Expectation Maximization Clustering Using Gaussian Mixture Model for Energy Efficient Routing Protocols in Wireless Sensor Networks

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***Abstract*: In the recent years, the technology of wireless networks has gained a lot of importance. Wireless networks are a special case of ad-hoc wire- less networks. A wireless network is a collection of sensor nodes that communicate through wireless links to work together to carry out functions. In this paper gives a bird eye over routing protocols of sensor network that concentrate over energy efficient routing in other to longer survival of Sensor network.**

***Keywords*: Wireless Network, Sensor Network, Machine Learning, Clustering, Feature Selection, Energy Efficient, Routing Protocol, Sink Node.**

1 INTRODUCTION

An ad-hoc wireless network is a distributed kind of wirelessly connected network. The ad-hoc nature demonstrates that, it does not depend on a pre-existing infrastructure, like routers in wired networks. . In wired networks, there is an access point which is connected to all other devices in network for communication, as shown in figure 1. In wireless network, each node contributes in routing by forwarding data to other nodes. Energy saving is a major issue in ad-hoc wireless networks. In ad-hoc wireless network, energy consumption is based on number of data transmission. This means, more number of transmissions is equal to more energy consumption and less number of transmissions is equal to less energy consumption. We studied that network coding uses less transmission, so that network coding can used to reduce energy consumption in ad-hoc wireless network. With network coding energy can be reduce by help of encryption / decryption of data, due to encryption/decryption data transmission will be more secure from external users, this will create confusion to eavesdropper and eaves- dropper cannot detect the actual data. Data also contains redundant data and false data that has to be eliminated or reduce for better performance of ad-hoc wireless network. We studied that Support Vector Ma- chine (SVM) can detect and reduce these redundant data by using Locality Sensitive Hashing, it is based on the data similarity on each node and improved network performance with less energy consumption.

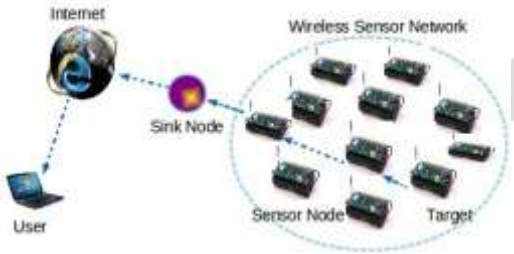

Fig. 1 Wireless Sensor Network

In addition to the classic routing, ad-hoc networks can use coding for forwarding the data. Figure1 wire-less ad-hoc network that communicate with router and wireless access point that manage the wireless network.

The earliest wireless ad-hoc networks were the PR- NETs. An ad-hoc network is created by multiple devices connected by links. Links are subjective to the node's behavioural properties and resources, similarly link properties. The links are unstable by nature and connectivity is affected at any time, a network is dynamic, preferably in a way that is efficient, timely, robust, reliable and scalable to be able to cope with restructuring
The network must allow cooperative communication by forwarding the information through other nodes. So, a path is a sequence or a number of connected devices.
Wireless networks consist local, metropolitan, wide and global areas. In most wireless ad-hoc networks, nodes participate to access a shared wireless channel, frequently causing in collisions and packet drop. That improves immunity to snooping by having the sink node associate self-interference and a different node interference to enhance decoding of the preferred signal.
Mobile ad-hoc network is a wireless network that communicates from device to device. It means such devices can directly

communicate with all other nodes within their radio range. By which all devices must communicate at a central administrative unit, the peer to peer communication methods can extend the range of wireless communication networks. To access the services, one of the devices can be linked through wire or wireless to a service provider.
Ad-hoc wireless devices can detect the connection with neighboring nodes or devices but also identify their type and corresponding attributes. There is no need to use fixed infrastructure. Ad-hoc mobile devices implies battery capacity of devices which can vary device to device, and for forwarding the data packet Ad-hoc mobile network consumes power, so that, it is very crucial issue.

There are some metrics proposed for power aware routing: There are some metrics proposed for power aware routing:
-Minimum energy consumed per packet
-Maximum time to network partition
-Minimum variance in node power level
-Minimum maximum node cost
-Minimum cost per packet

1 Routing Protocols

An ad-hoc routing protocol is a standard, that regulate how nodes and the way to route packets among communicating devices in an ad-hoc networks. In ad-hoc networks initially nodes do not figure out the topology of networks; therefore to discover it. The basic concept is that a new node may broadcast its presence and observe broadcast by its adjacent nodes. Each node acquires knowledge about nearby nodes and for path to reach those.

1.1 Pro-active Routing

Such kind of protocols manages fresh lists of destinations and their routes. That is performed by updating routing tables overall the network. The main difficulties of such algorithms are:
-Corresponding amount of data for maintenance.
-Deliberate reaction on rearrangement and failures.

1.2 Reactive Routing

This type of protocols routes are discovered on-demand basis using coding concept with Route Request packets. The main drawbacks of such algorithms are:
-High latency time in route finding.
-Excessive coding can lead to network congestion

1.3 Flow-oriented Routing

This type of protocols discovers a route on-demand by considering the current flows. One opportunity is to unicast sequentially when forwarding data while supporting a new connection. The main drawbacks of such algorithms are:

-Takes long time when discovering new routes without a previous knowledge.
-May rise to existing traffic to reward for missing knowledge on routes.

1.4 Hybrid Routing

This type of protocols hybridizes the benefits of proactive and of reactive routing. The routing is initially recognized with pro-actively mined routes and then obliges the demand from additional nodes using reactive coding technique. The selection of one or the different method involves pre-computation for complex cases. The main drawbacks of such algorithms are:
-The benefits depends on the number of active nodes.
-Traffic demand response gradient depending on traffic volume.

1.5 Hierarchical Routing Protocols

The selection of pro-active and of reactive routing is subject to the hierarchic. The routing is basically arranged by some pro-actively prospected routes and serves on demand on the lower levels. The selection technique requires proper acknowledgment for particular levels. The main drawbacks of these algorithms are:
-Advantage depends on depth of nesting and addressing scheme
-Reaction to traffic demand depends on meshing parameters

1.6 Backpressure Routing

This type of routing paths is pre computed. It selects next-hops when a packet is in progress towards destination. These judgments are based on congestion of neighbor nodes. This routing is used with max-weight scheduling; this produces optimal throughput.

1.7 Host Specific Routing Protocols

This type of protocols needs administration to adapt the routing for certain network topology and a unique flow approach;

the main difficulties of these algorithms are :
-Depending on the quality of the benefits plan administration addressed.
-Proper reaction to changes in topology demands reconsidering all parameters

2 RELATED WORK

Smriti Sachan et.al[1] presents a new probabilistic algorithm to analyze the network connectivity by taking in account the parameters like network probability, detection area, radius of the individual nodes and whole detection area etc. The targated area is taken for free space propagation. This methodology ensures the network connectivity, sustainability of communication and optimizes the energy consumption at utmost level. The probability theory has been used to find out a feasible mathematical network model. In this model the variation of sensor nodes with respect to the detection area has been observed and analyzed. Also, the relationship between communication radius, sensor nodes deployed, and detection area has been identified. A new algorithm is also proposed to optimize energy and maintain the connectivity by increasing the connectivity factor. Also the simulation graph of the proposed model is presented to validate the mathematical network model.

C. B. Vinutha et.al. [2] combined design of non uniform sampling and reliable routing for efficient energy saving and fast data communication in the sys- tem while minimizing control signal overhead charges. Our work enhances the reliability in packet transmission by predicting energy robust and near-by nodes in the data forwarding path towards the destination, using back propagation neural network algorithm. Authors have demonstrated through simulation results the improvement in battery energy consumption without trading o with the speed of data communication which is achieved at the cost of minimal overhead charges.

Hosein Azarhava et.al [3] consider a TDMA based Wireless Energy Harvesting Sensor Network (WEHSN) in which the time slot consists of two time intervals; the rest one is utilized to absorb energy whereas the second one is used to transmit the sensors' data. Authors investigate the energy efficient resource allocation in WEHSN with constraints on time scheduling parameters and transmission power consumption, where an EH sensor is allowed to transmit its data if the amount of its harvested energy is more than the consumption power. Authors derive the closed form expression for the optimization problem, corresponding to the energy efficiency and convert it to a parametric form, using Dinkelbach method. Then, Authors solve the new problem using Karush-Kuhn-Tucker (KKT) conditions. The numerical results shows the effectiveness of the proposed method.

Jiazu Xie et.al [4] attempts to solve relay node placement and energy efficient routing problems for HWSN. Both problems have seldom been studied together in the literature. Authors first constructs a mathematical model for both problems. For relay node placement problem, it is assumed that HWSN contains un-reachable area, where sensor nodes could not be placed. For energy efficient routing, it is transformed to path length of wireless communication. As the problem is non-deterministic polynomial (NP) hard, a heuristic method called whale optimizer is used. The paper studies the effect of whale optimizer method with three adaptive schemes. Numerical simulations are done to test the proposed method for HWSN. The analysis and discussion show that the proposed method is useful to address NP hard relay node placement and energy saving problems for HWSN.

Guorui Li et.al [5] propose a Data Collection scheme based on De noising Auto encoder (DCDA) to solve the above problem. In the data training phase, a De noising Auto Encoder (DAE) is trained to compute the data measurement matrix and the data reconstruction matrix using the historical sensed data. Then, in the data collection phase, the sensed data of whole net- work are collected along a data collection tree. The data measurement matrix is utilized to compress the sensed data in each sensor node, and the data reconstruction matrix is utilized to reconstruct the original data in the sink. Finally, the data communication performance and data reconstruction performance of the proposed scheme are evaluated and compared with those of existing schemes using real world sensed data. The experimental results show that compared to its counterparts, the proposed scheme results in a higher data compression rate, lower energy consumption, more accurate data reconstruction, and faster data reconstruction speed
.

L.-L. Hung et.al [6] propose an energy saving routing mechanism, named Energy Efficient Cooperative Routing Scheme for Heterogeneous Wireless Sensor Net- works (EERH for short), in which several WSNs deployed in the same geographical environment form a heterogeneous sensor network and sensors relay packets for its own WSN and also for other WSNs. Routing paths are dynamically established according to the transmission directions of event packets and the residual energy of the underlying sensors and their neighbors. In addition, the packets routed to the same direction by the same sensors are aggregated to save delivering energy. Moreover, the network parameters
of the EERH, like propagation delay of an event pack.

Muhammad Nawaz Khan et.al [7] proposes a novel scheme, Energy Efficient Adaptive Scheduling Scheme (EASS) for Mesh Grid Wireless Sensor Networks . In EASS, a sensor node configures and schedules its functions/roles according to the contents of sensed data packets and frequency of generated traffic. Like energy cloud, tasks are uniformly distributed on all nodes in mesh-grid in four states each state of a node is responsible for configuring its components on a specific energy level which aims to avoid link disconnection and vanish redundant data packets

generation. Simulation results show that EASS increases energy- efficiency by 50% due to the four-states model, 62.5% due to alive nodes, 92.60% due to minimized Cluster- Heads overhead and 38.11% due to the reduction in dead nodes ratio.

Manish Kumar Singh et.al [8] proposes a Genetic locations on the trajectory for each cluster. The moving sink stops at the optimal sink locations and gathers data from the nodes of the related clusters. An optimal sink location consumes minimum node energy in data transmission. For determining the optimal sink location for a cluster, the GA initializes a population of chromosomes. Further, a network energy consumption model is proposed that implements the fitness evaluation operator of the GA process. The developed GA model converges into a set of optimal sink locations on the trajectory for each cluster. The results depict that the GA based sink mobility provides in- crease in network lifetime than other protocols.

S. Gopinath et.al [9] proposes the Secure cluster based efficient energy routing is adopted to attain the more network lifetime. In first phase of the research, network and routing assumptions are made to initialize the effective packet transmission. In second phase, stability metric is determined for the cluster to maximize the energy efficiency. There are two cluster metrics used for the analysis of network stability. In third phase, the optimal cluster design model is initialized to balance the network integrity and energy efficiency. The proposed scheme is evaluated with network simulation tool in terms of node stability ratio, node reliability ratio, network lifetime, packet delay and energy efficiency.

D. Laxma Reddy et.al [10] intends to and the optimal cluster head for energy-efficient routing protocol in WSN. As the main contribution deals with the Cluster Head Selection (CHS), this paper intends to propose a new hybrid algorithm namely Ant Colony Optimization (ACO) integrated Glowworm Swarm Optimization (GSO) approach (ACI-GSO), which is the hybridization of (GSO) and (ACO) algorithms. The objective of the CHS is to reduce the distance among the selected CH node. It makes the fitness function using multiple objectives like distance, delay, and energy. Finally, the performance of the proposed work is evaluated and the efficiency of the proposed work is proved over other conventional works.

Osama A.Khashan et.al [11] addresses these issues by designing FlexCrypt an automated lightweight cryptographic scheme for WSNs. In the FlexCrypt scheme, a new dynamic clustering technique that supports mobility among the sensor nodes is developed. Moreover, the proposed scheme introduces a flexible lightweight cryptographic method to control the complexity of the encryption by automating the selection of encryption parameters based on the presently available resource.

Algorithm (GA) based sink mobility technique for WSN. of each sensor node to encrypt the data. In addition Network region is divided into the optimal number of clusters and a sink movement trajectory is built over there. The GA process determines the optimal sink. a new lightweight key management and authentication method is designed to establish secure communication and the exchange of data and keys among the various WSN nodes. The proposed FlexCrypt scheme was evaluated using the Cooja simulator with Contiki OS. The results prove that the proposed scheme provides a significant improvement in terms of delay and encryption time in addition to power consumption and network lifetime compared to other ciphers that use fixed encryption parameters. It can effectively extend the network lifetime by 86%, 94% and 90% compared to the FlexenTech AES and TEA ciphers, respectively. The security analysis demonstrates that the FlexCrypt scheme can resist various attacks such as brute-force, eavesdropping, man-in-the-middle and replay attacks.

S.Balaji et.al [12] proposes that the cuckoo search algorithm is proposed to identify the maximum number of sensor covers. It is observed that the proposed algorithm outperforms than existing algorithms by eliminating redundant sensors and supplementing with a sensor when it is required. The simulation results of various problem instances show the superiority of pro- posed algorithm in terms of network lifetime, and it is validated by comparison with other few existing algorithms.

3 RESEARCH GAP

There have some recent works that promised to improve the Energy Consumption and Security for increasing the routing protocol's performance. Basically a common concepts are used that encryption/decryption technique and network coding, that proves the secure data transmission in less number of transmission in network. They defined that, each node in network have some attributes (like identity, threshold), based on these attributes data can transmit from one node to their neighbor node. It include the allowable overhearing of control messages from adjacent nodes and limiting the local repair for a small topological range of the link break therefore alternative routes to the sink node can be found quickly with optimum routing overheads. A range of threshold values for changing network scenarios specifically for different network load conditions.
Clearly demonstrate that a decision making process for energy saving and security technique that is flexible and adaptive for different network load conditions, and lead to obtain a performance improvement. A route table that is maintained by each node in network contains the following information:
-Destination

-Next hop
-Number of hops
-Destination sequence number
-Active neighbors for this route
-Expiration time for the route table entry

After studied different research papers and article, some of the problems associated with previous paper are investigated and they are:

-Dynamic topology is a main problem in previous work done.
-When the density of network nodes increases the through- put of network decreases.
-Dynamic multicast routing problem arises through the node moment independently with different speed in the network.
-Dynamic topology create the current issues such as- data redundancy problem, false data problem, lost data in routing, TSP problem, route break frequently problem, channel bit issues (BER) problem and other real time problem.
-Dynamic topology also increases the packet drop ratio and end to end delay.

4 CONCLUSION

Energy Consumption and Security for increasing the routing protocol's performance. Basically a common concepts are used that encryption/decryption technique and network coding, that proves the secure data trans- mission in less number of transmission in network.
They defined that, each node in network have some attributes (like identity, threshold), based on these attributes data can transmit from one node to their neighbor node. It include the allowable overhearing of control messages from adjacent nodes and limiting the local repair for a small topological range of the link break therefore alternative routes to the sink node can be found quickly with optimum routing overheads.

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