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A Novel Route Adjustment Scheme For WSN Using Dynamic Virtual Grid Method

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ABSTRACT
Wireless sensor network are spatially distributed autonomous sensors to monitor physical or environmental conditions such as temperature,sound,pressure etc. and to cooperatively pass their data through the network to a main location. Wireless sensor network consists of small nodes with sensing, computation and wireless communication capabilities. In wireless sensor network, exploiting the sink mobility has been considered as a good strategy to balance the nodes energy dissipation. Many routing power management and data dissemination protocols have been specifically designed for WSNs where energy awareness is an essential design issue. To overcome this above, this technique proposed a Virtual grid- based dynamic routes Adjustment scheme(VGDRA) to minimize the route reconstruction cost of the sensor nodes while maintaining nearly optimal routes to the latest location of the mobile sink. Experimental results demonstrated reduced routes reconstruction cost and improved network lifetime of the VGDRA scheme.

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I. INTRODUCTION

Wireless sensor network was a self-organized network of tiny computing and communication devices have been widely used in several unattended and dangerous environment. In a typical deployment of wireless sensor network nodes are battery operated where they cooperatively monitor and report some phenomenon of interest to a central node called sink. Sink mobility not only helps to balance the nodes energy dissipation but also link isolated network segments in problematic areas. In wireless sensor network sensor nodes are low powered and small devices mainly deployed in critical regions. Due to their energy constraint issues many routing algorithms have been developed for efficient forwarding of data for minimizing energy consumption. The proposed algorithm is enhanced form of VGDRA algorithm which is grid based routing algorithm but lacks the concept of estimating energy on the basis of distance. Mobile sink is widely used in industrial wireless sensor network to collect sensory data and alleviate the hotspot problem effectively. In VGDRA, a mobile sink can adjust its movement dynamically according to the changes in event areas. The first one is the dynamic adjustment of a mobile sink’s parking time and second one denotes the moving toward event area of a mobile sink. The locations where mobile sink must arrive to acquire data from RP’s are called sojourn locations. RP’s are prone to exhaust energy due to the additional activity of forwarding the data and create the energy hole problem.

The AODV routing protocol uses an on-demand move toward for finding routes, that is a route is established only when it is required by a source node for transmitting data packets. It employs destination sequence number to identify the most recent path.

Whenever a node receives a broadcasts from a neighbor it updates its local connectivity information to ensure that it includes their neighbor. If a node has not sent any packets to all of its active downstream neighbors within hello interval, it broadcasts to its neighbors a hello message. The hello message contains the nodes identity and sequence number. This hello message is prevented from being rebroadcast outside the neighborhood of the node. Neighbors then update their local connectivity information. Receiving a broadcasts or a hello message from a new neighbor indicated that the local connectivity has changed. Failing to receive hello messages from inactive neighbors does not trigger any protocol action.

A new route maintenance algorithm called AODV-BA(AODV with Break Avoidance) was proposed to avoid route breaks because each intermediate node on an active route detects a danger of a link to an up stream node and reestablishes a new route before a route break. This route maintenance algorithm is based on AODV.

Each intermediate node transmits information of the transmitting side to the next hop of the destination route. The threshold of the received power is defined. When the receiving power at the time of receiving data packets is less than the threshold and has decreased as compared with the previous received power, the node notifies the upstream nodes about the danger of the link. After that the received RREQ which is transmitted from the upstream node is discarded and not processed. When an intermediate node detects the danger of the link break, it notifies the danger to the upstream node.

The DSR is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad-hoc networks of mobile nodes. DSR allows the network to be completely self organizing and self configuring without the need for any existing network infrastructure or administration.

When a source node S attempts to send a packet to destination node. D it will obtain a suitable source route by searching its route cache of routes previously learned. If no route is found in its cache, it will initiates the route discovery protocol to dynamically find a new route to D. In this case, S is called as initiator and D the target of the route discovery. To initiate the route discovery, S transmits a route request message as a single local broadcast packet. This RREQ packet is received by all nodes currently within the wireless transmission range. Each RREQ message contains the source address, destination address and a unique request ID determined by the source. Each RREQ also contains a record listing the address of each intermediate node through which this particular copy of the RREQ message has been forwarded. This route record is initialized to an empty list by the initiator. When another node receives the RREQ, if it is the target, then it returns the route reply message to the initiator. When the initiator receives this RREP, it caches this route in its route cache for use in sending data packets to destination.

II. SYSTEM OVERVIEW

The main objective is to optimize the trade off between nodes energy consumption and data delivery performance using a single mobile sink. A wireless sensor network is a wireless network consisting of spatially distributed autonomous devices using sensors to monitor physical or environmental conditions. Nodes other than the cell-headers associate themselves with the closest cell-headers and report the observed data to their cell-headers. Exploiting the sink's mobility helps to prolong the network life time there by alleviating energy-hole problem, it brings new challenges for the data dissemination process. To hope with the dynamic network topology, nodes need to keep track of the latest location of the mobile sink for efficient data delivery. In the virtual infrastructure based data dissemination schemes, only a set of designated nodes scattered in the sensor field are responsible to keep track of sink's location such designated nodes gather the observed data from the nodes in their vicinity during the absence of the sink and then proactively or reactively report data to the mobile sink.

The virtual infrastructure was designed by partitioning the sensor field in to a virtual grid of uniform sized cells where the total number of cells is a function of the number of sensor nodes. A set of nodes close to centre of the cell are appointed as cell-headers which are responsible for keeping track of the latest location of the mobile sink and relieve the rest of member nodes from taking part in routes re-adjustment. Taking into consideration the scarce energy resource of nodes, frequent propagation of sink's mobility updates should be avoided as it greatly undermines the energy conservation goal. In this regard to enable sensor nodes to maintain fresh route towards mobile sink while incurring minimal communication cost overlaying based virtual infrastructure over the physical network is considered as an efficient approach. In the virtual infrastructure based data dissemination schemes only a set of designated nodes scattered in the sensor field are responsible to keep track of sink's location such designated nodes gather the observed data from the nodes in their vicinity during the absence of the sink and then proactively or reactively respect data to the mobile sink.

The location awareness in the existing scheme specifies whether the considered scheme requires the nodes to be aware of their physical/relative coordinates. This feature is quite helpful in constructing the virtual infrastructure as well as routing of the query and response packets, however it incurs some additional energy cost. The second parameter provides an estimate of the overhead cost involved in establishing and maintaining data delivery routes to the latest location of the mobile sink. For prompt delivery of data packets to the mobile sink ,nodes need to be informed of the latest location of the mobile sink. Similarly the convergence time is an estimate of how promptly the sensor nodes come to know about some significant position change of the mobile sink and indirectly reflects the efficiency of the subsequent data delivery phase.

III. SYSTEM DESIGN

The most creative and challenging phase of the system lifecycle is system design. The term design describes a final system and the process by which it is developed. It refers to the technical specifications that will be applied in implementing the candidate system. It also incudes the constructions of the programs and program testing. Important inputs and outputs are defied and performance requirement are specified. The first step in system design is to determine how the output is to be produced and format. Secondly, input data and master files have to be designed to meet the requirements of the proposed output. Finally, the details related to the justification of the system and an estimate of the impact of the candidate system in the user and organization are documented and evaluated by management as a step towards implementation. Fig.1 shows virtual grid structure for hundred nodes.

Fig.1 Virtual Grid structure for hundred nodes

3.1 VGDRA Scheme

A virtual infrastructure was designed by partitioning the sensor field in to a virtual grid of uniform sized cellswhere the total number of cells in a function of the number of sensor nodes. A set of nodes close to centre of the cells are appointed as cell-headers which are responsible for keeping track of the latest location of the mobile sink and relieve the rest of member nodes from taking part in routes re-adjustment. Nodes other than the cell-headers associate themselves with the closest cell-headers and report the observed data to their cell-headers. Adjacent cell-headers communicate with each other via gateway nodes. The set of cell-headers nodes together with the gateway nodes constructs the virtual backbone structure.

3.2 Network Characteristics

The methodology of VGDRA scheme, it is worthwhile to highlight the various assumptions of the sensor network. We assume the following network characteristics:

☆All the nodes are of homogeneous architecture and know their location information.
☆Nodes adapt their transmission power based on the distance of the destination nodes.
☆The mobile sink does not have any resources constraints.
☆The mobile sink performs periodic data collection from sensor nodes while moving along the periphery of the sensor field and maintains communication with the closest border line cell-headers for data collection.

3.3 THE VIRTUAL STRUCTURE CONSTRUCTION

The VGDRA scheme constructs the virtual grid structure by first partitioning the sensor field in to several uniform sized cells based on their number of nodes in the sensor field. The rationale behind such partitioning is to uniformly distribute the work load on part of the cell-header nodes which consequently results in prolonged network lifetime. Given N number of nodes ,the VGDRA scheme partitions the sensor field into the K uniform sized cells, where K is a squared number. After the network partitioning next VGDRA scheme appoints a set of nodes as cell- headers. Initially in every cell, the node closest to the midpoint of the cell is elected as the cell header. Nodes using the knowledge of sensor field dimensions and the total number of nodes compute the midpoints of all the cells. In order to reduce the communication cost in the cell-header election, only those nodes take part in the election whose distance to the mid-point of the cell is less than a certain threshold. The threshold distance to the mid-point is gradually increased if no node can be found within the threshold distance around the midpoint of the cell. This threshold based cell-header election strategy not only helps in energy conservation but also elects the cell-header at the most appropriate position with in the cell.

After the initial cell-header election, each cell-header notifies its status not only to the surrounding nodes within its cell but also to the nodes which are slightly beyond the cell boundary. After the cell-header election and establishing the adjacencies communication route are setup considering the mobile sink is located at coordinates(0,0). As a result of the initial routes setup , all the cell-header adjust their routes to the initial position of the mobile sink.

3.4 DYNAMIC ROUTES ADJUSTMENT

In order to cope with dynamic network topology caused by sink mobility, nodes need to setup theirdata delivery routes in accordance with the latest location of the mobile sink flooding. The sink's latest location to the entire sensor field have most naïve approach in this regard but greatly undermines the energy conservation goal and is therefore avoided. Using the VGDRA scheme, only the set of cell-header that constitute the virtual backbone structure are responsible for maintaining fresh routes to the latest location of mobile sink.

For periodic data collection from the sensor field, the mobile sink moves around the sensor field and collects data via the closest border -line cell-header. The closest border- line cell- header upon discovering the sink's presence shares this information with the rest of the cell-headers I a controlled manner. The VGDRA scheme defines a set of propagation rules so that only these cell-headers take part in the routes re-adjustment process that really require to adjust their routes.

Mobile sink updates its location to the closest cell-header. The closest CH becomes origination cell-header(OCH). If the previous, next hop of OCH is not the mobile sink , set mobile sink as the next hop of OCH. OCH sends route update packet to the previous OCH and to the downstream adjacent cell-header. The current OCH is set as next hop of the previous OCH. The downstream CH upon receiving the sink's location update checks whether the sender CH is the same as its previous next hop or different. If it is same, the downstream CH drops the sink's location update packet and does not propagate further it to be next downstream CH. This process continues till the downstream CHs adjust their data delivery routes forwards the latest location of the mobile sink. When the mobile sink move from cell2 to cell3 the cell-header at cell 3 exercises to update its downstream cell-header. In this way only a limited number of cell-headers take part in their routes readjustment process thereby reducing the overall routes re-adjustment process thereby reducing the overall routes re-adjustment cost of the network.

3.5 CELL-HEADER ROTATION

An integral part of the proposal VGDRA scheme is rotating the role of the cell-header in every cell. The cell-header being the local data collector is vulnerable to high energy dissipation and therefore to prolong the network lifetime, the cell-header role needs to be distributed among the nodes within the cell. In order to achieve uniform energy dissipation, the VGDRA scheme keeps track of the residual energy level of the current cell- header where if it gets below a certain threshold the new cell- header election is initiated by the current cell-header.

In the re-election process the node that is relatively more close to the midpoint of the cell and has a higher energy level compared to other candidates is elected as the new cell-header. Also in the reelection process the search zone around the midpoint in every cell is slightly increased or the energy threshold level is decreased progressively if no suitable node can be found. In order to preserve the virtual backbone structure the current cell-header before stepping down, shares the information of the new cell-header not only with all its member nodes but also with the adjacent cell-headers in its neighbourhood.

IV. SYSTEM IMPLEMENTATION

The virtual grid is constructed by partitioning the given sensor field in to equal sized cells. Each cell contains number of sensor nodes that collect sensor information. Each cell contains number of sensor nodes that collect sensor information. Each cell contains a cell-header for data transmission. The data from sensor nodes are collected by the corresponding cell-headers. A mobile sink moves around the virtual grid to collect information from cell-headers. Initially, the mobile sink is at the origin. At first the midpoint of each cell is calculated. The midpoint is calculated using the knowledge of sensor dimensions and total number of sensor nodes In the cell. The sensor nodes which is closest to the midpoint is elected as cell-header.

Each cell-header form adjacencies with neighbouring cell-headers using gateway nodes. In order to achieve uniform energy dissipation, after a particular period, the current cell-header will elect a sensor node which is closest to the midpoint as the new cell-header. The mobile sink will not stay at one place. It moves around the sensor field to collect information. When a mobile sink is at origin it updates it location to the closest cell-header. The cell-header then propagates the mobile sink location update to the adjacent CH. After a long time period, the mobile sink moves from the origin to another place and above process takes place.

Once the location update is completed, the data transmission process takes place. The sensor nodes collect the information and transmit it to their cell- headers. The cell-headers in turn propagate the data to other cell-headers based on the routing information. Stored in their routing table. Finally, the information is collected by the mobile sink.

V. CONCLUSION

A novel VGDRA scheme was proposed that incurs least communication cost while maintaining nearly optimal routes to the latest location of the mobile sink. The proposed scheme partitions the sensor field into a virtual grid and constructs a virtual back bone structure comprised of the cell-header nodes. A mobile sink while moving around the sensor field keeps an changing its location and interacts with the closest border-line cell-header for data collection. Using a set of communication rules, only a limited number of cell-header take part in the routes reconstruction process there by reducing the overall communication cost. In terms of nodes energy consumption, the simulation results reveal improved performance of the proposed VGDRA scheme for different network sizes.

Considering the scope of this paper, the proposed scheme has not included the actual data delivery model. The future work will analyze the performance of the proposed VGDRA scheme at different sink's speeds and different data generation rates of the sensor nodes. The proposed VGDRA scheme though offers a light weight solution and does not impose many constraints on part of the resource constrained sensor motes, yet its practical implementation on real hardware needs to be confirmed. Moreover, the future work is aimed to improve the performance of the proposed scheme by using communication based on distance priority which will improve the lifetime of network and reduce the route reconstruction. Cost even more than this scheme energy consumption will also be reduced by using distance priority communication.