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A Survey on Routing Algorithm for Wireless Sensor Network

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Abstract— a sensor network is an infrastructure having functionality comprised of sensing, computing, and communication element which provide instrument an ability to observe event and reach in specific environment. The environment can be physical world, a biological system or an information technology firm work. WSN has an wide range of potential application in agricultural field, horticultural field and in military. But despite of these application a current research and development challenge is to develop low power communication with low cost on node processing & self organize connectivity protocol because sensors are limited battery power devices which have limited amount of initial energy and so for efficient use of wireless sensor network it is necessary to manage and maintain the energy level of sensor to increase the lifetime of network.

In this survey, we focused on energy efficiency issue of wireless sensor network and present a comprehensive study of different routing algorithm for extending lifetime of battery powered WSN. First we review the significant algorithm such as geographic k-anycast routing algorithm, energy balance routing protocol for data gathering, and ad-hoc on demand distance vector routing algorithm. Further I compare this algorithm in the form of energy conservation approach they adopt and discuss their merits and demerits.

Based on the outcomes of these review, i got number of open research issue for achieving efficient routing and maximum lifetime in WSN to develop a new algorithm.

Keywords—*sensor networks (WSNs); algorithm; lifetime; Routing; Battery power; GKAR; EBRP.*

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I. INTRODUCTION

In wireless sensor network sensor have two state in one state sensor are in sleep state and in another state are in active state. In active state it perform various operation such as routing data packet, generation of packet, monitoring of packet etc. For power saving in WSN scheduling of sensor between sleep mode and active mode is required. WSN is composed with large amount sensors around or more than the thousand sensors would be used and that network is spread in wider area. Sensors can communicate with each other directly or through other nodes. One or more nodes can act as base station and they have unlimited power supply as compare to other subnodes. Subnodes have limited power supply most probably not rechargeable. Small amount of power in sensor is used for their internal operation and sensing operation and most of the power supply is consumed for routing of data packet i.e. transmission purpose. According to [1], one bit transmission in WSN consumes power near about power required for the execution of 800-1000 instruction. Thus power requirement for routing is large enough as compare to power required for other operation. But as if power consumption in WSN is manage in proper manner then we can overcome that limited power problem. Because WSN have provide large area of application due to which researcher are attracted towards it.

Application of WSN includes medical monitoring, Biological detection, Home security, Battlefield surveillance and inventory tracking. WSN is a group of nodes and each node have limited amount of power. There could be many possible routs available for communication between two nodes over which data can be transfer. Each nodes generates some information i.e. data packet and this data packet need to transfer one node to destination node , that information can be easily transfer if it have sufficient battery power. If any node is at long distance then large amount of energy is required for data transfer. After every transmission energy of node get reduce and after some amount of data transmission this node will get eliminated from the network because of empty battery power. Because of such condition came around that no node is available for transmission due to which lifetime of network get reduce. Where lifetime of network is define as the time up to which first node in the network dies. For increasing lifetime of network data should be routed such that energy use of node is in up to same amount among the nodes in proportion to the energy they have. Instead of routing data on the path that minimize the power of limited sensor.

The organization of rest of the paper is as follows section II contains energy efficient Routing algorithms and its comparison, section III contain summary, and last section is of reference.

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II. ENERGY EFFICIENT ROUTING ALGORITHMS

In simplest terms, a routing algorithm is a way for one network device to determine which other device or network link to use to reach a particular other network device or group of network devices. Basic idea is that you keep track of which links or devices know how to reach which other devices. If more than one device has a way to reach the same device, you use some mechanism to pick the 'best' one.

a)GKAR: A Geographic *K*-Anycast Routing algorithm for Wireless Sensor Networks

This algorithm propose a distributed *geographic K-anycast routing* (GKAR) protocol for WSNs, which can efficiently route data from a source sensor to any *K* destinations (e.g., storage nodes or sinks)[2]

To provide guarantee of *K*-delivery, an iterative approach is developed in GKAR algorithm, where in each round, GKAR can determine the next hops at each node, and also a set of use full destinations for every next hop node which need to cover. Algorithms is designed to determine the selection of the next hops and destination set division at each intermediate node, aim of this algorithm is to design a *geographic K-anycast routing* (GKAR) protocol, using this a source node can efficiently find any *K* destinations out of all possible and available destinations. If we compare GKAR algorithm with 1-anycast routing, *K*-anycast routing has two main design challenges. First one is to reach *K* destinations properly, namely *K-delivery*, each intermediate node have to determine that which neighbours should be selected as the next hops, and needs to consider how many destinations each selected next hop could be reach. In GKAR, all the routing decisions are taken with help of local information available at the intermediated nodes and due to this computational complexity of the algorithm can be reduced on large amount, so GKAR is scalable for WSNs.

•in this algorithm *K*-delivery guarantee can be achieve by an iterative routing approach at the source node. And also avoid the same destination being found by different routing messages.

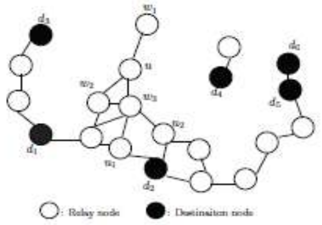
• here also derived the expected number of rounds need to reach *K* destinations out of all the available destinations. as the number of available destinations increases then

Theoretical analysis shows that the number of available destinations increases when the number of available destinations increases

Example of GKAR algorithm

Let us consider Fig.1 as an example[2], where current node *u* required to find any 3 destinations out of *D* ={*d*1, *d*2, *d*3, *d*4, *d*5, *d*6}, and this destination has 3 neighbours as *w*1, *w*2, *w*3.

• When we need to forward the packets, it is not efficient to select *w*1 as one of the next hops. Because *w*1 is farther to any destination than *w*2 or *w*3, which required more energy to reach the destinations as compare to *w*2 and *w*3.
• Considering these two solutions in which both select *w*2 and *w*3 as the next hops. As In the first solution, *w*2 have to find 1 destination while *w*3 have to find 2 destinations. While In the second solution, reverse operation needs to follow.
• Then they consider that *w*3 is will reach 2 destinations and it follow to each its two neighbors *u*1, *u*2 to reach 1 destination.



(a) Network example with u being the current sending node

u needs to find any 3 destinations in $D(u)$
$D(u) = \{d_1, d_2, d_3, d_4, d_5, d_6\}$
$N(u) = \{w_1, w_2, w_3\}$

	d_1	d_2	d_3	d_4	d_5	d_6
u	15	15	13	12	18	18
w_1	20	20	15	15	21	19.5
w_2	10	14	14	15	23	22
w_3	14	10	18	14	20	19

(b) Distance from u and its neighbors to each destination in $D(u)$

Fig 1: Example of GKAR [2]

• Suppose that we have *d*4, *d*3, *d*1, *d*2 are the closest four destinations to *u*, but it is found that *d*4 is disconnected to *u*. In this condition, the next hop assigned to reach *d*4 can be fail to find the assigned number of destination

Fig [1]: Example of GKAR [2]
In this algorithm we have to face some challenges due to which it become complicated and have too much delay in processing as compare to EEMLR algorithm, this challenges are
•if in case all destinations are not available and because of such availability information is unknown to the intermediate nodes, it is not possible that one round will successfully reach *K* destinations. Hence
• When forwarding the packets, the current intermediate node needs to determine which neighbors should be selected as the next hops, and need to define assignment of how many destinations are selected that next hop is expected to reach. Because of the localized routing, the same destination may be found by several different routing messages, Due to which wastes of energy can occurred along some unnecessary paths.

b) Online Algorithms for Mining Inter-Stream Associations from Large Sensor Networks
Data mining is an area of active database research because of its applicability in various areas such as decision support and direct marketing. One of the important tasks of data mining is to extract frequently occurring patterns or associations hidden in very large datasets. Different on-line data mining algorithms have been devised for mining data of different nature. As a couple of examples, there are the classic Apriori algorithm for market-basket transactions and SPADE for mining sequence

data. There are also algorithms for mining text, time series, multimedia objects, and DNA sequences. In recent years, stream processing and in particular sensor networks has attracted much research interest. Stream processing poses challenging research problems due to large volumes of data involved and, in many cases, on-line processing requirements.

Any device that detects and reports the state of a monitored attribute can be regarded as a sensor. For example, thermometer, barometer and anemometer are sensors for monitoring weather conditions, while a stock quotation system is a system of sensors for monitoring stock prices. In our model, we assume that a sensor only takes on a finite number of discrete states. (For continuous values, we assume that a suitable quantization method is applied.) Also, we assume that a sensor only reports state changes. (An alternative model would require a sensor to report its state periodically even when there are no state changes. This model could be mapped to ours by simply removing duplicate state values.) A sensor stream can thus be considered as a sequence of updates (or values) such that each update is associated with a time at which the state change occurs.[6]

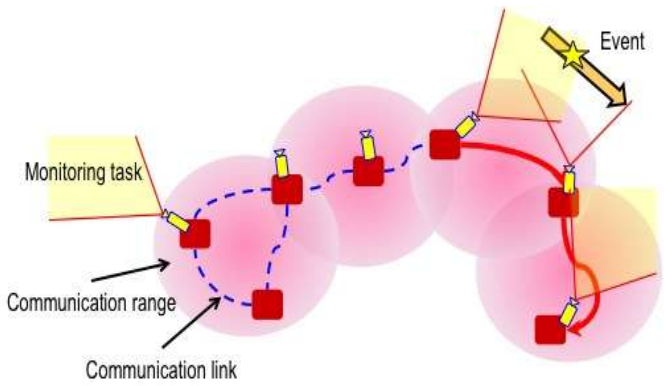


Fig 2: Example of Online Algorithms for Mining Inter-Stream Associations

c) EBRP: Energy-Balanced Routing algorithm for Data Gathering in Wireless Sensor Networks

As we have seen in GKAR algorithm here we required iterative process to successfully reach K-destination which is time consuming and time delaying process, to overcome such disadvantage and to achieve appropriate trade-off between energy efficiency and balance energy consumption, EBRP algorithm suggest five possible solution to balance energy consumption as deployment optimization, topology control, mobile sink, data aggregation, energy balance routing.

In EBRP algorithm they use topology control to accomplish energy balance routing in five units as in [3]

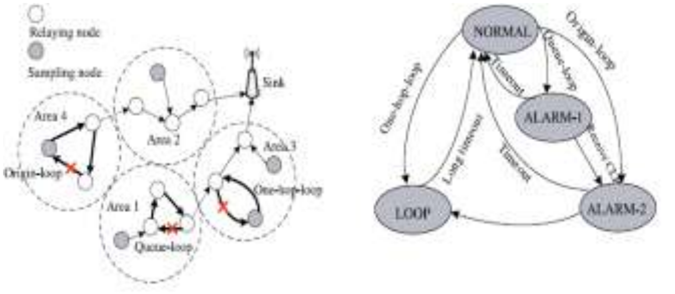


Fig.2.example of EBRP algorithm
a.Type of routing loop b.State transition diagram

1) One-hope-loop:
It occurs between local nodes and its parent. As we can observe in Fig.2, two nodes in area 3 select each other as their parents, which form a one-hop-loop. This loop can be easily determined by checking the source address available with the header of received packets. The source address of a packet can be use as ID of the former node which sending this packet, and changes according to each hop. When a packet is received, then local node need to perform a search operation to identify that source address is identical with ID of its parent, then it can provide a confirmation that an one hop-loop is arrived.

2. Origin-loop.
As we can understand that different feature as compare to one-hop-loop of this routing loop is that it must have to include one or more sampling nodes. Then, we can define it as origin-loop. This loop chain itself may be one-hop or multihop. As we can observe in Fig.2, there are three nodes in area 4 which form an origin-loop chain back-to-back. Then to detect this loop we have to check the origin address which is carried by the header of packets.

3. Queue-loop.
This Queue loop is said to be a special multihop loop chain. It does not contain any sampling nodes. As in Fig.2, we can determine that one routing loop which comes under such category appears in area 1. But that type of loop cannot be properly detected by checking both origin and source addresses. Then also we can define it, because packets can't go out of this routing loop, as the queue of the nodes in the chain shall grow in drastic manner. This process will be work as symptom for the occurrence of such loop. Therefore, we call it as "queue-loop." To determine the queue-loop, EBRP required to verify the length of the local queue and check for the condition that is it comes over a certain threshold in a short time, but it is not sufficient to identify the queue-loop only referring to the variance of the queue length because the congestion is likely to be mistaken as a queue loop [3]. As in [3] the symptom of queue-loop occurrence is that the queue length increases by 20 percent of buffer size.

4. Loop Elimination

Once the routing loops are confirmed, it will be straightforward to eliminate them by cutting off the loop chain [3]. It is unnecessary to cut off all the links, so EBRP can be preserve those that can make packets move closer to the sink. When a loop is detected, and if the parent is not closer to the sink and there is at least one active neighbour is available besides the current parent, EBRP will shield this current parent by cutting off the link between the local node and its current parent.

5. State Transition

Combining with various elements in above two conditions, we can evaluate that the state transition in loop detection and elimination mechanism in Fig.2.b Originally in state “normal” in which the node can work in normal condition. As we can consider “alarm-1” is the queue-loop indicator, and “alarm-2” is the origin-loop indicator [3]. “alarm-1” and “alarm-2” will wait for a time out and in some condition long time out before returning to “normal.”

The main contributions of this algorithm are: 1) Borrow the concept of potential in classical physics to build a virtual hybrid potential field to drive packets to move toward the sink through the dense energy 2) Classify the routing loops and devise an enhanced mechanism to detect and eliminate loops. But the main disadvantage of EBRP algorithm is it belongs to the class of data-gathering based routing algorithm, and does not deal with data dissemination and point-to-point communication [2]. And another Drawback of this algorithm is lack of sufficient understanding about the dynamics of time-varying potential field.

III) SUMMARY

In this paper I have studied three algorithm, first one is A Geographic *K-anycast* Routing algorithm for Wireless Sensor Networks which provide an efficient routing path as compare to 1-anycast algorithm but have one important limitation that it operate in iterative manner due to which time delay get increase, so we carry forward to next algorithm which is Energy-Balanced Routing algorithm for Data Gathering in Wireless Sensor Networks which define energy balance routing with avoiding iteration and provide better efficiency, but main disadvantage of EBRP algorithm is it belongs to the class of data-gathering based routing algorithm, and does not deal with data dissemination and point-to-point communication. And we also studied Online Algorithms for Mining Inter-Stream Associations from Large Sensor Networks which is well known for its simplicity and efficiency for point-to-point communication.

But its main limitation is potentially very high overhead because data packets may be delivered to too many nodes which do not need to receive them and potentially lower reliability of data delivery. So I want to summarize here that as we have to achieve maximum life time and more energy efficiency then we need to develop these algorithms using advance routing path. This paper helps to recent researcher to develop better solution for maximum lifetime and alternately energy efficiency.

IV) CONCLUSIONS

As WSN provides potential area of application in military, agricultural field, environment monitoring, abnormal behavior detection, it is need able to develop energy efficient and lifetime increasing algorithm for WSN. GKAR and EBRP algorithm provide energy efficient path as we have discuss before but have serious limitation which gives inspiration to research new algorithm. Online Algorithms for Mining Inter-Stream Associations from Large Sensor Networks attracts us due to its large area of coverage and better understanding of routing path. So we can conclude here that for more energy efficient routing and maximum lifetime we need to develop Online Algorithms for Mining Inter-Stream Associations from Large Sensor Networks.

So in future work I am thinking to implement a new path in AODV algorithm using heuristic formula of link cost calculation, using which we may be avoid the repeat use of multiple nodes for transmission of single packet to destination which can save energy of nodes. And embed greedy formula with this path to reduce communication delay and to achieve improved lifetime parameter.

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