An Optimized Energy Efficient Routing Algorithm For Wireless Sensor Network

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Asbstrac-: **Wireless sensor network consists of thousands of individual nodes which collectively work as per application of the network. Each node made up of various parts which individually having a big research area. One of the upcoming research area of it is its power consumption which in turn depends on energy wastage of nodes. So various steps are to be taken to overcome this problem of energy wastage, one of them would be the proper designing of routing algorithm that considers the factor that enhances energy wastage. In this paper firstly outline of WSN is being discussed which includes MAC and routing protocols of WSN , then an optimised routing protocol is proposed and its analysis is done by MATLAB simulation tool. Finally paper is concluded and its future scope is being discussed.**

Keywords- MAC protocols, Routing protocols, S-MAC, Leach, SPIN, Directed diffusion, QoS based routing protocol etc.

I. INTRODUCTION

The concept of wireless sensor networks *[1, 2]* is based on a simple equation: Sensing + CPU + Radio = Thousands of potential applications. Wireless sensor networks *[3]* consist of multiple sensor nodes exchanging data per wireless connection. Each sensor node can collect process and transfer local environmental information. This opens a wide range of applications, not only in the military field, but also in environment and habitat monitoring, healthcare systems, home automation, traffic control, and early disaster detections. The major factor that influences the sensor network design is lifetime of node which can be enhanced by making an energy efficient routing algorithm. Section 2 gives the idea about MAC protocols and routing protocols in wireless sensor network and gives overview of various existing protocols. In Section 3 a new routing algorithm is being proposed which considers the factors that leads to energy wastage and also the algorithm is optimized in sense of distance travelled. Then analysis of proposed algorithm is done on MATLAB simulation tool. And last section includes conclusion and future aspects.

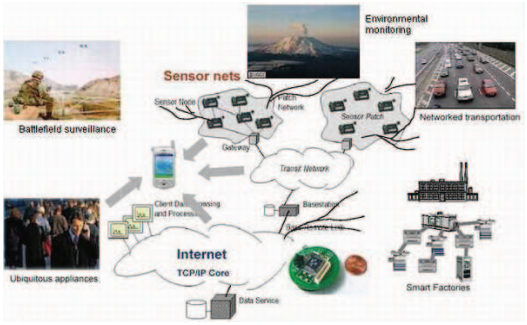

Figure1 WSN architecture with applications

II. MAC AND ROUTING PROTOCOLS IN WIRELESS SENSOR NETWORK

Medium Access Control (MAC) protocols *[4, 5]* coordinate the times where a number of nodes access a shared communication medium. MAC protocol task is to regulate the access of a number of nodes to a shared medium in such a way that certain application-dependent performance requirements are satisfied or in other words it specify how nodes in a network access the shared communication channel. MAC protocols can be classified as: whether the protocol is Fixed assignment, Demand assignment and random access based. Second is on the basis of which problem of energy wastage is being solved by the protocol. Another classification is whether the protocol is contention based or scheduled based. Various MAC protocols are [*9-11*]:

MAC PROTOCOL	DESCRIPTION	ADVANTAGES	DISADVANTAGES
S-MA	The S-MAC (Sensor-MAC)	The energy waste	Broadcast data packets

C	protocol provides mechanisms to circumvent idle listening, collisions, and overhearing. S-MAC adopts a periodic wakeup scheme, that is, each node alternates between a fixed-length listen period and a fixed-length sleep period. It includes periodic listen and sleep, collision and overhearing avoidance, adaptive listening, and message passing.	caused by idle listening is reduced by sleep schedules.	do not use RTS/CTS which increases collision probability. Sleep and listen periods are predefined and constant, which decreases the efficiency of the algorithm under variable traffic load.
T-MAC	T-MAC protocol solves the drawback of constant sleep and listen period. In T-MAC, listen period ends when no activation event has occurred for a time threshold *TA*	Gives better result under variable load.	Early sleeping problem.
DEE-MAC	DEE-MAC protocol reduces energy consumption by forcing the idle listening nodes to sleep using synchronization performed at the cluster head. DEE-MAC operations consist of rounds. Each of the rounds includes a cluster formation phase and a transmission phase.	Reduce the cost of idle listening.	Power of cluster head is easily depleted.
LEACH	In LEACH the nodes organize themselves into local cluster with one node acting as cluster-head. The operation of LEACH is broken up into rounds, where each round begins with a set-up phase followed by a steady state phase.	Proper rotation of clusterhead in a cluster.	Efficient for short range applications only.
A-MAC	A-MAC is a TDMA-based MAC protocol that uses the supplied energy efficiently by applying a scheduled power down mode when there is no data transmission activity.	Additional flag field called MORE PACKET. Node can transmit to multiple destinations	Overhead increases.

Table1 Various MAC protocols for WSN

Routing means providing path for the data to flow in the network i.e. sending information from source to sink via intermediate nodes. Routing in WSNs[6, 7, 8] is very challenging due to the inherent characteristics such as: due to the relatively large number of sensor nodes, it is not possible to build a global addressing scheme for the deployment of a large number of sensor nodes, in contrast to typical communication networks, almost all applications of sensor networks require the flow of sensed data from multiple sources to a particular BS, sensor nodes are tightly constrained in terms of energy, processing, and storage capacities, in most application scenarios, nodes in WSNs are generally stationary after deployment except for, may be, a few mobile nodes. Routing protocols can be classified as network structure based and protocol operation based.

Various routing protocols are:

ROUTING PROTOCOL	DESCRIPTION
SPIN	SPIN disseminate all the information at each node to every node in the network assuming that all nodes in the network are potential base-stations. This enables a user to query any node and get the required information immediately. These protocols make use of the property that nodes in close proximity have similar data, and hence there is a need to only distribute the data that other nodes do not posses. The

	SPIN family of protocols is designed based on two basic ideas: 1. Sensor nodes operate more efficiently and conserve energy by sending data that describe the sensor data instead of sending all the data; for example, image and sensor nodes must monitor the changes in their energy resources. 2. Conventional protocols like flooding or gossiping based routing protocols waste energy and bandwidth when sending extra and un-necessary copies of data by sensors covering overlapping areas.
DIRECTED DIFFUSION	Directed diffusion is a data-centric (DC) and application- aware paradigm in the sense that all data generated by sensor nodes is named by attribute-value pairs. The main idea of the DC paradigm is to combine the data coming from different sources enroute (in-network aggregation) by eliminating redundancy, minimizing the number of transmissions; thus saving network energy and prolonging its lifetime. DC routing finds routes from multiple sources to a single destination that allows in-network consolidation of redundant data. In directed diffusion, sensors measure events and create gradients of information in their respective neighbourhoods.
PEGASIS	The protocol, called Power-Efficient Gathering in Sensor Information Systems (PEGASIS), is a near optimal chain-based protocol. The basic idea of the protocol is that in order to extend network lifetime, nodes need only communicate with their closest neighbours and they take turns in communicating with the base-station. When the round of all nodes communicating with the base-station ends, a new round will start and so on. This reduces the power required to transmit data per round as the power draining is spread uniformly over all nodes. PEGASIS has two main objectives. First, increase the lifetime of each node by using collaborative techniques and as a result the network lifetime will be increased. Second, allow only local coordination between nodes that are close together so that the bandwidth consumed in communication is reduced.
QOS BASED	In QoS-based routing protocols [6], the network has to balance between energy consumption and data quality. In particular, the network has to satisfy certain QoS metrics, e.g., delay, energy, bandwidth, etc. when delivering data to the BS.
COHERENT BASED	In coherent routing, the data is forwarded to aggregators after minimum processing. To perform energy-efficient routing, coherent processing is normally selected. Since coherent processing generates long data streams, energy efficiency must be achieved by path optimality.

III. PROPOSED ROUTING ALGORITHM

The energy efficient shortest path routing algorithm proposed includes MAC protocols and routing protocols of WSN. It also includes the concept of ACO for getting the shortest path between sender and receiver.

The routing algorithm is designed as follows:

Step 1: Get number of nodes and id of sink node from user.

Step 2: Deployed the nodes in network as per topology defined, number of nodes deployed is 5 more than given by user (by default). After that initialise all nodes properties as default, these are radio, id, sender or receiver, distance, sending

packet, receiving packet. And then distance between each node is to be taken.

Step 3: In this step nodes are checked for their radio to be 'ON' and to find sender and receiver. After finding sender, receiver is to be choosen on basis of shortest distance out of the nodes whose radios are 'ON'. After getting sender and receiver the nodes of all other nodes should be 'OFF' for energy conservation.

Step 4: Now set the property 'sp' of sender as it has to send packet to the desired receiver choosen above. When Receiver starts receiving data st its property 'rp', if time of reception is less than transmission the data is transmitted successfully, otherwise retransmit the data for prescribed number of times if reception time is less in between those number of times than transmission time data is transmitted successfully other data is unable to read, in that case again the nodes are checked for their radio 'ON' at that time and whole procedure is repeated.

Step 5: Put that sender and receiver node's id in path file. Now put the radio of nodes acting as sender and receiver in 'OFF' condition.

Step 6: Now again set the default properties of all node in network. And procedure repeats from step 3 to step 5, but the difference is that now last element of path is taken as sender.

Step 7: The whole procedure repeats till last element of path is same as sink provided by user.

Step 8: Now links are made between all elements of path defining route from source to sink via intermediate nodes. Source node is displayed by green colour; sink by red colour and intermediate nodes by magenta colour.

The routing path obtained by this method is energy efficient shortest path.

IV. RESULTS AND ANALYSIS

The proposed routing algorithm is being simulated in MATLAB. The GUI designed consists of number of nodes and sink node, both of these are user defined. It also contains pushbuttons topology and routing described below. It also gives the path followed by data from source to sink via intermediate nodes with low energy consumption and shortest path. The axis shows the deployment of nodes in network and routing path from source to sink. Nodes with red colour shows sink node, green colour is for source node and magenta colour for intermediate node.

The whole routing algorithm consists of 3 main parts:

1 First step include user's defined number of nodes and sink node.

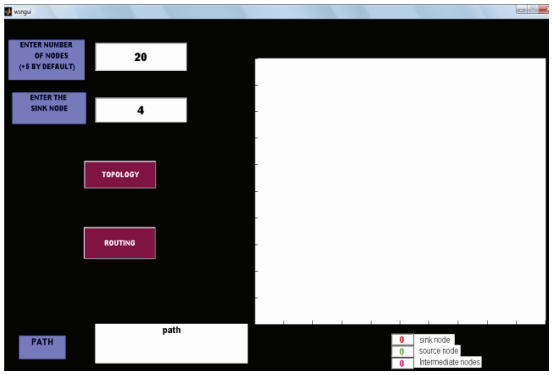

Figure 2 Number of nodes and sink node (user defined)

2. In this nodes are being as deployed as per topology defined by the user.

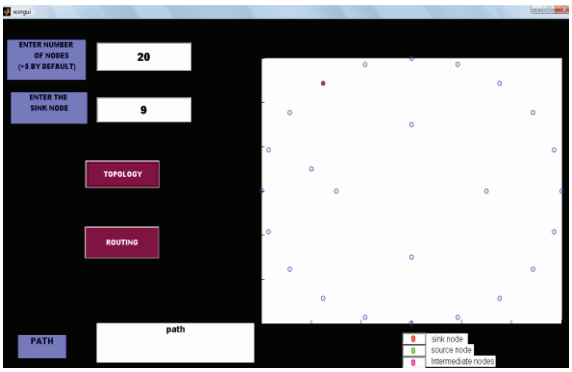

Figure 3 Topology (deployment of nodes in network)

3. This is the final step of routing algorithm. It consists of following sub functions: nodes, final sender, final receiver, transmission, reception and path.

Nodes tell the how many nodes have their radio 'ON'.

Final sender decides the nodes act as final sender.

Final receiver is to be taken on the basis of shortest distance among active nodes, after this except final sender and final receiver radio of all other nodes should be kept 'OFF' so that there would be no energy wastage in terms of collision, overhearing and idle listening.

After decision of final sender and receiver data transmission take place then reception of data take place. Next step is to check the data whether it is transmitted successfully or not and if not it would be retransmitted for specific number of times.

Final step is to get the whole path traversed by data from source to sink node i.e path consisting of source, intermediate and sink node

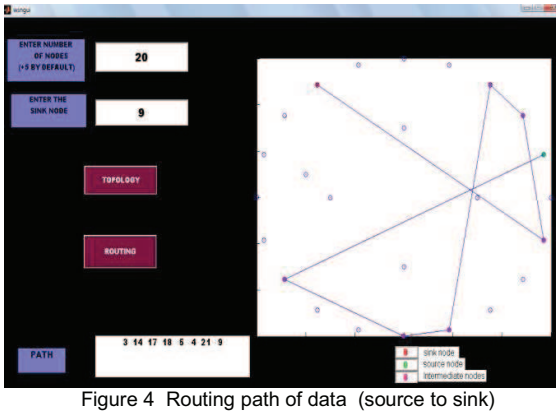

Figure 4 Routing path of data (source to sink)

The final graph showing less energy consumption by proposed routing algorithm in comparison to the existing algorithms.

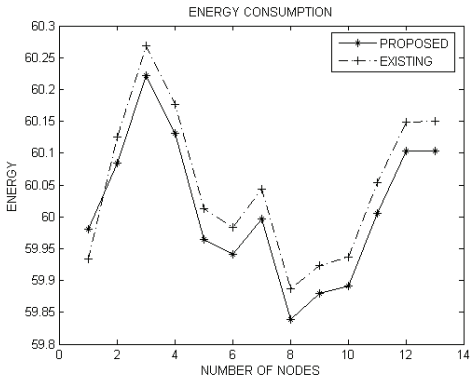

Figure 5 Energy comparison between proposed and existing routing algorithm

V. CONCLUSION AND FUTURE SCOPE

Routing in sensor networks is a new area of research, with a limited, but rapidly growing set of research results. This thesis work design an energy efficient optimized routing algorithm that combines the features of both an energy efficient routing algorithm and shortest distance routing algorithm thus the main factor that effect the proper working of Wireless Sensor Network i.e lifetime of WSN nodes has been reduced. Since the energy consumption reduces and distance is also optimized so the proposed routing algorithm is cost effective.

In designing the algorithm some points are taken into consideration, these are:

1. Nodes only listens the data when radio is in 'ON' state so idle listening reduces.
2. After selection of sender and receiver all other nodes except them should make their radio' OFF' till transmission took place.
3. Nodes radio status is kept 'ON' randomly so that energy consumption of all nodes are in balance mode.

The proposed routing algorithm can be further improved by taken into consideration the environmental factors. This can be done by deploying the WSN nodes in physical environment and then transmit data between nodes and compare the data with the work done in above thesis this will gives the effect of environmental factors on routing algorithm in WSN.

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