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Study of Routing Techniques in Wireless Sensor Networks

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***Abstract*: Wireless Sensor Network (WSN) is consists of large no of sensor nodes. A sensor node has all information of its sensing range. Routing process is used to access the information present in other sensing range . To continuously routing the information to the base station, the sensor network lifetime decreases this arises the routing problem in wireless sensor network (WSN). A route or path is consists of set of sensors that establish a connection between a source node and a destination node (base station). The routing problem is used to check the set of different paths with maximum aggregated lifetime while restrain the life of each sensor by its initial battery life. In WSN, we need an energy-efficient path to send the collected information to the centre base station. The received data at base station are processed further. In this paper, we try to develop the energy- efficient paths to maximize the network lifetime using some selected sensors instead of all sensors. In this dissertation, we give a new energy-efficient routing algorithm for designing these paths to maximize the total network lifetime of wireless sensor networks. The simulation section gives a clear proof of effectiveness of proposed algorithm when compared with some existing approaches.**

***Keywords: Wireless* Sensor Networks (WSN), Routes, Network Lifetime, Routing problem, Energy Efficiency, Base station.**

I. INTRODUCTION

Wireless Sensor Network (WSN) consists of sensor nodes which are used to collect the information in a network. These sensors are deployed in the network in a particular manner. Number of sensors to be deployed completely depends on the requirement of the application. Normally, sensors are deployed in large number for quality of service (QOS) parameter. These nodes have wireless communication and sensing computing capabilities [1-2].

Now a days due to recent technologies, manufacturing of sensor nodes become feasible in both ways economically and technically [3]. Sensors have limited battery life and it is necessary to utilize the energy in an efficient manner to increase the sensor network lifetime. The batteries of sensors are impossible to replace or renewed with the help of available technologies [8]. For example we also place sensors in the wild forest therefore, sometimes, it is very dangerous for a human being to replace the batteries of sensors over there, Because of this battery constraint, we must use sensors in an efficient way so that it will function for a long time. Sensor nodes can be used in various applications like Environmental Monitoring, Military, fire detection, humidity, medical industry which require unattended operation [5].

Wireless Sensor Network can be of either type homogeneous or heterogeneous. In homogeneous network all the sensor nodes has same battery life and in Heterogeneous networks, sensors may have different batteries [8].

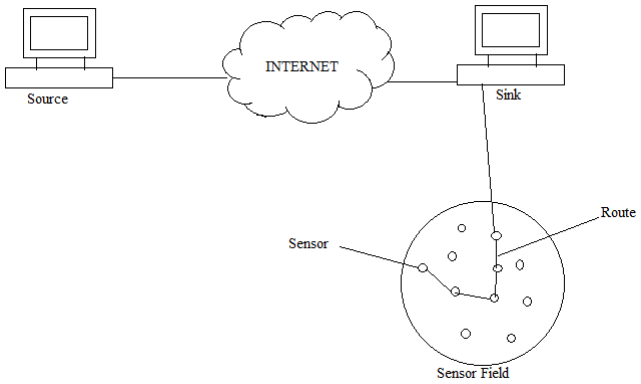

Fig 1

As shown in fig.1, these sensor nodes communicate directly to each other or to an external base station which is called as sink node. A sensor node sends the information to base station (sink node) and at sink node process received data further.

We can use two types of algorithms in Wireless Sensor Network centralized and distributed. In centralized approach, algorithms are always executed at base station and then pass the result to each sensor in the network k. In distributed approach, a number of sensor nodes perform the required task and then pass the result to other sensor nodes. Sensor nodes can be of mobile or static. Mobile sensor nodes do not have the fixed location because they are moving in the network as per application requirement. Static sensor nodes have fixed location and location can initialize at starting or they are randomly generated in the network [4]. A sensor has either type of mode active or sleeping. In active mode sensor is used to find a route while in sleeping mode sensors do not involved for finding a route. In large scale sensor network, at a time some sensors are used to find a route and remaining sensors are not used. Therefore, remaining sensors goes to sleeping state until they are not used to find a route.

Our objective is to activate/deactivate sensor nodes in a manner so that sensor network will be functional for a long time. We do this because it is impossible to recharge the sensor nodes battery. Therefore, we try to find maximum

number of routes in such a way that total network lifetime can be maximized.

As we have already discussed that sensors are deployed in large proximity. Also sensors are using limited battery life. So, our objective is not to activate all of the sensors to route information from source to sink, but design a multiple energy-efficient paths and then alternatively activate these paths to achieve maximum life for the sensor network. There are many existing routing techniques [3] [4] [5] [6] by various researchers.

This paper reviews all the techniques which we can use in routing and we propose a new energy-efficient routing algorithm to maximize the sensor network lifetime.

The rest of this paper is organized as follows: Section 2, we describe the review of all the papers which we studied to solve the define problem. Section 3, we present our problem statement. Section 4, explain the algorithm of the propose scheme. Finally, conclusions and future work are given in section 5.

II. LITERATURE REVIEW

All the routing techniques by which we can find a path between two sensor nodes are presented by Al-Karaki [3]. In this paper, we study all the routing techniques and then, we propose a new energy-efficient routing technique. Routing techniques are divided in to following category.

Network Structure

Flat Routing: In this technique [1] [4], all sensor node has the same role or functionality and they collaborate together to perform any task. In this data centric routing is used where base station sends a query to certain regions and waits until it gets reply from sensors located in those regions.

Hierarchical Routing: In this routing technique, all sensor nodes has different role. In this, we mainly do two functions. One of them is Routing and another is selection of cluster head [1] [4]. Higher energy nodes used to send data and lower energy nodes used for sensing.

Location Based Routing: In this routing, node's positions are exploited to route data. Sensor nodes are addressed by means of their locations [4]. Distance can be estimated on the basis of incoming signal strengths.

Protocol Operation

Negotiation based Routing: This technique uses high-level data descriptors [4] in order to eliminate redundant data transmissions through negotiation. In this Communication decisions are also made based on the resources available to them.

Multi-path based Routing: This technique uses multiple paths to enhance the network performance. The fault tolerance is measured by that a path is available when our path fails. This can be increased by maintaining multiple paths which increases the traffic and consume more energy [13]. By maintaining multiple paths we can increase network reliability.

Query based Routing: In query based routing, destination node sends a query for data through the network and the sensor nodes that have this data send data to the node who initiate this query. These queries are written in High level languages or in natural language [4].

QOS based Routing: In this routing, there is a balance between the data quality and the consumption of the energy and network will satisfy some QOS metrics like energy, bandwidth or delay, when it delivered data to the base station [1] [4].

Coherent and non-coherent based Routing: these are the data processing techniques. In non-coherent techniques, we locally process the data before sending it to other nodes for the further processing. Nodes which perform further processing are called as aggregators.
In coherent techniques, data is forwarded to aggregators after minimum processing like duplicate suppression and time stamping. In non-coherent technique we have low data traffic loading as compare to coherent technique [14].

A location based routing protocol is present by Kihyun Kim et.al [5]. The location based routing protocol uses three phases:
1. Start Advertisement Phase: In this phase, Source has limited routing space and it transmits an advertisement message to neighbor nodes.
2. Conditional Reply Phase: nodes who gets advertisement message decides whether to reply or not.
3. Routing of data: Now Source nodes forward the data to those nodes which sends him reply for advertisement message.

This routing technique assumes that each node knows its own energy level, current location and the location of the sink node using a global positioning system (GPS). This method generally focus to route the data but the energy consumption issue is not solved which is the measure issue in wireless sensor network (WSN). Location aided energy-efficient routing protocol is presented in [7] by P.T.V. Bhuvaneswari et.al.where the whole functionality is divided in four phases as shown in below figure 2.

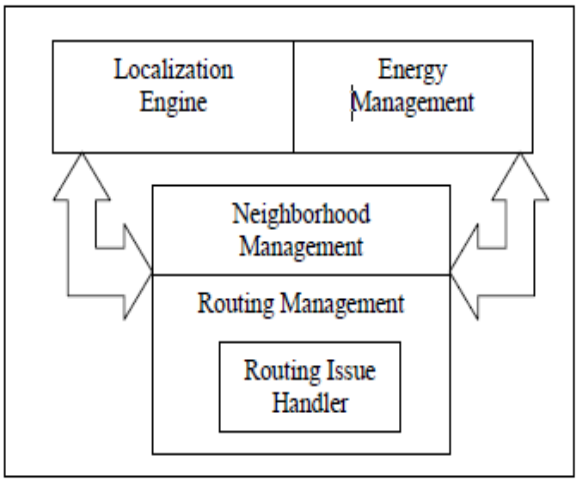

Fig 2

1. Localization Engine: This phase finds the location of each sensor node.
2. Neighborhood Management: This phase finds all the neighbors of a particular sensor and called them as forwarding nodes.
3. Routing Management: Now it sends the data to the nodes which we select in the second phase.
4. Energy Management: Here sensors which are not used goes to either sleep state or either idle state.

Location based Opportunistic routing protocol is presented in [6] by Jubin Sebastian E et. al. In this paper, a GPS based protocol is proposed where several forwarding nodes caches the data that has been received. If the best forwarder does not forward the data, then suboptimal node will forward that data to sink node. By doing so the data which we want to send to the node is always delivered by best available forwarding node. In this, user finds that all nodes carry the data so there is memory wastage and first give chance which has higher priority than next so more time consuming also.

Location aware event-driven multipath routing protocol in wireless sensor network is presented in [3] by A.V. Sutagundar et. al. Here, a user select special intermediate nodes for finding the three paths between the source and sink node. Then they compute rising and falling angle by using the location of special nodes. In this we find multiple paths so we can say that the network is so much reliable. But again energy consumption is not taken care to maximize the life of network.

By studied all these papers, we propose a new energy-efficient routing algorithm which primarily takes care of energy consumption to maximize the total network lifetime. Our proposed algorithm finds a shortest path by selecting those sensors that has highest remaining energy (battery). So, we focus on both constraints reliability and the energy consumption to increase the life of the sensor network.

III. PROBLEM DEFINITION

Let the n sensors s_1, $s_2, \ldots s_n$ be randomly deployed to cover objects in given sensor field. Sensor *si* has a battery life of b_i and can cover the objects if it lies within the sensing range of s_i. Routing is the process by which we send information from one sensor node to another sensor node. So our main problem is to find the route between the source and the sink node. And we use some intermediate nodes for finding the route in the sensor network. We select route in a way so that we can maximize our network life. The path which we select would be energy-efficient and reliable which delivered the information to the sink node in proper time.

IV. PROPOSED METHODOLOGY

In this section we propose a new energy-efficient algorithm for solving the routing problem in homogeneous network based on the attributes such as reliability and energy-efficiency. We observe that total lifetime parameter of the sensor network play an important role in getting a better optimal solution. Hence we are prioritizing the sensors according to their remaining battery life. There are following phases in our proposed energy-efficient algorithm.

Generate a Route

This algorithm generates a route P by selecting a sensor that covers the data which we required. Therefore route is constructed by selecting sensors of high priorities till we reach the sink node (base station).

Shortest Path

This will find the shortest path between the source node and the sink node from the route P. Generate a route return a path which is not the shortest path sometimes so we use this in our algorithm to find the shortest path. This gives us always the shortest route.

Lifetime

After finding the shortest path which is also energy-efficient, we decide the lifetime of that path means for how much time the path exist. This is denoted by X (P).

Update battery

After finding the value of lifetime in above step, we will update the battery of all sensor nodes those who are participating in above shortest path. We subtract the value of X (P) from all sensors battery. The pseudo code for the above said algorithm is as follows:

```
Initialize Stot=all sensors, S=stack and batt[]=battery of all sensors

While sink (base station) has connectivity with network
  Do
      Generate a route
                                  //generate an array P
      Initialize S=∅
      For all sensors,
          Set v[i] =0 where i=1, 2, 3…… Stot
      Select the sensor s
                                  // it covers the data
      Add s to S
      Do while S ≠ ∅
          Pop from S and find its neighbor nodes
          If v[s] =0,
              Add it to P and set v[s] =1
          If s is connected to sink node
             Return
          else
            Add all neighbor nodes 'n' to S, whose
            v[n] = 0
          End if
      End do
   Shortest path
   do while k ≠1
      Find connectivity of P[0] to the last node P[k]
      if connected
      delete the value present between P[1] and P[k]
      and return
      else, k--
  end do

   Lifetime
      X (P)← maximum - lifetime (P)

    Update battery
      For all si∈S,
      Update batt[i] =batt[i] - X (P)
      If batt[i] =0,        Stot= Stot-si
      Else, return
  End do
End while
```

V. Conclusion and Future Work

In our study, we have gone through a hierarchy of techniques briefly in terms of reliability with energy-efficiency with varied research techniques used in past for routing in wireless sensor network (WSN). Our ongoing research is to use the algorithm which we describe in section 4 to find a route which is the shortest path and we can maximize our sensor network lifetime. By using this algorithm we want to find energy-efficient route faster and accurately.

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