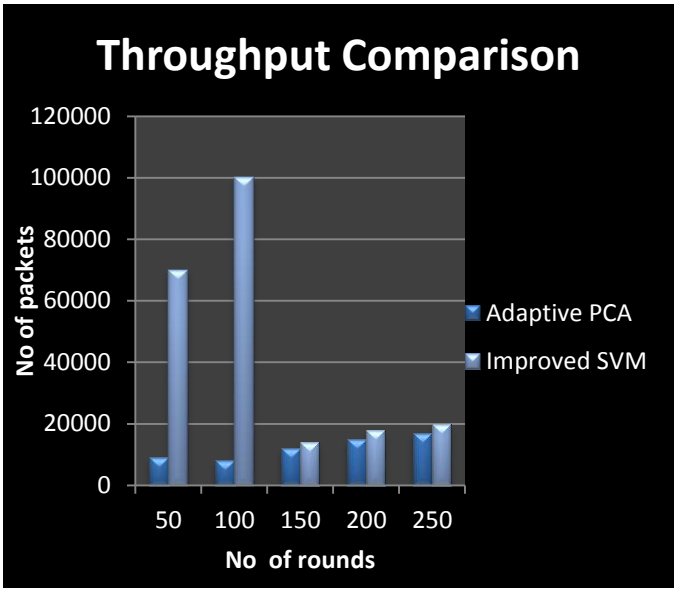

Figure 4: Throughput Comparison of Adaptive PCA and Improved SVM

In figure 4, graph shows the throughput with respect to the number of rounds. On x-axis, number of rounds are shown and on y-axis, number of packets, as output, are shown. By analyzing the facts, it is vivid that throughput is higher in case of Improved SVM Technique as compared to PCA.

CONCLUSION

In this work, PCA algorithm is applied which selects the signal for the modulation of the sensed information. Adaptive PCA is a dimensionality reduction technique, normally used for data aggregation. The data, collected by the sensor nodes, is of very low frequency due to which the network interferences affect the quality of sensed data. Adaptive PCA algorithm is applied in this work will select the carrier signal according to the type of data i.e. whether it is of high or is of low frequency. Selected data will be modulated using the PCA algorithm which is the principle component analysis technique that selects the best data according to selected component. The performance of both proposed and existing algorithms are tested using MATLAB and has been analyzed; according to which proposed algorithm performs better in terms of bit error rate and energy consumption.

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