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Design of Efficient Data Aggregation Methodology for Wireless Sensor Network Using Fuzzy Logic

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Abstract

Trending technologies in Wireless Sensor Technology gives researchers a chance to work for implementing effective methodologies so as to minimize some critical issues like computation of aggregated data, energy consumption of sensor nodes, implementation of algorithm for finding shortest route, security related issues in wireless sensor network and many more. Energy consumption can be reduced using data aggregation methodology which composed of clustering phenomenon. Data aggregation is an important thing which needs to be collected at proper time so as to make use of the energy of the sensor nodes efficiently. To make data aggregation more efficient, data from different sensors such as temperature sensors, humidity sensors, etc. with same attribute collected once and will be send for further processing. For reducing energy consumption and for decreasing the communication load, clustering is the best option which makes use of cluster heads in terms increases lifetime of network by minimizing the redundant information. In this research paper, Fuzzy Rule Based Inference algorithm has proposed for cluster head selection and data aggregation on sink node as well as shortest path is found by using Euclidean distance method to improve the lifetime of WSN working**.**

Keywords: Wireless Sensor Technology, data aggregation, clustering, Euclidean distance

INTRODUCTION

Wireless Sensor Networks (WSN) consists of network of sensor nodes deployed in environment which periodically senses the data, monitor it and send the data to the sink node at which the gathered data can be used to process for end-user. In the process of data gathering, data from different sensors will be fuse together to eliminate redundant transmissions because of its correlation in spatial and temporal fields. [1], [2], [3]

WSN network consists of thousand of sensor nodes which are randomly distributed for monitoring the different things useful for particular application. As the sensors are in numbers, it should follow some particular approach so as to minimize the processing time and regenerative data. Therefore, different approaches for wireless sensor networks such as tree-based, cluster-based and hybrid-based network topologies are widely used. For clustered based approach in WSN, the grouped of nodes are formed into the clusters. For every cluster there is one Cluster Head (CH) node that controls and coordinates the nodes and communicates with the nearest CH nodes in the network. Mostly the cluster-based approached based on two design issues such as router node that route the data packets to the sink or base node and aggregate node combined the data packet based on aggregation function and send it to the transitional node. The intermediate or transitional nodes aggregate the data packet from the source node and send it to the sink node. Data aggregation design approaches mostly based on mixed integer linear programming method that increase the network lifetime by using multiple sink or base nodes in the network. Heuristic-based data aggregation methodology used in unstable network traffic circumstances enhances the performance of the particular sensor network. [4], [5],[19]

Data aggregation methodology study gives spatial correspondence among sensor nodes data which is a most essential foundation that co relates to the correctness of the total aggregated data and the total energy consumption of sensor nodes. This paper relates to study of cluster based data collection at three different levels. At first level, data aggregation process collect data from each sensor node to send raw data on sink node. At second level, the redundancy

between the nearest sensor nodes is found and at last use similarity function that used to avoid redundant data used for improving the energy efficiency. Data aggregation in huge scale wireless sensor network not fulfils the challenges or objective such as scalability and energy efficiency network due to inadequate or limited energy and vast region.

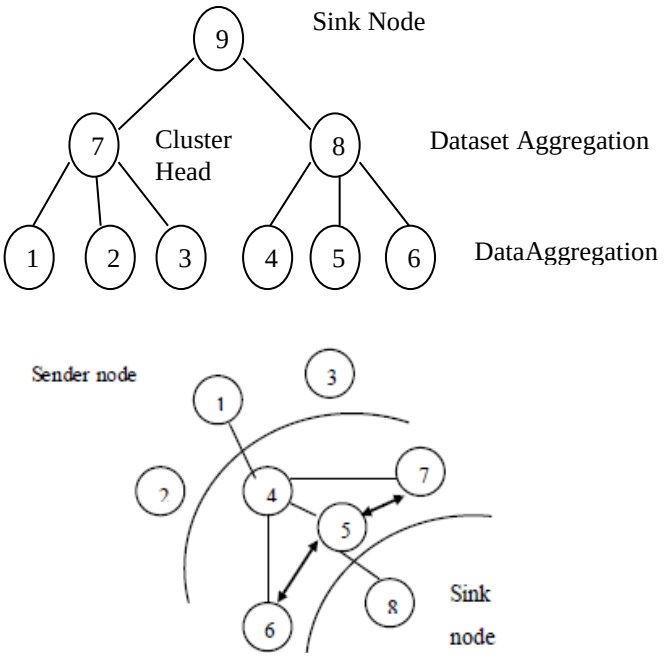

Figure 1: Dataset Aggregation based on clustering

Above figure are shows that path and data propagation using appropriate cluster head and associate member node. Cluster head forward the data packet to appropriate sink node for data processing phase while member node collects the data after some time interval and send it to appropriate cluster head.

RELATED WORK

Some of the researchers proposed a framework of joint wireless energy replenishment and anchor-point based mobile data gathering in WSNs by considering various sources of energy consumption and time-varying nature of energy replenishment. Developed system was first determine the anchor point selection strategy and the sequence to visit the anchor points which then formulate the WerMDG problem into a network utility maximization problem constrained by flow, energy balance, link and battery capacity and the bounded halt time of the mobile collector. After that they designed a distributed algorithm composed of cross-layer data control, scheduling and routing sub algorithms for each sensor node and halt time allocation sub algorithm for the mobile collector at different anchor points. They also provide the convergence analysis of these sub algorithms. Finally, they implemented the WerMDG algorithm in a distributed form and the impact of utility weight, link capacity and recharging rate on network performance was calculated. [8][21]

S. B. Pourpeighambar *et .al*. used the Rate Distortion (RD) theory which is a data aggregation technique related to correlation forms a cluster based communication model which detects object movement and incurred high computation overhead. The result to overcome the high computation overhead, several low overhead protocols are proposed based on this model, namely, a static cluster-based protocol that uses static clustering, a dynamic cluster-based protocol that uses dynamic clustering, and a hybrid protocol which takes advantage of the other two protocols. The results show that with the hybrid method, it is possible to save more than 36% of the nodes' energy when compared to the other approaches. [9]

Prabhudutta Mohanty *et. al.* proposed an energy efficient data aggregation and delivery protocol which aggregates the redundant data at particular time instant with the help of intermediate nodes. In this protocol, waiting time for packets at each intermediate node is calculated very sensibly so that data can be aggregated efficiently in the routing path. The sensed data packets are transmitted judicially to the aggregation point for data aggregation. The ESDAD protocol computes a cost function for structure-free, next-hop node selection and performs near source data aggregation. The buffer of each node is so maintained for different types of flows for fair as well as for efficient data delivery. The transmission rates of the sources and intermediate nodes are adjusted during congestion. The performance of the proposed system is evaluated by making use of simulation software which resulted in better performance in terms of energy efficiency, reliability and on-time delivery ratio when compared to previous systems. [10]

Some of the researchers have worked for scheduling of the link for data aggregation in wireless sensor network so as to reduce energy consumption. The proposed system introduced sleep scheduling algorithm to wake them up sensor nodes whenever necessary otherwise not. In this research work, researchers identify the contiguous link scheduling problem in WSNs and have assigned consecutive time slots so as to fulfill its data collection task. The objective of this project is to reduce time slots for interference-free link scheduling so as to save energy consumption. The proposed system not only solved the contiguous link scheduling problem but also presented efficient centralized and distributed algorithms. [11] [18][22]

Few researchers discovered a novel scheme for compressive data collection in wireless sensor networks using power-law decaying data model which can be verified by the use real data sets. The objective of the proposed system has to make compressive data collection system which can be achieved by a random projection based estimation algorithm for the data model ultimately making the system energy efficient. This

study also focused on achieving the optimal estimation error bound evaluations on real data sets [12], [13],[16].

Kyung-Ah Shim *et. al*. developed a secure data aggregation scheme with the help of cryptographic primitives. The proposed system is based on a practical secure data aggregation scheme, Sen-SDA, based on an additive homomorphic encryption scheme, an identity-based signature scheme and a batch verification technique with an algorithm for filtering injected false data. They also investigated the feasibility of scheme using low-cost, low power microcontrollers with the use of wireless sensor network hardware platforms used in real-life deployments. [14]

Some of the researcher worked on data aggregation and clustering approaches like principal component analysis which helps to reduce energy consumption and increases the scalability. The proposed system reduces transmissions among the sink and one or more data aggregation nodes (DANs) in the network considering without loss of generality a single cluster network and results show that the technique succeeds in satisfying the NMSE requirement and gets close in terms of energy consumption to the best possible solution employing subspace representations. Additionally, the proposed method alleviates the computational load with respect to an eigenvector-based strategy. [15][17]

SYSTEM OVERVIEW

a. System Model

Assume that the WSN made up of sensor nodes N = {*N*1, *N*2, . . . , *Nn* }, (small as well as medium size) deployed in a x and y i.e. two plane dimensional monitored region *A*. each and every sensor node *Ni (i* = 1. . . *n)* has location (*xi* , *yi*). The position of each and every sensor might be define or arbitrary such as G (V, A). In the real condition only sink node is used for gathering the data from other sensor node. Each and every sensor node has an own sensing range for *Sri*, this range suggest that it could be keep an eye on any target node within a radius of *Sri*. Consider the set of all V (S=n+1) represent the sink node and all other static sensor node which may be battery powered sensor nodes (*BPSN*). The network life time of wireless sensor node is described as the time period for which sensing node is away from the battery for first time. To accumulate the energy for the network, consider that the sensor node only resume when different data packet is send if not then it will stop to send the message to cluster head.

b. Network model

Assume that a fixed rechargeable WSN modeled as a Directed graph or undirected graph *G* = (*V*, *A*)., In network model the task of sensor network is to collect the sensing data from the number of nodes to the sink node. Basically the network model manages into the cluster. The sensor node send the data to its cluster head and then cluster head sends data to sink node.

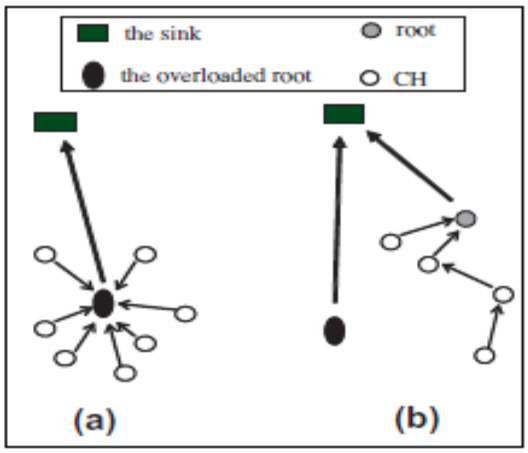

Figure 2: (a) CHs are its children in a straight line (b) the CH is remote from the additional CHs.

The environment parameters such as temperature, pressure and humidity will be sensed by the sensor nodes and its data will be send to cluster head and hence to the sink node. Consider that P = {p1, p2, p3,….pn} is a totally order mustiest of N element collected by all n nodes. Consider that message can contain one data item Pi. The packet size is at order of n (log n+ log k) where k is the constant upper bound value. TDMA scheduling is used so that a time slot duration allows transmission of exactly one packet.

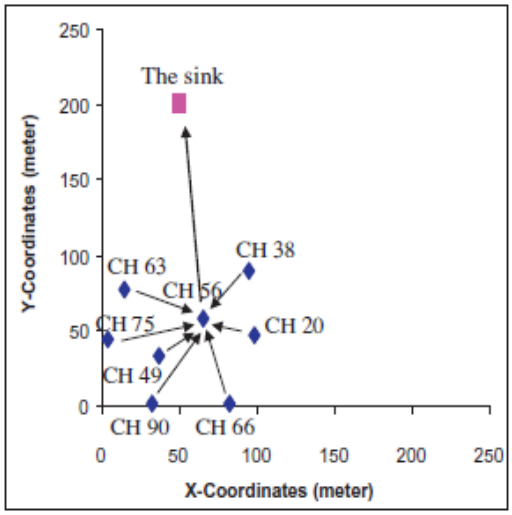

Figure 3: Root overload example

Cluster head send data to the sink node and reduced the load of the root with respect to the energy consumed in the transmission to the sink node. But it should be noted that if the number of roots are increased it not only results in a reduction in lifetime of sensor nodes but also increases the losses slightly.

PROBLEM STATEMENT

Efficient data Aggregation and compression ultimately maximize the network life. The lifetime of network can be defined as the time elapsed until the first sensor node in the network depletes its energy because once a sensor node in the network dies the sensing capacity of the network begins to degrade E as the energy consumption of node i.

The following equation for maximization network lifetime can be express as

$$Max(T) = Min\ Max(Ei) \quad i \leq m$$

The objective of data aggregation is to eliminate redundant data. Redundant data can be eliminated by following equation

$S(M_{i,}M_j)>T_j$

New measurement value Mi
compact the set of Measurement value Mi
For each obtainable measurement value of Mj €Mi do
If Analogous (Mi, Mj) =1 then
Occurrence (Mj) < - occurrence (Mj)+1
Reject Mj
Else add Mi to Mj
occurrence (Mi) <- 1
End if
End for

Following algorithm shows that how to find the nearest neighbor's such a way that energy-efficient node to Communicate with other node

Start finding NEAREST NEIGHBORSET for all (k)
N(k) ←¢ for each and *Every acknowledged signal data packets*
do
P ← Sender of the signal data packet
if p /∈ p(u1) then
Pk→s_1 _ compute the transmission power rate
P _candidate Node ← true
For every m1 ∈ P(u1) and P1_ candidate = true do

If P1 k →m+ P_1 m→s_1 < P_1 k→s_1 then
P_1_candidate node ← false
end if
if P_candidate node = true then
P(u) ← P(u) ∪ {k}
end if
end for
end if
end for
end

In the above algorithm P_1 $k \rightarrow m_1 \rightarrow n_1$ is the total transmit of power used for sending a data packet from node *m* to *n* via node *k* P_1 (*u*) is the nearest neighbor set of node *u* that is energy-efficient to Communicate directly[16]

Algorithm for Cluster head selection using Fuzzy Logic

1. Consider N number of sensor node spread randomly over K*K area where M clusters are assumed
2. N number of sensor node are separated into different stage Stage should be numbered according to the remoteness of base station, Battery Power and distance from centre.
3. Election of the cluster head at stage based on fuzzy model
4. Apply if then else rules to select cluster head
5. One sensor node with higher energy, distance to base station, node density, distance from node, distance from centered to base stationed Probability
6. Base station collect the aggregate data from cluster head

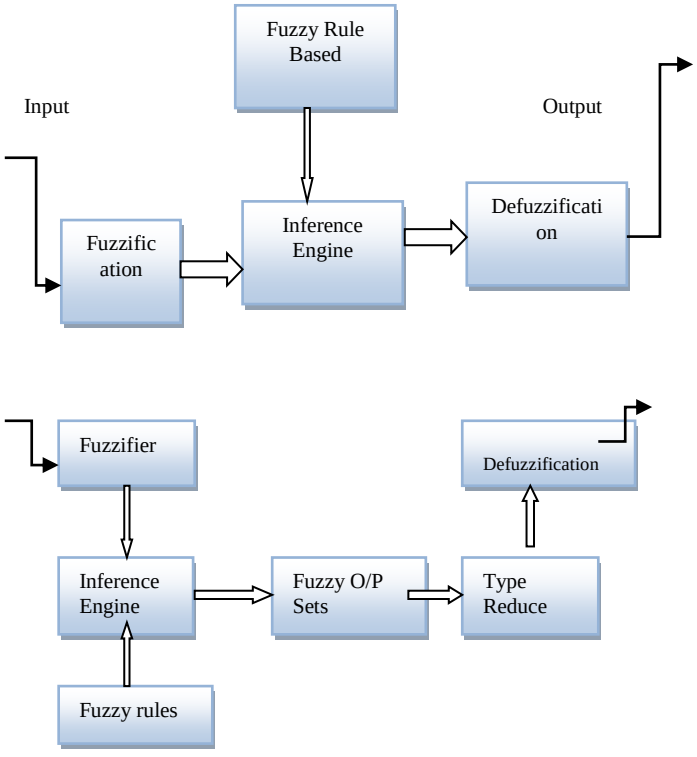

Figure 4: Block Daigram of Fuzzy Inference system

In the above block diagram we use the fuzzy inference system model which is used for selecting the cluster head. Initially we provide the input as a crisp input set then by using the different fuzzy rule for fuzzy fication. After fuzzyfication we convert it into again crisp data set by using defuzzification.

RESULT AND DISCUSSION

This work uses experiment set which includes file for total energy required and Throughput calculation. Delay is calculated by the difference in the arrival time and start time. Following figure shows the delay at particular time and graph for delay in the existing system

Table. a. Simulation parameter

Parameters	Values
Simulator	Matlab R2010a
Number of Nodes	200
Topology	Random
Area Size	100*100
Initial Energy	0.4 J
Routing	Single Hope
Queue Length	205 Packets
Size of Packer	256
Propagation Type	Amplifier

Above table shows the Simulations parameter that have been used for calculate the result in Matlab. To simulate proposed methodology we use the 200 wireless sensor nodes. For the simulation we consider area as 100*100.

Following figures describes the energy required for the simulation of data aggregation system in the existing and proposed system. As shown in the graph the amount of energy is reduces in proposed system which is shown by red line. Total Energy required in the existing system=77.5388J

Total Energy required in the proposed system=62.9010J

Therefore, Saved Energy=14.6378J

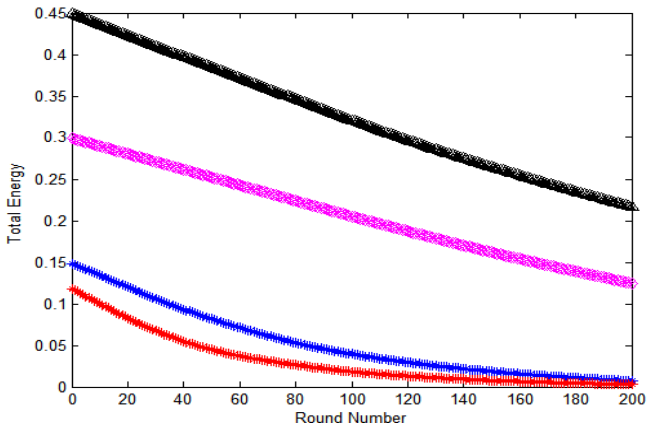

Fig.5..Total Ennergy

Following figure shows the throughput graph in the existing system. Throughput is calculated as the total amount of byte received with respect to the time.

Throughput=Total packet size/time

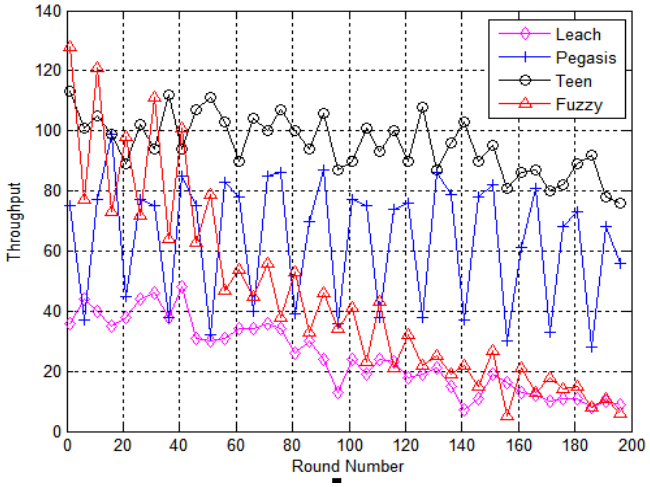

Figure 6: Throughput

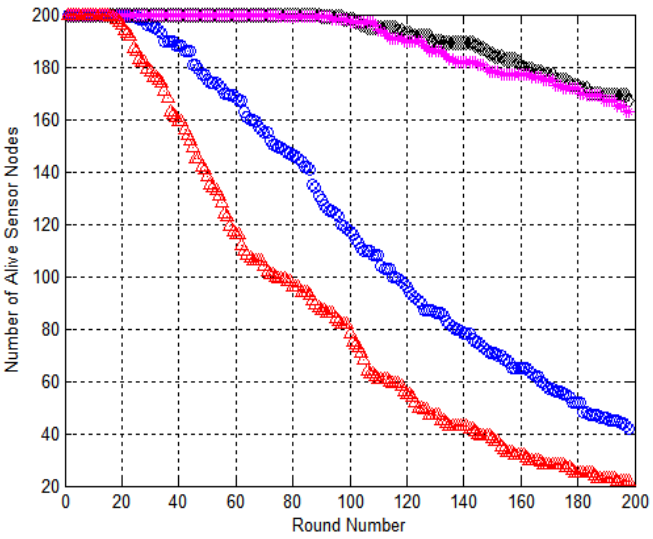

Figure 7: Lifetime of network

CONCLUSIONS

This paper proposed a system for cluster head selection as well as for data aggregation from sink node. Shortest path is found by using Euclidian distance technique. The sensor node to have the high association separated into same group or cluster allowing more precise data aggregation so as to make it energy efficient. The conducted evolutionary experiment highlights the cluster head selection protocol. The proposed algorithm has lower computational overhead and high accuracy for communication. Also the proposed system gives the data aggregation methodology allowing to the cluster head to eliminate the redundant data simulations execute under

special conditions. This methodology also gives design view about the system development in detail and helps them to optimize the result indices prior to deployment. Simulation results shows that cluster head selection out performs conventional sparsification tools when applied into data aggregation through delay, throughput and total energy.

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