World Academy of Science, Engineering and Technology
International Journal of Computer and Information Engineering
Vol:10, No:6, 2016

Tree Based Data Fusion Clustering Routing Algorithm for Illimitable Network Administration in Wireless Sensor Network

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***Abstract*—**In wireless sensor networks, locality and positioning information can be captured using Global Positioning System (GPS). This message can be congregated initially from spot to identify the system. Users can retrieve information of interest from a wireless sensor network (WSN) by injecting queries and gathering results from the mobile sink nodes. Routing is the progression of choosing optimal path in a mobile network. Intermediate node employs permutation of device nodes into teams and generating cluster heads that gather the data from entity cluster's node and encourage the collective data to base station. WSNs are widely used for gathering data. Since sensors are power-constrained devices, it is quite vital for them to reduce the power utilization. A tree-based data fusion clustering routing algorithm (TBDFC) is used to reduce energy consumption in wireless device networks. Here, the nodes in a tree use the cluster formation, whereas the elevation of the tree is decided based on the distance of the member nodes to the cluster-head. Network simulation shows that this scheme improves the power utilization by the nodes, and thus considerably improves the lifetime.

***Keywords*—**WSN, TBDFC, LEACH, PEGASIS, TREEPSI.

I. Introduction

A sensor node of the sensor network comprises of three subsystems specifically the sensor subsystem, which senses the surroundings, the dispensation subsystem which achieves limited calculations on the sensed information, and the broadcast subsystem which is accountable for message substitute with adjacent sensor nodes [2]. While entity sensors have incomplete sensing region, networking a huge amount of sensors gives increase to a forceful, dependable and precise sensor network casing a deeper province [3]. The network is thoughtful because numerous nodes are sensing the similar measures. Additionally, the nodes assist and work together on their information which leads to correct sensing of events in the surroundings [5].

Fuzzy fingerprint technique is used to transfer the data through field sensor that uniquely checks the original data that is based on fuzzy information which is provided by the sender [4]. Sensor nodes are horizontal to network failure. They are used for improved aggregated assortment of information [6].

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II. Related Work

The aggregated information gathered from wireless device networks is usually created by generating numerical information in a very distributed Wireless Device Network base station [7]. Append with existing level, the Open Geospatial Consortium (OGC) is developing any particular server to observe or supervise wireless sensor hybrid wireless networks [8].

In WSNs, information fusion filtering, aggregating, and making inferences concerning the gathered information are the necessary options [9]. Multimodal, spatiotemporal uncertainty aptitudes are required to extend the “regular” uncertainty aptitudes in ancient device networks [10].

WSN applications serve as atmosphere monitors in several applications [11]. Yet these miniatures suffer from strained resources in terms of computation facilities and power supply. Security issues can be rectified using the pairwise key Predistribution process [12].

There are 3 major fractions of a sensor network system: The expansion so as to be supervised, the sensor nodes. By considering the mobility standing of these 3 parts, it can be distinguished into totally different categories of device networks. In static networks, the mobility of sensors, users, and the monitored phenomenon itself is smallest or unnoticed. For example, temperature sensors in a sunroom might collect relevant data and use it to regulate motorized shades so as to take care of the parameters among predetermined limits.

- Sensor level mobility: The sensors themselves might be moving. Examples include sensors mounted on moving cars or flying pilotless aerial vehicles [1].
- In sequence altitude mobility: The incident supervised by the network is mobile.
- User level mobility: Users accessing the information collected by the device network might themselves be moving.
- Space and time are receiving revived stress as process parameters in the information assortment theme. The timely dissemination and processing of collected data becomes a lot of complicated than a network resource improvement drawback, as it has got to take into consideration user and phenomenon quality.

There exists the anticipation of superior points of modeling within the network, so that it will respond in a very timely manner to rising things and reconfiguring itself to satisfy the corresponding demands.

III. Proposed Work

A. Fuzzy Fingerprint Technique

The fuzzy fingerprint technique provides the fuzzy information that enhances data privacy during data-leak detection operations. This paper presents a fuzzy fingerprint feature that provides fuzzy information that typically avoids the comparison and transmission of bulky data. Wasteful energy can take place due to packet collisions and generating/ handling control packets. The system does not allow the bulky data to transfer on WSN. The security of this system is low. The sensor network is modeled by an untrustworthy standard, Manhattan framework, and terminologies for assorted components of the routing transparency are obtained. Results are compared against ns-2 simulations for regular and random topologies, which substantiate the critical individuality of the investigative consequences.

B. Cluster Formation Method

In cluster-based WSN, sensors are categorized in clusters each comprising one sensor encouraged as cluster head. All non-cluster head nodes broadcast their information to their cluster head, which communicates it to the isolated cluster members. Clustering can supply for considerable energy reduction, since only cluster head sensors are concerned in routing and relaying information. Furthermore, clustering assuages latency, facilitates its reclaim, and preserves accordingly to improve network scalability. Moreover, the reality that merely the cluster head is broadcasting data elsewhere of the cluster assists evade crashes among the sensors within the cluster and helps evade the exposed hole difficulty.

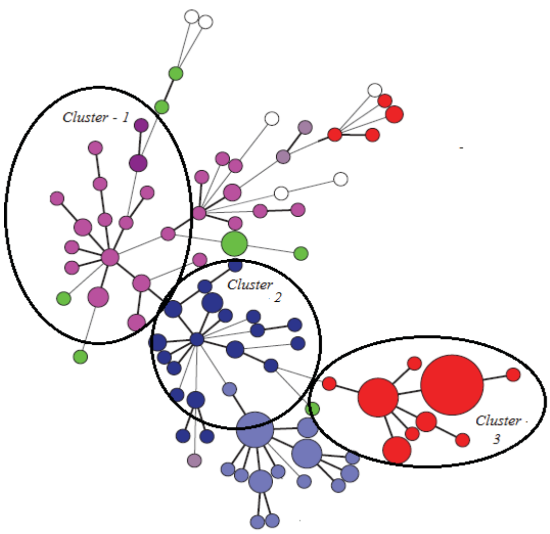

Fig. 1 Cluster Formation

Nevertheless, because cluster heads utilize supplementary power in cumulative and routing information, it is significant to encompass an energy-efficient method for cluster head selection and revolution. In dissimilarity, in centralized networks, cluster heads broadcast summarized information to the cluster members, moreover straight or in multiple. For the sake of reducing power utilization, together most favorable quantity and best possible assignment of cluster heads encompass to be mandatory. This accumulates power because the communications determination only is activated by cluster heads quite than all other sensor nodes. LEACH is absolutely centralized, it utilizes communication between cluster heads and the sink node, which is power consuming and not appropriate to networks organized in huge provinces. Though, this protocol is not most favorable because of the unrestrained coverage redundancy due to the arbitrary feature of power on or power off of sensors.

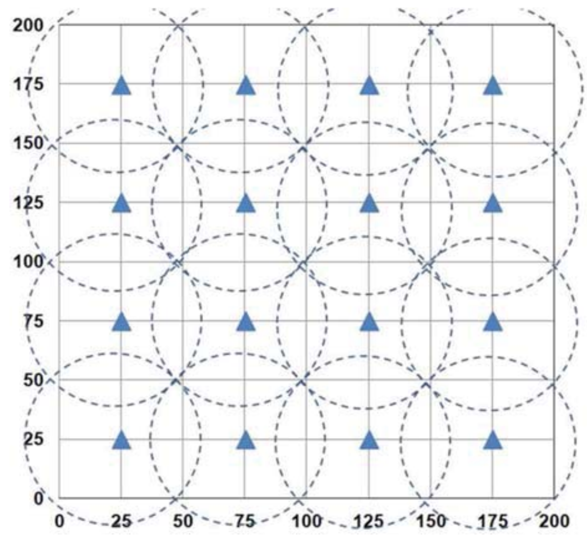

Fig. 2 Ranges of Communication

C. Graph Based Decision Method

Graph based decision is an acyclic directed graph D with the following conditions:

i) It has True and False nodes
ii) Each node is labeled with $\{a_1, a_2, a_3, \ldots, a_n\}$, this value is called selector value.
iii) Each node labeled by a_i has the same amount of outgoing variable edges as $x_i - y_i + 1$ where $[x_i, y_i]$ is the subset of a_i.
iv) If a connector edge node has the selector value a_i and a_j, then $j > i$.

A high edge is a connecting edge with sector value ai and aj with $j > i + 1$. γ is the root node which has the value of γ belongs to D, $var(\gamma) = a_j$, where node γ is labeled by a_j. An edge σ belongs to D, σ = edge $(\gamma, \mu, [[a_i = j]])$ if σ merges the node γ and μ where $a_i = j$.

The most common routing structure with data fusion is a tree. In some applications, special cases such as star (e.g., cluster-based networks) and chain (e.g., bridge or railway monitoring systems) are also practical data fusion structures. We model a fusion routing structure rooted at the sink s as a reverse tree T=(V U {s}, Є), where V denotes the set of sensor nodes in the fusion tree and E is the set of edges representing the communication links between pairs of nodes. Let N be the total number of sensor nodes in the fusion tree.

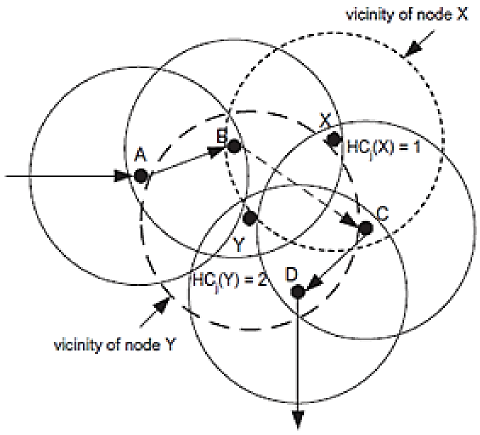

Fig. 3 Node Vicinity

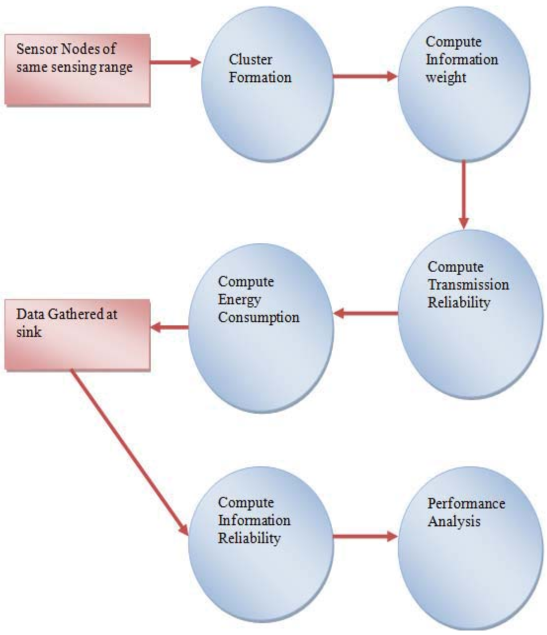

Fig. 4 Data Gathering

For simplicity, nodes in V will be designated by their indices such that V={1, 2, ..., I,..,N}. Each node has the same sensing and communication range. For a node I Є V, the data weight Di denotes the outgoing packet size of the node.

In addition, an edge e Є E is denoted as e = (I, j), where I is the child node and j is the parent node of i. Assuming that all nodes adopt the same transmission power to send packets and the unit transmission cost for each byte is C, the transmission cost (measured in terms of energy consumption) of edge e is equivalent to the transmission cost of its starting node, which is denoted by E_i^{TX}. Obviously, $E_i^{TX} = D_i$ x C.

D. Algorithm

Step 1: At the setup stage, all nodes send energy status and location data to the baccalaureate.

Step 2: The BS calculates the average node energy (E_{ave}) and most energy (E_{max}) from the knowledge that device nodes transmitted.

Step 3: Strong and weak nodes are determined according to the E_{ave}.

Step 4: Compute Node Vicinity using Network connection.

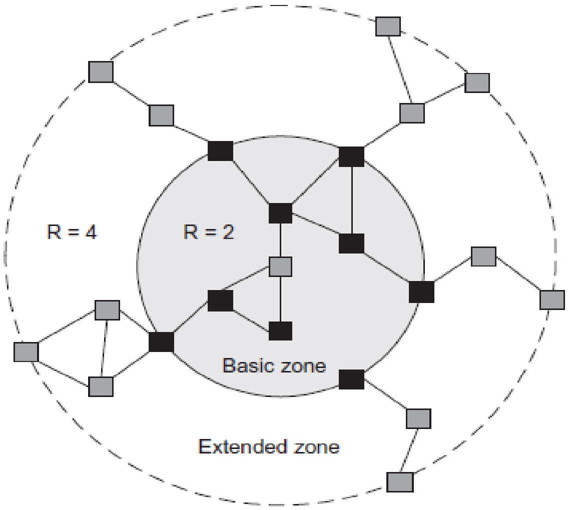

Fig. 5 Node Vicinity

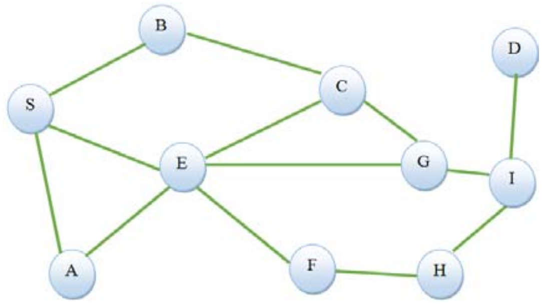

Fig. 6 Route Discovery

E. Route Discovery Procedure

Route Discovery procedure is used to establish a network communication between the groups of mobile nodes in the network.

F. Route Maintenance Procedure

Active Network Route Timeout (ANRT) is used for the source node and the destination node in the network.

$$\text{Request Route Failure RRF}(R_i) = P_s\,[X=1] = p^x q^{n-x} \quad (1)$$

$$Route\ Rediscovery\ Procedure\ (RRP) = \begin{cases} Received, RRF > 0 \\ Retransmit, RRF = 0 \end{cases} \quad (2)$$

$$Total\ Possibility = \sum_1^i \frac{P_s\,[X=1]}{N} \quad (3)$$

$$\text{ANRT} = 1 - \text{RRP} \quad (4)$$

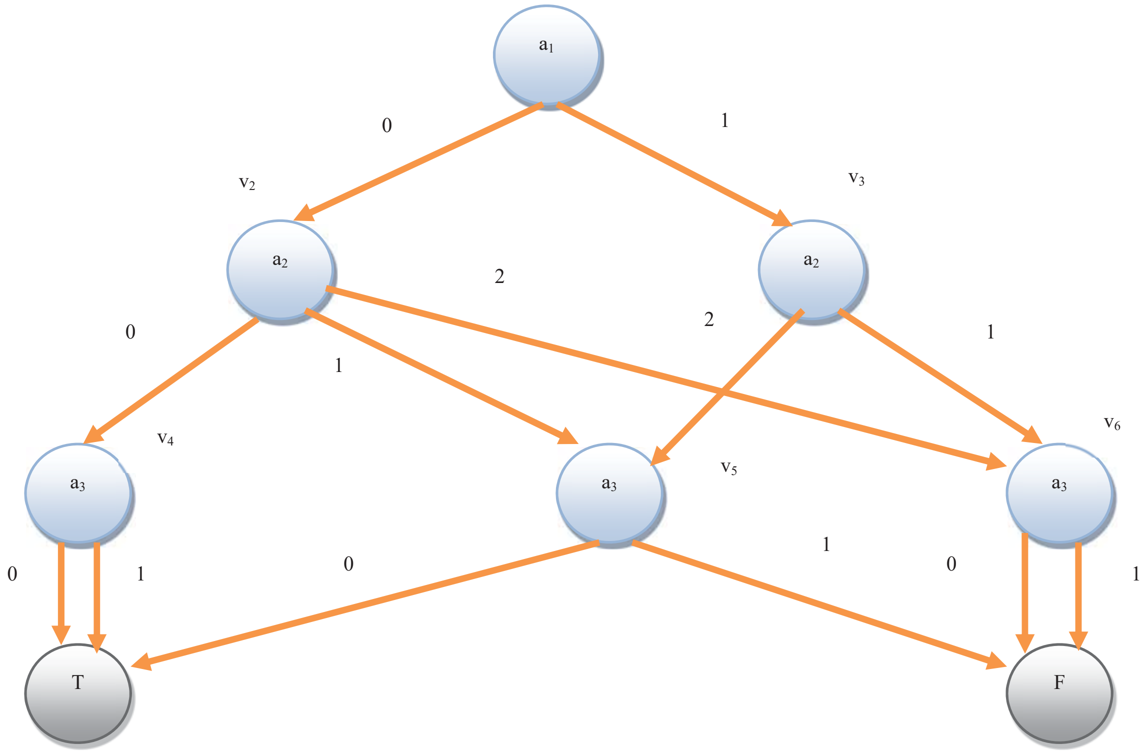

Fig. 7 Graph Based Decision method with Initial Stage

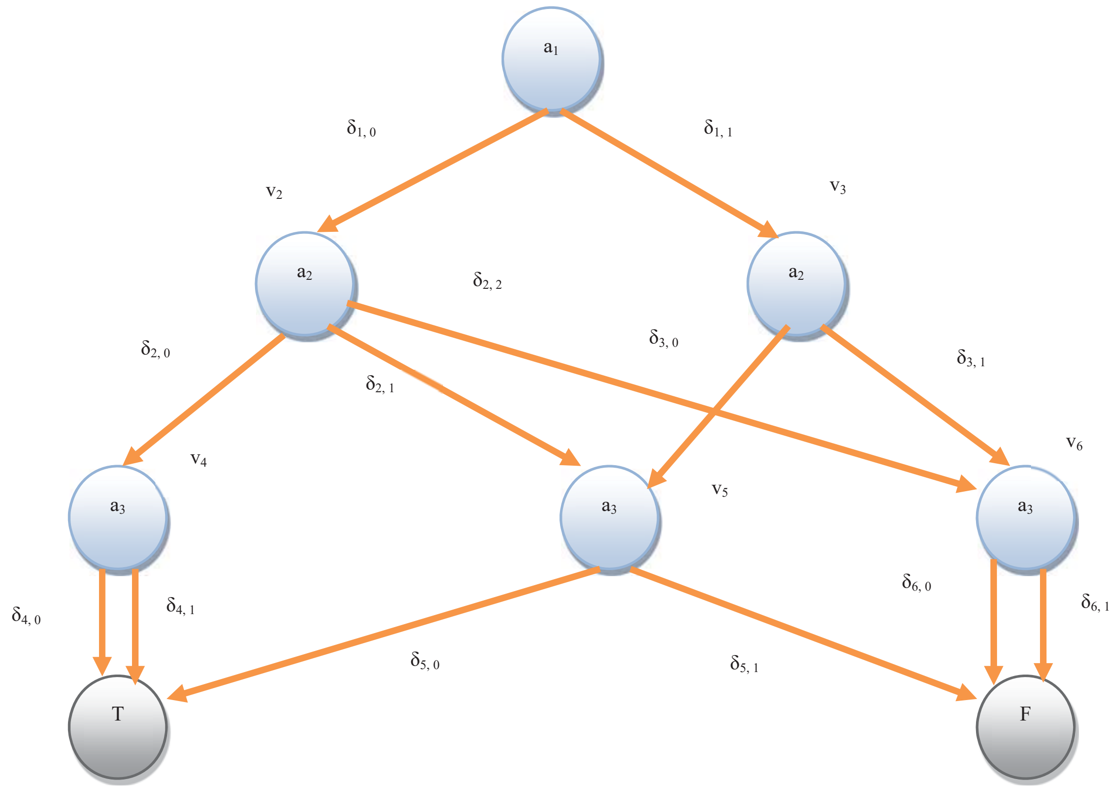

Fig. 8 Graph Based Decision method with Implementation Stage

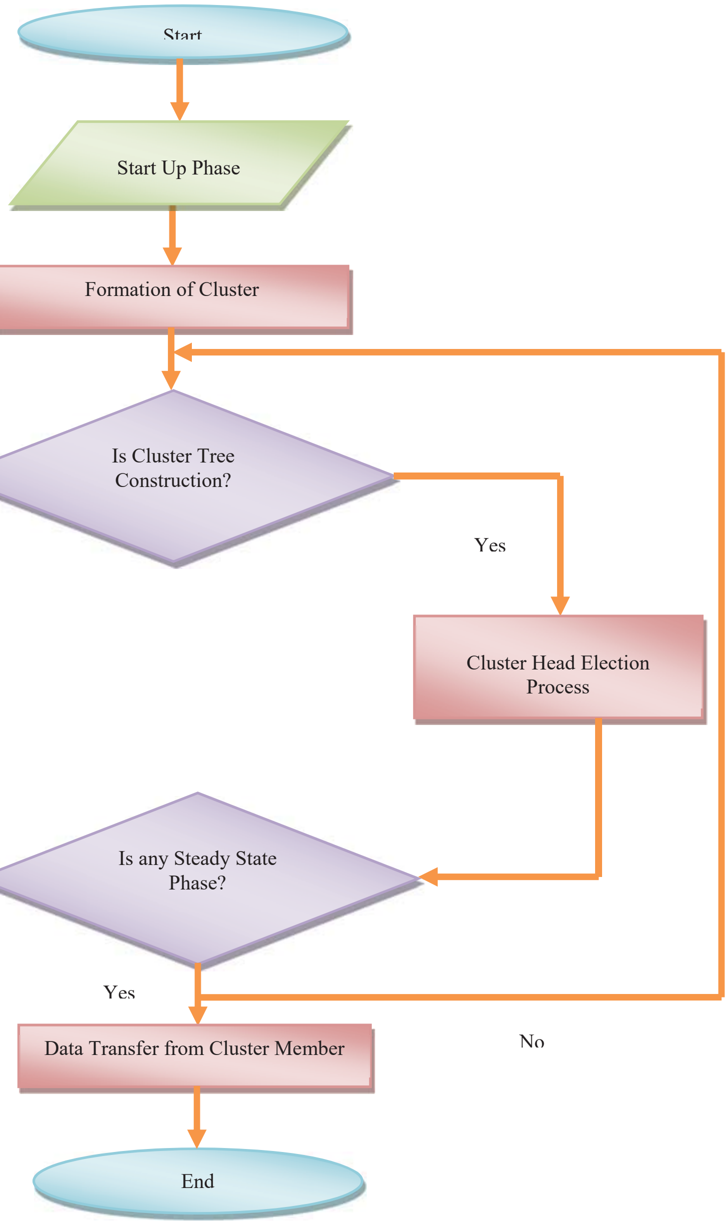

Fig. 9 Flowchart for proposed work

G. TBDFC Algorithm

Input:
    Source Route_Request Packet from the Neighbor node
    Treshold Value T_{max}
Step 1:
    Begin
Step 2:
    Set Caution Declaration Timer (CDT for Power)
Step 3:
    Set Re Transmit Timer (RTT)
Step 4:
    If R is a Route_Request Packet then
    If Route is Active then
        Find the possible Route from the Network Routing Table
        Send the Route_Reply Packet R
    return
  endif
    Goto Step 1
  Endif
Step 5:
    If Route_Request Packet value <= Threshold T_{max}
        Then
            Receive the transmitted packet successfully from the source node in the network
            CDT = 0
Step 6:
    Else If CDT = 1
        Link is breaking
        Node would not transmit the packet
        Receiving Signal
        Send Receiving Message to the Source node
        RTT = 1
    Goto Step 7
Step 7:

Else Find Alternate possible Route from the Network Routing Table
RTT = RTT + 1
Repeat this process until each node reaches to the destination
Update Route_Reply Packet
Update CDT
Update RTT
Goto Step 5
Goto Step 6
Step 8:
End

H. Route Rediscovery Procedure

Procedure:
At every amount of duration step do
Target_Value (source_node, Destination_node)$_i$:= 0
Transmit (source_node, Destination_node) with Target_Value$_i$
Accumulate information from sensor nodes and renew Target_Value$_i$
If any Target_Value is involved in Target_Value$_i$ then
Compute the adjacent Target_Value (source_node, Destination_node)$_i$ in Target_Value$_i$
Move forward in the network
Route_1:
S → E → G → I → D
Route 2:
S → B → C → G → I → D

$$\text{Average Time\_To\_Live} = (M_e - M_p) \quad (5)$$

$$Average\ End\ To\ End\ Delay\ = \frac{(P_{st} - P_{rt})}{P_r} \quad (6)$$

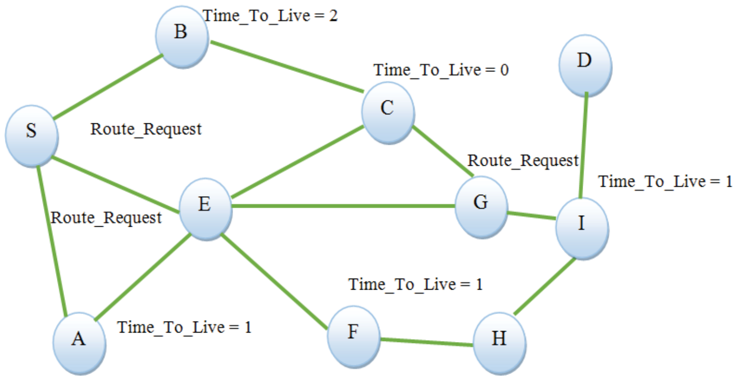

Fig. 10 Route Rediscovery

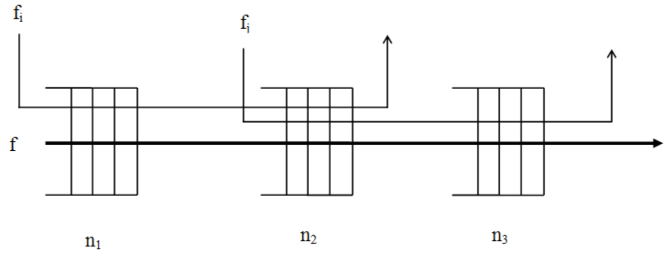

Fig. 11 Network Model for Data Flow

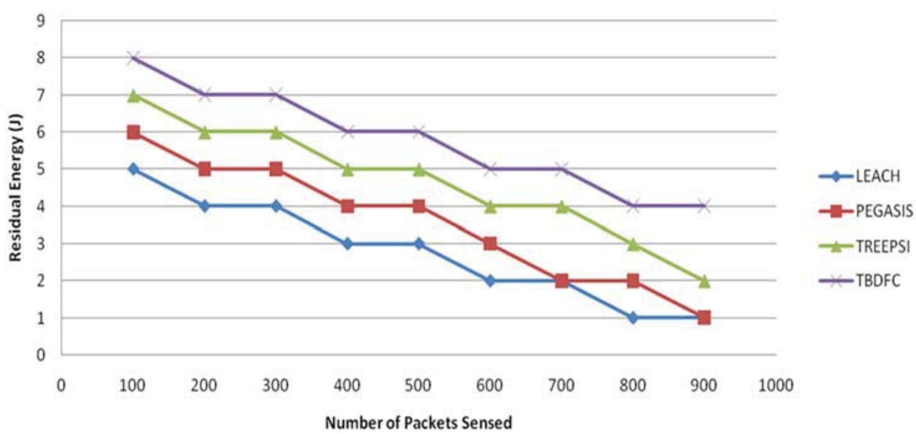

Fig. 12 Residual Energy

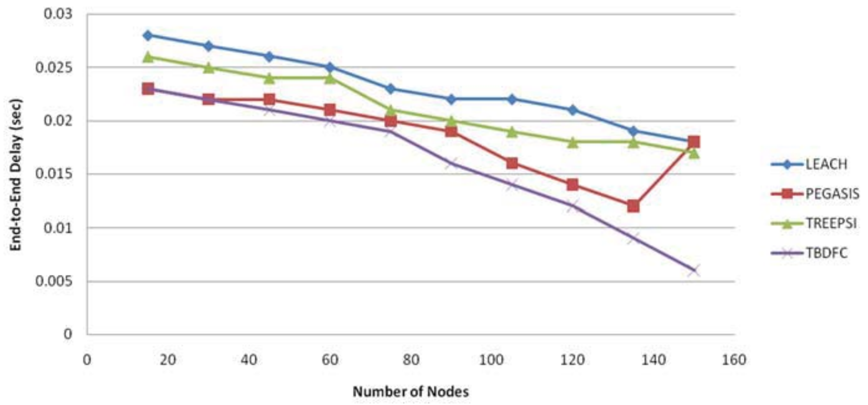

Fig. 13 Average End to End Delay

IV. Performance Evaluation

The **information weight** is computed for all the nodes in the network in order to find out the importance/accuracy of the data packet after fusion. Therefore, the information weight sent out by a fusion node (cluster head) will be defined as the sum of all information weights it received (including its own). The information weight for each node is given as

$$I_p=I_{c1}.R_{c1}+I_{c2}.R_{c2}+\ldots\ldots\ldots.I_{cn}.R_{cn}+I_{p0} \quad (7)$$

where I_i is the information weight of the packet sent by node i. I_{p0} denotes the primitive information weight of raw data sensed by each node. R_i denotes successful transmission probability of packet sent by node I to its parent.

The **transmission reliability** (R_i) is the successful transmission probability of the packet from node i to its parent. This is computed as

$$R_i=1-r^{\,ti} \quad (8)$$

$$iet_i=\log_r(1-R_i) \quad (9)$$

Thus, t_i also denotes the number of transmissions of node i or it denote the number of copies sent out by node i and r denote the packet error rate on the wireless channel.

Energy consumption or the total energy cost of successfully gathering all sensed data in one round is computed as

$$E=E^{TX}+E^{RX}+E^{FS} \quad (10)$$

where E^{TX} is the total transmission energy cost; E^{RX} is the receiving cost. E^{FS} is the data fusion cost.

Information Reliability, R provided by the sensor network is computed as follows. Here, the amount of information weight provided by the network, denoted by I_{total} is the total information weight of the unprocessed information sensed by each and every one sensor nodes in the network. I_{sink} is the information weight definitely received by the sink.

$$R=\frac{I_{sink}}{I_{total}} \quad (11)$$

V. Conclusion & Future work

The proposed work implements a data fusion mechanism which conserves the energy in WSNs. The key idea here is to assign different transmission reliability to the packets owning different information weight and use multiple transmissions without acknowledgement to guarantee the desired transmission reliability. A simple tree data fusion structure explored and the optimal number of transmissions for each structure type is analytically proved.

The approximation solutions for tree structure are proposed by averaging the information weight that could be lost among all nodes. Theoretical proofs and experimental results show that the packages with more information should be delivered with higher reliability. Furthermore, the simulation results guarantee that the desired information reliability is achieved with high energy efficiency.

As future research directions intend to develop a more sophisticated heuristic to improve the network lifetime. Furthermore, we assume that the packet error rate is fixed and the information weight of fused data is simply the sum of all incoming information. In our future works, we will explore an adaptive feedback mechanism which can automatically adjust the number of transmissions along with the variation of node/link errors. We also intend to study the partial fusion model and other schemes to quantify the fused information.

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