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A New Approach for Energy Efficient Routing and Aggregation in Wireless Sensor Network

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ABSTRACT: Wireless sensor network (WSN) is one of the most popular and hot research topic for the researchers where sensed data is transferred to sink node wirelessly. Routing is one of the major issue in wireless sensor network as nodes are operated by battery power and when a node sense some information then that sensed information is routed to sink node, but this process consumes lots of battery power, hence lifetime of the network reduces gradually. In order to improve the lifetime of the network, the node's energy should be preserved and routing should be effective one. In this project a new approach for energy efficient routing and aggregation in WSN is proposed to prolong the network lifetime. In this, a new routing methodology is proposed which is a combination of cluster based and ant based routing. To reduce the redundancy in the data one of the popular aggregation technique is adopted. Multiple agents are being introduced in this so that energy consumption should be less with enhanced network lifetime. The results shows that proposed work consumes less energy with improved efficiency and less delay.

Keywords: Routing, Aggregation, Energy, Network Lifetime, Cluster, Mobile Agents.

I. INTRODUCTION

Wireless sensor networks are used for monitoring environmental conditions including temperature, pressure, sound etc. in recent year wireless sensor networks are most widely used in military applications. Wireless sensor network consists of set of sensor nodes [1-2]. The lifetime of these nodes depends on battery capacity and energy efficiency. The sensor nodes are used for transmitting and receiving the data from one node to other node. Sensor nodes perform several functions therefore these nodes are known as multifunctional. Sensor nodes are small in size, low cost and low power. Sensor nodes are capable of communicating wirelessly with each other in short distance. In wireless sensor network energy efficiency is critical to increase their lifetime therefore in order to achieve good performance Ant colony optimization is used. Microcontroller, transceiver, external memory, ADC and power source are the components of sensor nodes. Microcontroller is used for controlling functionality of other components in the sensor node [3]. Microcontroller is low cost and low power consumption. Trans-receiver combines the functions of both transmitter and receiver into single device. Sensor nodes use power supply for sensing, communicating and processing data. WSN makes it possible to run main supply to sensor node. ADC is used for digitizing analog signal produced by the sensor [9-10].

Routing is the process of forwarding sensed data to sink node from sink node to destination. Routing protocol supports energy reduction across network. There are mainly three types of routing hierarchical routing, flat based routing and location based routing [4-8] [11-15].

Data aggregation main goal is to collect and aggregate data in efficient energy. Lifetime of the network is increased with the help of aggregation techniques. Aggregation can be used to aggregate information collected by different sources. It will reduce number of transmission and energy consumption and thus increases lifetime of network [9].

Agent is software that can hold out a specific task in a self-sufficient way. There are mainly two types of agent's static agents and mobile agents. Static agents are stationary used for sensing, updating information and for finding path and mobile agents are used for collecting information until it finds destination.

Software agents: Agent is a software that achieves tasks in autonomous way and it acts upon the environment to achieve its goals. Agents are the intelligent entities that are able to respond to the user needs and releave the user from being the controller of the system. The agents perform the following important tasks: (1) It eliminates data redundancy among the sensor nodes (2) It adapts aggregation methodology to avoid spatial redundancy among closely located sensor nodes. (3) Agent will reduce communication overhead by concatenating data at the combined task level. Agents are classified into two types' static agents and mobile agents. Static agents are used for calculating the path between the nodes and mobile agents are used for collecting the data from different nodes and aggregating them. Agent-based approaches have been a source of technologies to a number of research areas, both theoretical and applied [16]. In order to interact and cooperate with other agents that have possibly contradictory aims agents are deployed in the environment. Such environments are called as multi-agent systems.

Mandatory and orthogonal are the special properties of the agents [16]. The orthogonal properties offer strong idea of the agents. The mandatory properties are as follows: autonomy, decision-making, temporal continuity, goal oriented. The orthogonal properties are as follows: mobility, collaborative, learning.

The paper is organized as follows, section 1 provides the proposed work, section 3 describes simulation and results and finally section 4 concludes the paper.

II. PROPOSED WORK

We have considered some of the major problems in wireless sensor network and based on the problems we are proposing the proposed work. The proposed work highlights the system we have considered for energy efficient routing and aggregation which enhances the overall network lifetime. In this section we present System Environment, Agent interaction, and Algorithms of the proposed work.

A. System Environment

The following figure 1 shows the system environment of the proposed work. The system environment consist of sensor nodes, Head Node, Sink Node and Controller / User. The proposed work is divided into two scenarios that is, event driven and user driven. Whenever there is an event in the node deployed area then corresponding nodes will sense the event information and sensed information will be sent to the Head Node using ant based routing and Head Node will send the information to Sink Node and later Sink Node will send the information to controller / user. This process is called Event Driven. In some cases, user will request for an information and send the query to Sink Node, Sink Node will ask for the Head Node and Head Node intern asks the nodes which comes under its cluster. Once the information is collected and aggregated, the information is sent to Sink Node and Sink Node intern will send the information to controller / user. This process is called User Driven. In some critical situations nodes will not wait for the request for Head Node or Sink Node or it will not use the defined path to send the information. Such scenario is called Emergency driven. During emergency driven no defined protocols are used.

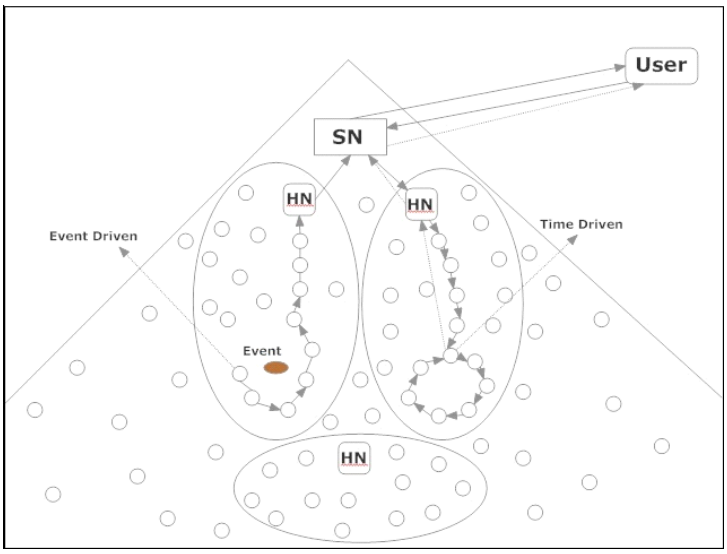


Fig. 1. System Environment.

B. Agents and their Interactions

Agents playing an important role in this proposed work. Agent will reduce the amount of energy required for the transmission of data from node to sink mode. Agents work independently and changes according to the situation. Agent are intelligent and act upon the environment and achieves its goals within the mean time.

In our proposed work we are proposing one more new mobile agent which not only finds the energy efficient path, it also aggregates the data and reduces the amount of data to be transferred to sink node hence improving the network lifetime. The proposed agent is Ant Aggregator Agent (AAA) which is a mobile agent and more intelligent than the conventional agents.

Sink node Agency. Sink node agency comprises of Sink Manager Agent, Sink Database, Clusters and Ant aggregator agents as shown in figure 2.

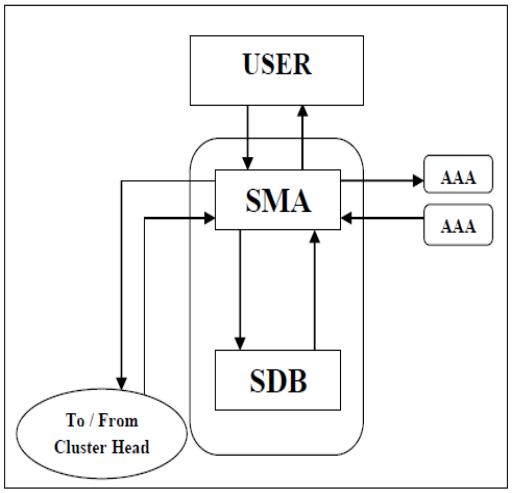


Fig. 2. Sink Agency.

Sink Manager Agent: Sink manager agent is a static agent which will control all the activity in the sink node. SMA will continuously monitor the data/query coming from user or cluster heads. In case of event driven if any data (event related information) coming from cluster, then that information is updated into the database that is Sink Data Base (SDB). In case of user driven, there is a request from the user side and after receiving the request SMA immediately calls AAA agent and informs AAA about the location where the data is going to be collected. Now AAA will go to defined area using ant based routing and collects the information and returns to SN then dies. For monitoring and controlling of all the activity in the SN, SMA a very important role which also reduces the redundancy in the information.

Sink Data Base: Sink Data Base is also called as Sink Black Board which is a database of the Sink Node (SN). SBB has all the information regarding its nodes available in its range. SBB also gas the cluster and cluster head information and it also give the information regarding which type of running presently. It has information regarding node's position, node's status, cluster head, area selected for processing, status of the sensed data. SDB usually updated by SMA.

Node Agency: Node agency comprises of Node Manager Agent, Node Database and Ant aggregator agent as shown in figure 3.

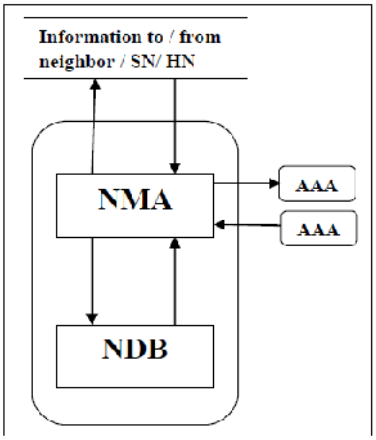


Fig. 3. Node Agency.

Node Manager Agent: Node Manager Agent is a static agent and which is present in all the sensor nodes [17]. It controls all the activity in the node. NMA will decide when to go into sleep mode and when to wake up. NMA only decides whether the sensed data is same as previously sensed data or not. During event driven NMA will generate AAA agent and AAA will migrate to all the event sensed nodes and collects the information and updates the database. Later using ant based routing the information is routed to HN and from HN to SN. In case of User Driven the NMA waits for the request coming from the SN/HN. When AAA arrives to the node the NMA checks for the latest sensed information from SDB and allow AAA to update the information into its database. NMA always updates NDB which is a database. **Node Data Base:** Node Database is node black board which is a database for general sensor node. NDB comprises of position of its own, signal strength, battery status, neighbor info, last sensed info with time, status and it's ID. NDB usually updated by NMA which is static agent. The below table shows the node data base [17].

Table 1: Sink Data Base.

Node id	Location	Power left	Last sensed data with time	Present sensed data with time	Signal Strength	Status	Neighbour information			
							Node id	Location	Power	Status
45	(12,49)	70%	43 degree 12.34pm	40 degree 5.10pm	73%	Active	23	(08,43)	79%	Active
							39	(14,56)	83%	Active
							22	(17,50)	12%	Nonactive

Ant Aggregator Agent: Ant Aggregator Agent (AAA) is a mobile agent which has more intelligence than any conventional mobile agents. This type of agents can be generated by Sink Node (SN) or normal nodes. Based on the type of driven AAA either generated by SN or normal nodes. When there is a request from user side then sink node will generate the AAA. AAA will migrate to defined area and collects the updated information from the sensor node. AAA will select the path from SN to defined area using ant based routing methodology and clustering approach. AAA will also aggregate the information and make it into only one packet which provides sufficient information regarding the environment. In the other case when there is an event in the sensor field then one of the event sensed node will generate AAA agent and AAA will migrate to all event sensed nodes later it will opt energy efficient path (ant based routing approach) from source point to SN and send the aggregated data to SN and later data can be used by the user for further actions. AAA has its own database where it stores all the information regarding the sensed data as well as source node info and destination node info with their position, battery status, signal strength level and bandwidth info.

Agent Interaction: Agent interaction is mainly divided into two steps Event driven, User driven. Agent interactions are as shown below figure 4.

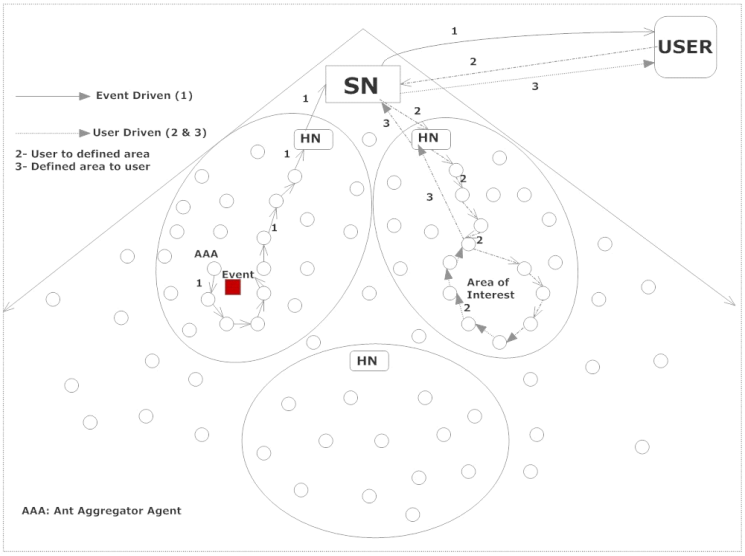


Fig. 4. Agent Interaction.

Algorithms. Nomenclature: CH / HN = Cluster Head / Head Node, C=cluster, a=area, MA=mobile agent, ETA=event triggered agent, SN=sink node, RE=residual energy, D=distance, EON=event occurred node, ARA= Ant routing agent.

Event driven

- Create a network with area A=200*200.
- Deploy number of nodes in the network=N nodes.
- Create 'C' with definite size.
- Selection of CH.
  - a) Check the RE
  - b) Check 'D' between selected node and SN

5) Assume 'r' nodes will sense the event.
6) MA is generated by any one node from 'r' nodes.
7) MA will migrate EON and collect information.
8) ETA will aggregate sensed information from all sensed nodes.
9) ETA will find best optioned path using Ant based routing.
10) ETA will send all the information to SN and dies.
11) SN will send information to controller.

User driven

- Select the area like a=200*200.
- Create 'C' with definite size.
- User will send query to SN.
- SN accepts the query and generates MA.
- MA from SN goes to respective 'C' and reaches CH.
- From CH ARA will find the efficient routing using Ant based routing.
- Now agent migrates from one node to another in the mentioned area and gathers updated information.
- Now aggregation of information is done.
- Agent uses same path and returns to CH and from CH data sent to SN and agent dies.
- Now SN will send the information to user.

Cluster head selection

1) Select the area for node deployment and formation of network
2) Deploy the nodes randomly
3) Form the cluster where more numbers of nodes can be covered
4) Select the node

If the selected node's residual energy > Threshold energy &&
Distance between node and sink node is less
Then Select node as Head/Cluster Node
Else
Select the other node && perform above operation once again.
End

III. SIMULATION and RESULTS

The software Turbo C is used to implement the proposed work with the consideration of area AXB square meters. All the nodes are static and are randomly deployed in the network. Sink node (SN) is fixed at the corner, all the sensed information in the network is given to the sink node. Wireless sensor network have communication radius 'r' meters and bandwidth BW kbps. Network is divided into clusters and cluster head is selected depending on its residual energy or node which is nearest to the sink node. Sensor network consists of very low Battery energy which is in terms of few joules. Packet transmission takes more energy than reception. The SN which is placed at the corner of the network has unlimited energy. For transmitting and receiving the packet in the network fixed amount of energy is spent in our approach. For sensing 10nano joules of energy is used. Transmission of packets needs 15micro joules of energy, reception of packets needs 10 micro joules of energy. For one attempt of transmission energy consumption is T=Energy*distance2 for the cluster formation energy needed is 25nj. For aggregation process each node requires 25nj of energy. The performance parameter considered in this proposed scheme are Energy, Delay, Network lifetime, Bandwidth Requirement, Data aggregation.

1. Energy: Each node requires some energy for receiving/transmitting, computation, cluster formation, cluster head selection and for aggregation process.

2. Delay: Time to transmit data to CH and from CH to SN. Time also consumes for creation of cluster.

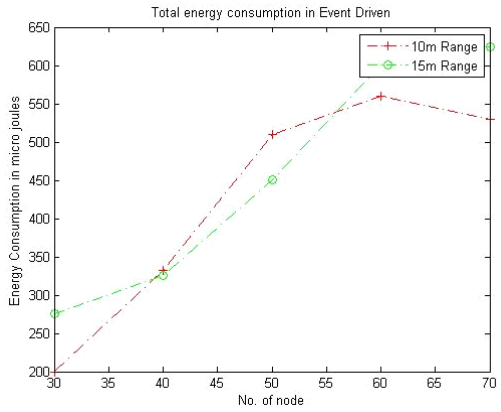
3. Network lifetime: This metric gives the time of the first node running out of its energy.

4. Bandwidth Requirement: It is the amount of bandwidth required to transmit the image to sink node, i.e., it is a ratio of image size to available bandwidth. It is given by

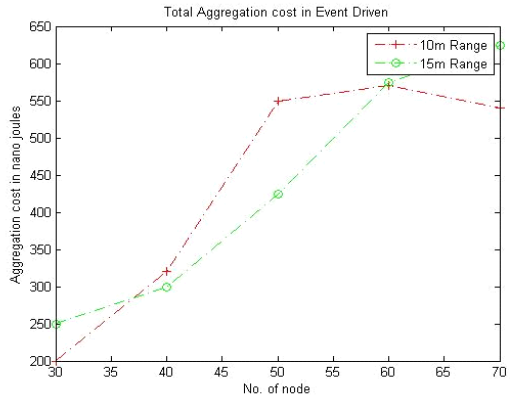
BW required = Size of the data \ Available Bandwidth

5. Data aggregation: instead of sending raw of data to the SN which consumes lot of energy, nodes compute data aggregation method in it to reduce redundancy in the data. For example if more than one has same information means only one node's data is considered and transferred to the SN discarding other two nodes data.

The below shown graph will show how the energy varies with respect to the number of nodes.

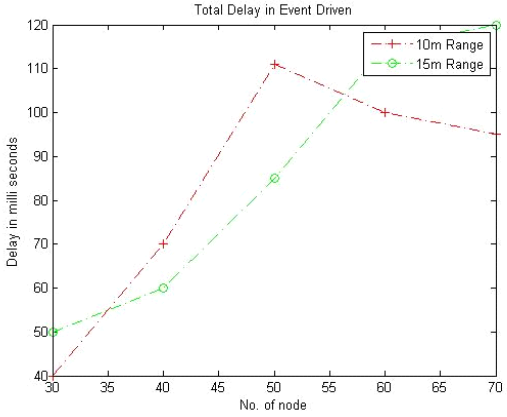


Energy consumption is the important parameter in the WSN network. Node have less energy as they are operated by battery power hence preserving the battery energy is the important concept. In this graph the nodes are considered in the x-axis and energy consumption is considered in the y-axis. Here in this case energy consumption is calculated for both event driven and user driven. The results shows that, as the communication range and number of nodes increases the energy consumption increase.



Aggregation cost is also one of the problem in WSN environment. If data is directly transferred to SN then huge amount of energy is wasted and the node within a short period of time will go out of battery energy. Hence to improve the lifetime of the network, aggregation approach is adapted. The results shows that, the aggregation cost increase as the number of active nodes increases and aggregation cost also increase if communication range increase as more number of nodes are covered if more communication range is considered. Delay defines the time requirement in sending the information from source point to destination point. As the number of active nodes increase the delay also increases.

As the communication range increase the number of active nodes increases and likewise the delay factor also increase.



IV. CONCLUSION

Routing and aggregation are the major issues in wireless sensor network. In order to improve the network lifetime of the sensor network we must concentrate on its transmission and reception energy. The proposed routing protocol along with agent technology will reduce the usability of the node's battery power and it also avoids the transmission of unwanted data to sink node i.e removal of redundant data. The results shows that, the proposed work holds +well in all environment, i.e Event driven and User driven. The combinational routing approaches i.e cluster based and ant based routing have given a remarkable results with improved network lifetime. Agents also played an important role in reducing energy consumption. It acted upon the environment and hence improved in achieving less delay with less aggregation cost. The results also shows that, as the number of active nodes increase the overall requirement of energy become high with increase in delay but it is still less than compare to conventional routing techniques.

REFERENCES

[1]. Jamal N. Al-Karaki Ahmed E. Kamal. "Routing Techniques in Wireless Sensor Networks: A Survey", *Wireless Communications, IEEE*, 2004 pp: 1-37.

[2]. Ritesh Madan, Shuguang Cui, Andrea J. Goldsmith "Modeling and Optimization of Transmission Schemes in Energy-Constrained Wireless Sensor Networks", *Trasn. IEEE*, Vol. 15, NO. 6, December 2007.

[3]. Zhengmao Ye, Habib Mohamadian "Adaptive Clustering Based Dynamic Routing of Wireless Sensor Networks via Generalized Ant Colony Optimization", *International Conference on Future Information Engineering*, LA 70813, USA, pp: 2-10, 2014.

[4]. Debnath Bhattacharyya, Tai-hoon Kim, and Subhajit Pal, "A Comparative Study of Wireless Sensor Networks and Their Routing Protocols", *Sensors journals*, pp: 10506-10523, 2010.
[5]. Ashish Rajshekbar Chalak, Sudip Misra, Mohammad S. O,baida, "A cluster-head selection algorithm for wireless sensor networks", *IEEE ,ICECS 2010.*
[6]. Chao Jing, Tianlong Gu, Liang Chang, "ESCAL: An Energy-Saving Clustering Algorithm Based on LEACH", *Trans. IEEE*, China, 2008.
[7]. Shirshu Varma, Neelam Nigam, U.S.Tiwary, "Base Station Initiated Dynamic Routing Protocol for Heterogeneous Wireless Sensor Network using Clustering", *IEEE Trans,* Allahabad, India, 2008.
[8]. R. Saravanakumar, S. G. Susila, J. Raja "An Energy Efficient Cluster Based node scheduling Protocol for Wireless sensor networks", *IEEE Trans.* Tamilnadu, India, 2010.
[9]. Nandini. S. Patil, Prof. P. R. Patil, "Data Aggregation in Wireless Sensor Network", *IEEE International Conference on Computational Intelligence and Computing Research,* pp: 1-6*,* 2010.
[10]. Kuang-Chiung, Chih-Hung Huang,and Kuang-Chiung Chang, "A Minimum Hop Routing Protocol for Home Security Systems Using Wireless Sensor Networks", *IEEE Trans*, Vol. 53, No. 4, NOVEMBER 2007.
[11]. Jin Wang, Zhongqi Zhang, Feng Xia, Weiwei Yuan and Sungyoung, "An Energy Efficient Stable Election-Based Routing Algorithm for Wireless Sensor Networks", *Sensors journals*, pp:14301-20, 2013.
[12]. Haibo Zhang and Hong Shen, "Energy-Efficient Beaconless Geographic Routing in Wireless Sensor Networks", *IEEE transactions on parallel and distributed systems*, Vol. 21, No. 6, pp: 881-896, June 2010.
[13]. Eunil Park, and Kwangsu Cho, "Energy Efficient and Reliable Geographic Routing in Wireless Sensor Networks", *World Academy of Science, Engineering and Technology*, pp: 631-636 2010.
[14]. Karthikeyan Vaidyanathan, Sayantan Sur, Sundeep Narravula, Prasun Sinha. "Data Aggregation Techniques in Sensor Networks", *Technical Report* OSU-CISRC-11/04-TR60.
[15]. W. Heinzelman, J. Kulik, and H. Balakrishnan, "Adaptive protocols for information dissemination in wireless sensor networks," *In Proc. Fifth Annual ACM/IEEE International Conference on Mobile Computing and Networking (MobiCom)*, 1999.
[16]. A.V. Sutagundar, S. S. Manvi "Agent Based Approach to Information Fusion in Wireless Sensor Networks" *IEEE Trans* pp.1-7, 2008.
[17]. Prashant Sangulagi, A. V. Sutagundar. S. S. Manvi, "Agent based information aggregation and routing in WSN". *Springer-verlog CNC 2011*, Bangalore, 2011, pp: 1-3.