Analytical study of Data Dissemination Techniques used in Wireless Sensor Networks

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Abstract: **In wireless sensor network (WSN), various energy efficient data dissemination protocol has been proposed. As energy consume for communication is much higher than other activities like sensing, aggregation etc [1]. So lot of effort has been done to reduce the distance between two devices (single hop to multi hop), size of packet (by data aggregation).It results into less consumption of energy, as energy and bandwidth are among the scare resources in wireless sensor network. Due to sink mobility, new challenge came in field of WSN.As for every sensor node to transfer some information, it needs to keep track the sink location. As the most common method to propagate sink location throughout the sensor field is flooding, but it results in communication overhead, bandwidth consumption and collision [2]. So some other techniques proposed in this domain. Some of them are Grid based , cluster based etc.**

Keywords: wireless sensor network, grid based cluster based, dissemination node, dual radio range. Hierarchical clustering, master sink

I. INTRODUCTION

In WSN, there are tiny, low cost sensor nodes sensing the behavior of one or more event in the network having one or more sink that is static or dynamic in nature. Nodes can be deployed via preplanned fashion in which location of sensor nodes known. This method of deploying the odes is used in very limited situation cannot be used in harsh environment like disaster area, fire detection etc. 2nd method of node deployment is random as it is also applicable in harsh environment but it increase control complexity. If sink is static, initially path is set up by flooding the location of sink ,as WSN have some scare resources like energy , every time same no of nodes participate in communication that results into following issues:

i)Failure of node (due to less energy) results into failure of network.

ii) Amount of traffic is not balanced among nodes

iii) Security can be breached (as same path followed to transfer the information).

if sink is mobile: sink location need to known to sensor nodes in order to transfer the sensed information.

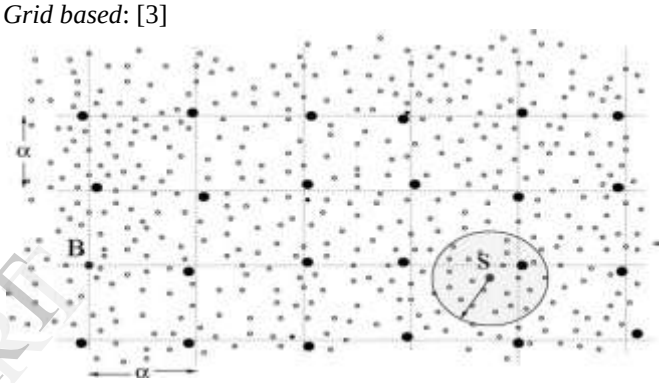
If flooding [2] is used throughout the sensor field for propagating the sink information then it creates following issues:

i) Duplicates packet may keep circulating in the network.

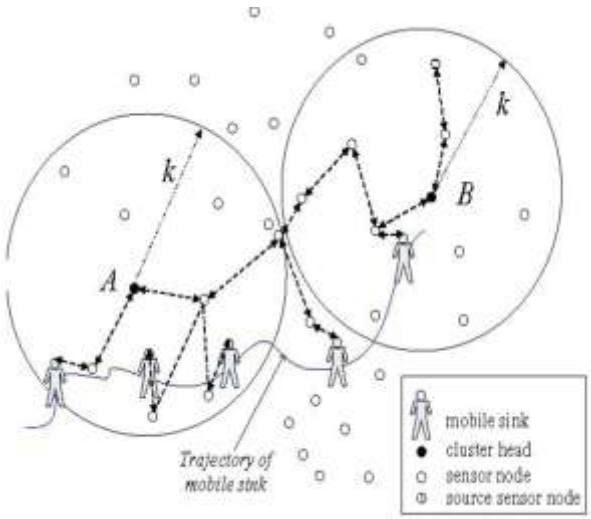
ii.) More energy consumption due to participation of all nodes in flooding mechanism.

There are some techniques proposed in this domain like grid based, cluster based etc

Grid based: [3]



Cluster based:



II. RELATED WORK

There are various routing approaches proposed based on the technique:

A) Grid based [3][4][5][6]

B) Cluster based [7][8][9]

A) Grid based:

Haiyuan luo etc all [3] proposed a technique that constructs a virtual grid to solve the problem of flooding the location

of mobile sink throughout the sensor field that reduces the no of nodes needed for communication. Author have assumed homogenous (all nodes have same capability) sensor nodes, each sensor node aware about its own location either through GPS or other techniques and as stimulus (event) appear, sensor generates the data reports

Methodology:

Grid of square size(alpha) is constructed throughout the sensor field by each source .As source generates the data about some event , it start constructing grid by using as one crossing point itself(as they assume that every sensor knows its location) using greedy geographical forwarding phenomenon. There may or may not be sensor nodes at the calculated crossing point so the nodes nearest to the crossing point is selected as dissemination node(DN).In upstream direction, the location of selected DN is forwarded .Once a grid for specified source is built a sink can flood its queries within local cell to receive the data further. The query will be received by nearest DN on grid which then propagates the query upstream via other DN to the source. Data is forwarded by just reversing the path in data query message. Data and query aggregation is performed at the node level as multiple sensor nodes sense the same event which may introduce the redundancy resulting in increasing packet size.

Comments:

i) No of nodes participating in communication reduced as flooding is limited to local grid only.

ii) Cell size (alpha) is not defined.

iii) Grid is constructed on per source basis, so grid construction overhead.

iv) No reusability of grid.

v) This approach assume that no information about sink location so grid is formed in all sensor network resulting in wastage of resources where sink never roams.

vi)If event is mobile, grid constructed very frequently by multiple sources.

vii) Failure of DN is handled by upstream duplication message (information is replicated to all neighbor of that DN) is not efficient in term of storage.

T. P. Sharma etc all [4] solved some issues of [3] using dual radio concept, they estimate the size of grid using high and low radio range. Per source construction overhead is reduced by constructed the grid when sink appears first time in network and remain valid for large duration. Author have construct a zone ADZ (alternate DN zone) to handle the failure of a DN by using clustering technique (1 hop)at every corner of grid

Methodology:

Grid is constructed in the similar way used in [3] by calculating the four crossing point in which grid size is determined using dual radio range concept.

Grid Size (alpha) = d/square root of2

= (RH – RL)/ square root of2;

Whenever a sink appears in the network it search using sink probe message whether any valid grid present already or not. If no valid grid is present, it means either the sink appear first time in network or grid is destroyed (time out).Failure of DN is handled by ADZ where every cluster member have an indexed list of other member according to residual energy level. When a particular DN fails, a new node is selected as DN having high energy level among the entire cluster member. If an event moves outside the grid, by using the path sharing it handles efficiently the movement of event.

Comments:

i) Cell size is estimated.

ii) reusability of grid by searching the previously constructed grid.

iii) while selecting new DN after failure of new DN, energy levels of nodes is considered.

iv.) Delay is reduced as diagonal path is followed for transmission.

v) Sink and event movement is efficiently handled by utilizing existing grid through local message passing and path sharing.

vi) If residual energy level of node is considered while creating the DN of grid, then it may be more efficient as DN less prone to failure.

vii) For high sink speed, it consumes more energy as cell size is smaller as [3] because sink changes grid more rapidly which further needs to select new IDN or link with old DN.

viii) For making grid, the shape of grid may be some other like pentagon or hexagon besides square, as no. of nodes involved in communication that results into reduction in construction overhead.

Amar Mahmoud etc all [5] proposed a concept

In which author have changed the shape of grid square [3][4] to hexagon that results into Increasing the area of grid (2.6*area of Square grid) and No. of sensor nodes in hexagonal grid are more (2.5*no. of nodes in square grid) that results into reducing the no of nodes participating in transmission causing less drain of energy in sensor nodes.

Methodology:

Grid is constructed in the same way in [3][4] besides the shape of grid is hexagonal. The crossing points are calculated as considering the source as one Lp (crossing point) and calculating its two member Lpcos60 and Lpsin60.In this grid is constructed per source basis to solve the scalability problem (where no of mobile sinks are more).Query and data are aggregated in the same way as in TTDD. Mobility of sink is handled via trajectory forwarding selecting two nodes primary agent and intermediate node. Failure of node (DN) is handled by upstream duplication message (Duplicating the information at 1hop neighbor nodes).

Comment:

i) Area of grid is increases having same value of alpha as compare to [3].

ii) The no. of nodes participating in transmission is reduced, resulting less consumption in energy.

iii) Grid construction overhead and no reusability of grid.

iv) Energy level of nodes is not considered while constructing the grid, so DN nodes prone to failure due to less energy.

v) Failure of a DN is not handled efficiently as its information is replicated to neighbor nodes (resulting extra storage) followed by normal grid construction.
vi) Failure of DN can be handled by making a cluster having DN as a CH and consider the energy level, prolonged network life time and reducing the overhead.

Li Yue etc all **[6]** solve some issues of [3] **[4]** and proposed a technique in which grid is constructed only once basis on the sink (MS) appointed by SODD resulting in reduced grid construction overhead. To respond quickly in emergency areas it works well as delay is reduced in between the node receives the interest and sink receives the data packet. It does not respond to all sinks directly while communicate through the TA (tracing agent) having the PA (primary agent) information of all other 2^{ndry} sink.

Methodology:
SODD appoints a sink (MS) which initiate the grid construction process by selecting a neighbor node as an initial point. Grid construction also includes the location of a node called as TA (tracing agent) .TA stores PA information of all other 2^{ndry} sink. Data forwarding is similar to [3] except data is send to TA, then it is send to respective sink's PA. Every DN needs to store the information of its upstream and downstream DN because grid construction and query forwarding is done in one step while in [3] these 2 steps performed in a sequential way.

Comments:
Grid is constructed only once that result into Energy consumption is reduced. Delay is also reduced as compare to [3], but it consumes some time to construct the grid as it is initiated by the sink.
If grid is constructed before the sink appears in the network, it reduces the time in between the sink send the interest and it receives the data packet. Whenever the first sink appears in network it selects TA and send a query message including TA location .All other sink receives the data via TA. Grid should be reusable as there may be multiple mobile sources which would result in less grid construction overhead.

B.) Cluster based:

Guo-He Ye etc [7] all proposed a technique that use an algorithm to maintain a cluster that does not require GPS or other position device which results in less cost, less drain of energy in sensor. Some nodes are assigned specific task (index agent and gateway agent) to deliver the information in network. Data aggregation is performed at the cluster head as sensor nodes may sense redundant data.

Methodology:
Clustering using max –min d cluster algorithm is performed on all the sensor nodes .As in this ,cluster is made twice so cluster head finalized in first level of clustering participate in next level cluster formation. So two times cluster formation is done. Index and gateway nodes are selected based on the concept of higher connectivity of node to other neighbor cluster.
When sink comes in region, it registers itself to high level CH via low level CH. If Event is moving within range of local CH's: no problem occurs, as the sensing data is stored to the same local low level CH. If event is moving into range of different low level CH's: sensing data are send toward the new low level CH. When old CH found that event has been finished, then it deletes sensing data and inform to its indexing agent.

Comments:
i) The no. of message needed for communication is reduced as inter and intra cluster communication is done via indexing and gateway agents.
ii) Delay is less as cluster formation is done before the sink appears.
iii) Clustering is nested in nature means in 2^{nd} level clustering, the finalized CH of 1^{st} level participates, as sensor nodes are prone to failure, it may cause delay and wastage of resources if topology changes after 1^{st} level clustering.
iv) The algorithm used for clustering use a lot of flooding message which results into drain of sensor energy.
v) Energy may be considered as a parameter while selecting indexing and gateway agent and also in clustering formation.

Ren-Jhong Liu [8]etc all proposed a technique that add energy threshold and hop count in the piggybacked control information that results into less delay and high throughput assuming homogenous network in which sink have unlimited memory and rechargeable battery.

Methodology:
CH are selected on the basis of first declaration win.Initially hop count of sink(s) set to 0 and of all other nodes equal to the total no of nodes in network.Interst is propagated into the sensor field by adding 1 to hopcount of sink.every node compare the hopcount of itself to the received interest and decide weather to update hop count or discard the interest.After formation of cluster, the sensed data send to the sink via clusterhead and border nodes.As it contain the energy parameter in the control information,whenever the residual energy of nodes less than the energy set by sink., a reconstruction message is send to sink and reconstruction of cluster is done by sink.

Comments:
i) Energy parameter is considered while selection of CH its well and good but reconstruction is done by sink,it can be done bycollaboration of the nodes itself reducing the message overhead.
ii) Cluster mechanism is initiated by sink,its good as it coantains the id of sink but but if cluster is constucted before sink appears, it may reduce the delay between the interst is send and data comes to sink.
iii) Reliability factor is not considered.
iv)Shortest path among the nodes are find out, but it introduces overhead due to propogation of interst in entire sensor field.

Taghikhaki etc [9] all consider the reliability as a metrics, in this reliability as well as energy is considered as above mentioned approach do not.
They considered the energy as a parameter while selecting the cluster head (CH) unlike other approaches consider communication range while selection of CH.

Methodology:

Initially the area is divided into clusters using Y coordinate values. Then all nodes send their energy level to the BS, the BS select the node as first CH having highest energy, then find out all the nodes belonging to CH based on EER and DELAY parameter . Repeat this process, selecting the CH and its member until all nodes assigned to one of the cluster. As CH may not able to communicate to other CH, so select some intermediate node by maximizing the transmission range of CH. If this node is in the range of other CH then it's ok otherwise repeat this process to select intermediate node. All the data is aggregated to CH node, delay occurs while last node in CH sends their data to CH. To reduce the delay, omit the transmission link between the two nodes

Comments:

i) No limitation on cluster size.

ii) It considor residual energy as well as reliabilty.

iii) No error mechanism is used for reliability, so no extra overhead.

iv) All the info regarding to cluster construction is send to BS, as in wsn topology of network changes frequently , so it incurs message overhead resulting in energy consumption.

v) As link relebility and cluster maintainsce can be handled by the cluster head and cluster member itself locally such that energy consumption reduced and delay is also reduced.

III. CONCLUSION

In WSN, sink mobilty brings a new challenge. As for data dissemination, sensor nodes needs to keep track the location of sink.The simplest method to propagate the sink location throughout the network is flodding but it results into communication overhead , collison and bandwidth problem. So various other schemes proposed like grid based ,cluster based. Grid based limits the flodding to local area(grid) only . In cluster based communication is done in intercluster(in between cluster head and its member) and intra cluster(in between two clusterheads via sone intermediate node like gateway node) manner to reduce the communication overhead.

As a lot of efforts have been done by authors to overcome the issues of sink mobility, energy consumption and bandwidth problem, there are still some issues that needs to consider like to efficiently track the location of a mobile sink that incurs less communication overhead and minimum response time(time between the interst is send and data comes to sink). Reliability and security should also be consider a main parameter in emergency areas and critical regions like military with enegy parameter.

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