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Implementation A Geographical and QoS Aware Routing Protocol in Wireless Sensor Networks

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ABSTRACT

A sensor in wireless sensor networks (WSNs) periodically generates data as it monitors its environment. The major operation in such a network is the methodical gathering and sending of sensed data to the command node for more processing. Several geographical-based routing protocols have been proposed for data propagation in WSNs. In PBR, accumulating neighborhood information for selecting subsequent hop can obtain a high efficiency in position-based routing that is based on situation of neighboring nodes. In this paper, we combine both distance-based and direction-based methods to acquire trade-off between energy consumption and end-to-end delay. In distance-based topologies, the next hop node is selected according a node with the largest distance towards the sink. Furthermore, in direction-based topologies the subsequent hop is selected with the lowest angle deviation towards the sink. In addition, we have used a new technique that is based on sentinel nodes. Due to the presence of sentinel nodes, not all nodes of wireless sensor network need to be activated. Sensor nodes become active, when they have a responsibility to send packets to the sink.

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INTRODUCTION

It is clear that, wireless sensor networks have developed on data gathering, routing, and processing [1]. The significant challenge in WSNs is finite resources at sensor nodes, since packet routing in WSNs is the most important way to improve this problem [2], [3]. Saving energy has been perceived a basic problem and addressed with various approaches [4]. For instance, construction of special rooted broadcast tree, and combination of sleep/awake and probabilistic forwarding techniques [4], [5]. Some of topology-based routing protocols have been proposed that establish routes on-demand [6]. Whereas, these techniques are costly in terms of energy consumption and bandwidth requirement generally. Since, geographical-based routing protocols are inherently robust to topology alters, they can simply choose another next hop if the previously selected neighbor is no longer available [7]-[9].

In geographical -based routing protocols, packet-forwarding decision is locally made based on node positions, consequence achieving to saving energy. There are two specifics greedy forwarding strategies. Primary, distance-based strategy selects a neighbor node nearest to the sink as the next hop. Secondary, direction-based strategy selects a neighbor node, deviation angle from the line connecting the current node and the sink whose is the minimum between all neighbors [10].

In this paper, we propose an innovative routing scheme called Position-Based Routing (PBR) which combines these two techniques along with scheduling in order to select a node with a large distance progress but small deviation angle. In this algorithm, for scheduling sensor nodes have been considered both standby and active mode. These are managed by sentinel nodes. Initially, the sensor nodes are on standby mode. When Sentinel nodes send a signal to them, sensor nodes switch to the active state. Then, the sensor nodes are ready to routing process. Finally, using the routing algorithm based on the position of nodes, target's information sends to the sink In addition, we have focused on routing algorithms, with the review of protocols, have presented new

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algorithms called Position Base Routing (PBR) with greater speed and lower power consumption, and ensure the correct packet is compared to previous algorithms.

Related work:

Our work is closely related to the research work on the target tracking scheme and the protocol design based on energy efficiency for PBR provisioning in WSN.

The majority of routing protocols concentrates on reducing the traffic of packets by clustering, influence geographical information, etc [11], [12]. The Directed Diffusion (DD) is the famous routing protocol of sensor network, without complex routing procedures, the protocol transmits information of sensor nodes by diffusion directly. This plan guaranteed the high delivery rate of data and reserved low latency of transmission. On the other hand, the main problem was waste the power packets in transmission phase. To remedy this, energy-efficient differentiated directed diffusion (EDDD) proposed by KWON[13] . For probabilistic QoS guarantee in wireless sensor networks, Felemban innovate a new packet delivery method dubbed Multi-Path and Multi-SPEED Routing Protocol (MMSPEED).Timeliness and reliability are quality fields in QoS provisioning [14]. These mechanisms for QoS provisioning are comprehended in a localized way without global network information by using localized geographic packet forwarding augmented with dynamic compensation. This way, MMSPEED can guarantee end-to-end requirements in a localized way. Protocol SPEED presented by Abdelzaher, which is one of the best real-time communication protocol for sensor networks [15]. The SPEED, which Provides real-time unicast, real-time area-multicast and real-time area-anycast are types of real-time communication services. SPEED is a highly efficient and scalable protocol for sensor networks where the resources of each node are restrict. Frey demonstrated that under specific flat topology control plans, improvement from a greedy routing failure is always possible without changing between any adjacent faces. We afford complete and formal evidences that a number of proposed face routing and combined greedy-face routing schemes guarantee message delivery in specific flat graph classes. We inspect the behavior of face routing in arbitrary flat networks and reveal, while delivery guarantees cannot be supported in such a universal case, most face and combined greedy face routing variants support at least loop-free operation. For those variants, we extract worst-case upper limits on the number of forwarding paces [16]. Generally, one of the most efficient ways to deploy a WSN over a target area is to cover the whole terrain using minimum possible number of sensor nodes. The main objective of this paper is to design an efficient scheduling scheme to control sensor nodes tasks (sensing + communication) in order to extend network lifetime as much as possible. Basically, scheduling is classified into four main categories including: “always alive”, “random on-off”, “adaptive on-off” and “periodic on-off.

Proposed Model:

In this essay, we have examined estimating and tracking a moving target. It passes through Environment where is controlled by the sensor nods. After getting into the environment, Target is sensed by the first sentinel node. Sentinel nodes have a similar structure with other sensor nodes that are in the simulation environment. However, Sentinel node has the responsibility to control the environment and awaken to the nearest node to itself, when target enters the simulation environment. After receiving the signal of sentinel nodes, Sensor node will change the status from standby mode to be active mode. At this stage, only sentinel nodes was active and other sensor nodes are in standby status. Sentinel nodes are always responsible for monitoring the environment. The sentinel nodes that are closest distance to target active set of sensor nodes in order to collect the status information of target. Positioning target, collecting and routing collected data to the sink is authority of the sensor nodes. For this purpose, we must use appropriate routing algorithms. In order to packets, faster and with less energy reach to the sink. Algorithm proposed in this paper acts based on the geographical location of nodes in the environment (PBR). In this paper, we study the types of nodes, routing algorithms, sentinel nodes, send and receive packets algorithms, an energy consumption calculation algorithm.

A. Nodes:

Because of the importance of energy in the WSN and the lack of rechargeable sensor nodes, energy consumption is a major concern of researchers. Hence, in this paper we have used two types of nodes (sentinel nodes, sensor nodes). Sensor nodes contain two operating mode (standby, active) monitor the environment, and then send data to the sink. Because of All sensors are being activated due to high-energy consumption, these sensors are placed in standby mode. Therefore, certain nodes are defined as the sentinel nodes. Its task is analyzing the target and then, informs the sensor nodes. Using these sensors nodes, we offer a special algorithm in order to increasing the network lifetime.

B. sentinel nodes:

In order to improve the efficiency of network energy consumption, we have used sentinel nodes. We divide network nodes into two types: sentinel and normal. As discussed before, WSN nodes can operate in different

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modes: standby, active, etc. The nodes which operate in standby mode can only receive incoming packets, but active nodes can do everything and they have all the required preparations. In other hands, active nodes consume much more energy rather than that of standby nodes. Due to network efficiency considerations, it is crucial to make nodes active when they are needed to be fully functional. We can divide network performance into many phases. One of the energy consuming phases is the one in which there is no target in the network and nodes senses environment in order to find possible incoming target. In this phase sentinel nodes are active and the other nodes will be standby. The set of sentinel nodes should have one condition: they should cover entire the network target terrain. In other words, union of sentinel nodes sensing range must cover entire target terrain. As you know, each node has sensing range and communication range. Sensing range defines the area which node is able to detect target event. If two nodes are located in each other communication range, they can communicate with each other. We propose following optimization problem in order to find sentinel nodes. Considering coverage efficiency, optimization problem must select sentinel nodes as less as possible. The much less number of sentinel nodes is, the higher energy efficiency is achievable.

$$\text{Min}\left(\sum_{i=1}^{N} IS_i\right) + \left(\sum_{i=1}^{N} IS_i\left(\left\lceil\frac{dis(pos_i, pos_s)}{L_o}\right\rceil . L_o - dis(pos_i, pos_s)\right)^2\right) \quad (1)$$

$$\sum_{1}^{N} IS_i \,.\, EFL_{i0} \geq 1 \quad (2)$$

$$\forall i, \sum_{j=1}^{N} IS_i . IS_j \,.\, EFL_{ij} \geq 1 \quad (3)$$

$$\forall i, \forall j, FL_{ij} . FL_{ji} = 0 \quad (4)$$

$$\frac{\sum_{k=-d}^{+d} \sum_{l=-d}^{+d} \left\lceil \frac{\sum_{i=1}^{N} SC_{kli} . IS_i}{N} \right\rceil}{4d^2} \geq RC \quad (5)$$

$$\forall k, \forall l, \sum_{i=k-1}^{k+1} \sum_{j=l-1}^{l+1} \left\lceil \frac{\sum_{q=1}^{N} SC_{ijq} . IS_q}{N} \right\rceil \geq 1 \quad (6)$$

Equation 1 presents subject. The goal is to minimize the number of selected sentinel nodes while the coverage area is acceptable. There is N nodes in the network. IS_i determines whether nodes i is sentinel ($IS_i = 1$) or not ($IS_i = 0$). $dis(pos_i, pos_s)$ determines the physical distance between node i and the sink (node s). L_o determines the optimum distance between node i and node s, which is calculated based on nodes characteristics. Equation 2, guarantees that at least one sentinel is located at sink's communication range. Equation 3, guarantees that all the sentinels have at least one neighbor. Equation 4, presents that the links between nodes are directed only in one direction. Equation 5, coverage area is presented. Coverage area should be more than RC (required coverage) which is determined by the user. Equation 6 guarantees smoothness of the sentinel nodes in the network. EFL_{ij} determines whether a link exists between node i and node s. SC_{kli} determines whether $Cell_{kl}$ is covered by the node i.

C. Routing algorithm:

In the following, we briefly evaluate the existing proposals. Position-based routing is a routing plan in which each sensor node is presumes to be aware of its geographic position using GPS, and sensor nodes perform packet forwarding based on position of the node. Each node broadcasts a Hello message cyclically to inform its neighbors of its current location. Each sensor node sets up a neighbor information table that saves the locations of its one-hop neighbors, Based on location information. Generally, each packet is routed to a neighbor closer to the sink than the forwarding sensor node itself until the packet deliver to the sink. A fallback mechanism is triggered to overcome this local minimum, if a node does not have any neighbors closer to the sink. In Greedy Face-Greedy (GFG) routing, the protocol switches from greedy mode to face mode to circumnavigate the void. The left/right hand rule consists of "rolling" to the left/right along the edges. When the current node is closer to destination than the node initially starting the face mode, the protocol returns to greedy mode (the void is considered circumnavigated). In Greedy Geographic forwarding (GGF), to forward a packet to sink t, node h simply selects from its neighbor information able the neighbor that is the closest to t. The progress metric of a neighbor i is given by: $P(i) = D_h^t - D_i^t$, where D_a^b imply the distance between two points a and b. The neighbor with maximum progress is selected as the next hop node. As an instance given in Fig.1, node i is selected as the next hop node. By comparison, the projected progress is defined as the distance between existing

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node (i.e., h in Fig.1) and the projection point of a potential next hop node in the Most Forward within Radius (MFR) propose program. In Fig.1, points 1 and 2 are the projection points of i and j on the line-connecting node h and sink t, respectively. Since point 2 is closer to t which indicates j propose more projected progress, j is selected as the next hop neighbor in maximum projected progress-based selection. In contrast, direction-based scheme is based on the deviation angle. The neighbor with the minimum deviation angle (i.e., node m in Fig. 1) will be selected as the next hop node. Compared to the distance-based approach, direction-based plans intend to acquire a path with shorter end-to-end distance; nevertheless, more hop counts is likely to be needed. Basic Position base routing in this section, we first imply the distance- and direction based criteria. In Section III-B, focus on both distance and direction in the routing process. While achieving energy conservation, adjusting the weights of distance and direction in the next-hop-selection criteria can be satisfied in a wide spectrum of application-specific delay requirements. The theory of energy-delay trade- off is motivated by an interesting characteristic of some sensor nodes, which can be exploited to save energy consumption. That is, the sensor node has the capability to transmit at different power levels. Assuming free space transmissions with a path loss exponent 2, the per hop energy is proportional to the square of hop distance. Since a distance-based scheme intends to maximize progress, it may introduce larger hop distance than a direction based scheme. Thus, distance-based method intends to consume higher energy along the path towards the sink node, while the direction-based method impact smaller path energy consumption. However, results in larger hop counts with higher end-to-end delay.

A. Distance- and Direction- Based Criteria:

As illustrated in Fig. 1, let x_i indicate the projected progress of node i; Let θ_i denote the deviation angle between the line connecting h with i and the line connecting h with t. When node i receives a data packet from h, the location of its upstream node h (x_h, y_h) and the sink t (x_t, y_t) are piggybacked in the packet. Node i can next calculate the deviation angle by:

$$\theta_i = \arccos\left(\frac{(D_h^i)^2 + (D_h^t)^2 - (D_i^t)^2}{2D_h^i \cdot D_h^t}\right)$$

Where D_h^i is the distance between nodes h and i, D_h^t the distance between nodes h and t, and D_i^t the distance between nodes i and t. The projected progress can then be calculated by:

$$x_i = D_h^i \cdot \cos(\theta_i)$$

In this paper, x_i is deemed as the distance-based criterion for node i, while $\theta_i = D_h^i \cdot \sin(\theta_i)$ or $y_i = D_h^i \cdot \sin(\theta_i)$ is deemed as the direction-based criterion for node $i.^2$.

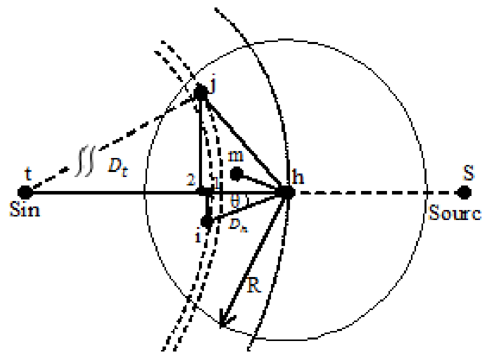

Fig. 1: Illustration of distance-based and direction-based schemes.

B. Joint Distance- and Direction-based Routing Decision:

Let Q_i indicate node i's eligibility (or priority) as the next hop. The greater the x_i, the larger the Q_i; the lower the θ_i. We can define different forms for Q_i to combine both the distance- and direction-based routing criteria.

C. The Weighted Joint Routing Decision:

The Q_i meanings in Section III-B are deterministic in the sense that the relative weights of distance-based and direction-based criteria are fixed. To adjust the impact of x_i on node i is properly as the next hop node, we can combination a weight factor (with exponent α) into the basic criteria given in Section III-B. An example of the weighted criteria is shown in Eqns. (7). This also could be some other variations. although, all the weighted hybrid criteria should follow a common law: if α is small, its second term is negligible and the routing method operates like a direction based technique, the second term in the equation dominates the first term, and the routing mechanism operates like a distance- Based technique.

$$Q_i = (1 - \alpha).\left(1 - \frac{|\theta_i|}{90^{\circ}}\right)^2 + \alpha.\left(\frac{x_i}{R}\right)^2 , \alpha \in [0,1]. \quad (7)$$

D. Adaptable Energy-Delay Trade-off:

We have researched on various definitions of weighted criteria. The PBR strategy is proposed to improve the energy efficiency of scalable transmission for delay-sensitive traffic by performing trade-offs between energy and delay depending on the network dynamics and application requirements in wireless networks. As shown in Fig. 2, energy and delay of both direction- and distance-based method remain constant since changing α has no effect on them. By evaluation, it can be observed that energy and delay show a trade-off relation with regard to α in PBR. As expected, for negative values of α, PBR behaves like a direction-based method attaining lower energy consumption, nonetheless for positive values of α, PBR behaves like a distance-based scheme yielding a power delay. Fig. 2 illustrates the energy-delay trade-offs in PBR, where a higher α value results in a lower delay, but simultaneously, a higher energy consumption owning to the larger hop distance. Given a specific delay requirement, it is desirable to alter α to a value as low as possible to decrease energy consumption, while satisfying the delay requirement.

Send and receive packets algorithm:

In proposed algorithm, data transfer processes are based on packet to packet. Nodes that have data to send refer to its own buffer and then send the first packet of the beginning of the buffer queue. After that, decrease a packet from the buffer queue. Consequently, again refer to the buffer if the buffer is empty, Transport of packets have finished. Otherwise, this procedure has done to empty the buffer. In the other side, a node that receives the packet adds it to the end of the buffer queue.

Simulation Methodology:

In this paper, environment of wireless sensor networks have simulated by MTLAB software. This software is one of the most useful software simulators for simulate environment of wireless sensor network. Significant advantages compared to other applications are a structured function and a dynamic work environment. These factors are causing the output at any moment, and display them on the charts with minimum error, because every detail has been considered in the simulation environment by coding. Therefore, the output has the highest level of accuracy. Then, our papers (PBR) have compared in term of Energy Consumption, Routing Algorithm with similar papers that can mention to papers of Mr. Zhang (EBGR).

A. Position Base Routing (PBR):

Simulations have located in environments with the dimension 1000 m × 1000 m. In this environment, a number of sensor nodes that are marked with the symbol of the circle (Figure 2) are randomly distributed. For the first time the target enters the environment. The target have sensed by sentinel nodes that have similar structure with sensor nodes and are marked with the symbol of the small diamond, after active are marked with symbol of the big diamond (Figure 2). Then, sentinel nodes select sensor nodes in order to relay nodes that have the responsibility of target track and are shown with the symbol of the asterisk. After receiving data from the target, relay nodes coordinate with proposed algorithm start to send information to the sink that are shown with symbol of the home. Finally, this process continues to send all of the packets to the sink. This procedure continues to target get out of the environment.

A. Energy efficiently Geographical Routing (EBGR):

This algorithm is based on the signals time delay to the nearest sensor nodes (are marked with the symbol of the circles in Figure 3) is called a Greedy routing algorithm. After entry target to the environment, the first sensor nodes analyze target coordinates. Then, send a signal to the sensor nodes that are in its radio range and toward the sink and nodes that receive this signal in response to this signal, send answer signals. Answer signals (minimum time delay) are analyzed by main nodes in order to realize that which Sensor node is located near to it. Finally, send packets to it. This Routing algorithm continues to reach the packets to the sink. This procedure is continuing to out the target from the environment.

D. Compare Energy consumption:

As in the previous section according to Figures 2 and 3 that the proposed algorithm described in this section, we examine the Energy Consumption, according to Figures 4 and 5 examine. Claims raised in this paper regarding the simulation results (Figures 4, 5) have been challenged. Figures 5 have derived from Mr. Zhang papers that have stimulated by MATLAB software. As mentioned previously, it is clear that the energy consumption in WSNs has a special significance. Therefore, our proposed algorithm and an algorithm Mr. Zhang have equal condition (the simulation environment in terms of the number of nodes (333) and the initial energy of each sensor node (5000 Jul) (Figures 4 and 5). Obviously, the energy consumption in our proposed algorithm (6362 Jul) is approximately halved algorithms Mr. Zhang (12906 Jul).

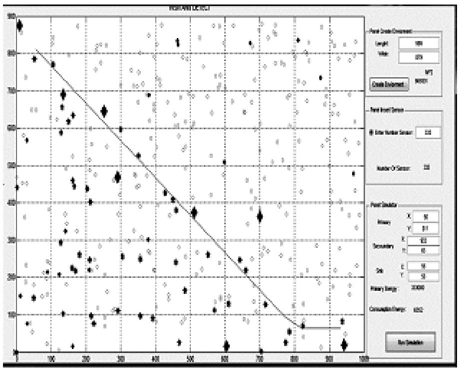

Fig. 2: Example of PBR algorithm simulation.

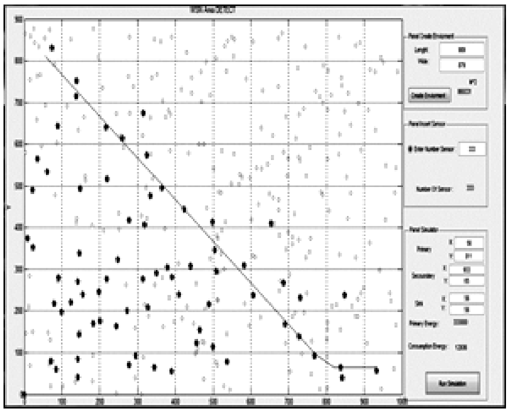

Fig. 3: Example of EBGR algorithm simulation.

Conclusion:

our paper indicated a new routing protocol based on position of nodes in region to acquire an efficient trade-off between energy consumption and time delay performance, called Position Based Routing(PBR). In this routing algorithm, we used a new technique that is based on sentinel nodes. Owning to the presence of sentinel nodes, all sensor nodes of wireless sensor network (WSN) do not need to be activated. Sensor nodes become active, when they had a responsibility to send packets to the sink. Furthermore, we used a novel hybrid method based on direction and distance to achieve properly neighboring nodes as the next hop relay. Tremendous simulations demonstrate that combination these methods in PBR schemes can achieve a flexible trade-off between delay and energy.

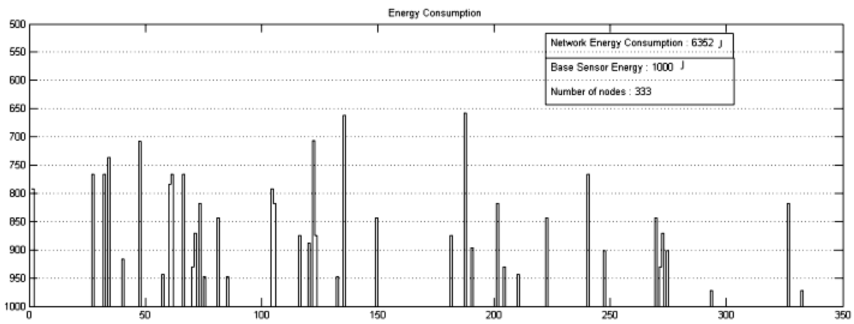

Fig. 4: Example of PBR algorithm energy consumption simulation.

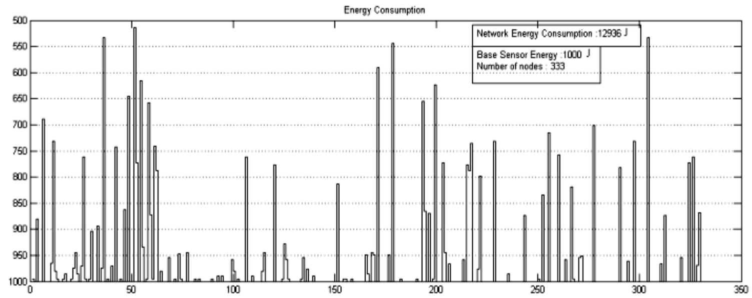

Fig. 5: Example of EBGR algorithm energy consumption simulation.

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