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SINK RELOCATION FOR NETWORK LIFETIME ENHANCEMENT METHOD IN WSN

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Abstract—Recent advances in micro manufacturing technology have enabled the event of cheap, normal power, unique functional detector nodes for the wireless communication. Sensing applications have normal conjointly as a reality of result. These embrace environmental observation, intrusion detection, battleground police work, and so on. In a very wireless detector network (WSN), the way the restricted power resources of sensors to increase that to conserve the network lifespan of the WSN as long as double whereas activity the sensing and detected knowledge news tasks, is that the most important issue within the network style. In a WSN, detector nodes deliver detected knowledge back to the sink as multi hopping. The detector nodes are very close to the sink can usually consume additional battery power than others; consequently, these nodes will been drain out their battery energy quickly and short the network lifespan of the WSN. Sink relocation have associate degree economical network lifespan extension methodology, that could avoids an excessive amount of battery energy for a selected cluster of detector nodes. during this paper, we have a tendency to propose a moving strategy known as energy-aware sink relocation (EASR) for mobile sinks in WSN. These projected mechanism uses info associated with the residual battery energy of detector nodes to be adaptively alter the transmission vary of detector nodes and therefore the relocating theme to the sink. Some theoretical and numerical analyze area unit given to point out that the EASR methodology will extend the network lifespan of the WSN considerably

Index Terms—Energy-aware routing, mobile sink, sink relocation, wireless sensor networks.

I. INTRODUCTION

A wireless sensor network, which is a key network to facilitate ubiquitous information environments, has attracted a significant amount of interest from many researchers. A wireless sensor network has a wide range of applications, such as natural environmental monitoring, environmental control in residential spaces or plants, object tracking, and precision agriculture. In a general wireless sensor network, hundreds or thousands of micro sensor nodes, which are generally compact and inexpensive, are placed in a large scale observation area and sensing data of each node is gathered to a sink node by inter-node wireless multi-hop communication. Each sensor node consists of a sensing function to measure the status of an observation point or object, a limited function on information processing, and a simplified wireless communication function, and generally operates on a resource of a limited power-supply capacity such as a battery. Therefore, a data gathering scheme and/or a routing protocol capable of meeting the following requirements has been mainly studied to prolong the lifetime of a wireless sensor network.

1. Efficiency of data gathering
2. Balance on communication load among sensor nodes

As the scheme that satisfy the above two requirements, gradient-based routing protocol has attracted attention. However, this does not positively ease the communication load concentration to sensor nodes around a sink node that is the source of problems on the long-term operation of a wireless sensor network. In a large scale and dense wireless sensor network, the communication load is generally concentrated on sensor nodes around a sink node during the operation process. In case sensor nodes are not placed evenly in a large scale observation area, the communication load is concentrated on sensor nodes placed in an area of low node-density. Intensive data transmission to specific nodes, such as sensor nodes around a sink node and sensor nodes placed in an area of low node-density, brings on concentrated energy consumption of them and causes them to break away from the network early. This makes the long-term observation by a wireless sensor network difficult. Each sensor node, in this scheme, sends sensing data to the nearest sink node. In comparison with the case of a one-sink wireless sensor network, the communication load of sensor nodes around a sink node is reduced. In the existing studies, however, the effective locations for sink nodes, which are an important design problem for the long-term operation of a wireless sensor network, have not been discussed.

The applications of WSNs are broad, like weather monitoring, field police work, inventory and producing processes, etc. In general thanks to the sensory environments being harsh in most cases, the sensors in a very WSN aren't able to be recharged or replaced once their batteries drain out of power. The battery drained out nodes may cause many issues like, acquisition coverage hole and communication hole issues. Thus, many WSN studies have engaged in coming up with economical strategies to conserve the battery power of device nodes, as an example, designing duty cycle programming for device nodes to let a number of them periodically enter the sleep state to conserve energy power, but not harming the in operation of the sensing job of the WSN coming up with energy-efficient routing algorithms to balance the consumption of the battery energy of every device node [9]–[15]; or exploitation some knowledge aggregation strategies to aggregate similar sensory data into a single datum to reduce the number of transmitted messages to extend the network lifetime of the WSN.

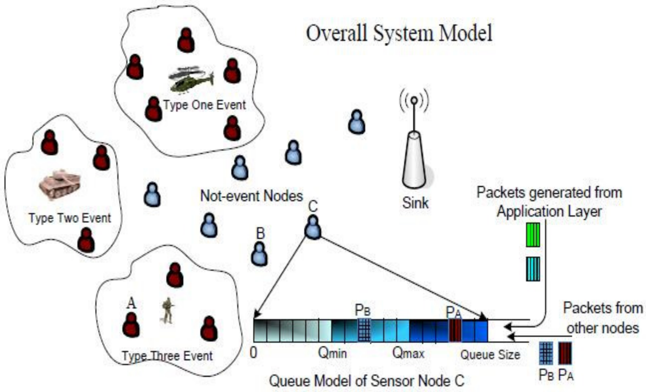

Fig.1.operating scheme of WSN

The other energy protective approach is to use mobile sensors to regulate their locations from a part with a high level of total battery energy of nodes to an occasional energy region[18]–[24]. Though this approach will extend the network lifetime of a WSN, the relocation of sensing element nodes will expand their battery energy. A compromise approach is to use a mobile sink to relocate its position rather than relocating the sensor nodes [25]–[31]. sensing element node a close to the sink can quickly drain out its battery power when relaying many rounds of detected information with reportable tasks being performed by different sensing element nodes, and consequently the WSN can die. we have a tendency to decision node a hotspot. In the case of the sink being capable of moving, before the hot spot node a drains out all of its battery energy, the sink will move to a different position to alleviate the case of heavy energy consumption of node a. As within the example of the right a part of Fig. 2, the sink relocates its position from thenearby node a to node b. In such the way, the role of the new spot are going to be interchanged from one node to a different node and consequently the network period of time are going to be extended.

In this paper, we have a tendency to propose a sink relocating theme to guide the sink once and wherever to maneuver to. Some mathematical performance analyses ar given to demonstrate that the planned sink relocating theme will prolong the network lifetime of a WSN. we've conjointly conducted simulations to investigate the performance of the EASR technique against some traditional strategies by numerical simulation. The organization of this paper is as follows. within the next section we'll concisely describe some background associated with the thought-about drawback, which includes the energy model of a WSN, the energy efficient routing theme which will be incorporated into the EASR theme, and therefore the connected works of sink relocation. In Section 3, we'll describe the EASR theme thoroughly. The performance analysis, which has each theoretical and numerical analyse is conferred.

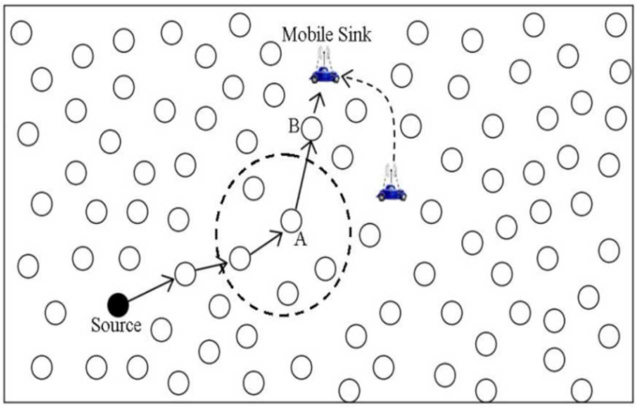

Fig.2.sink relocation of WSN

II. THE BACKGROUND AND RELATED WORKS FOR THE SINK RELOCATION

The EASR theme in the main focuses on once the sink can be triggered to perform the relocation method and wherever to move to. Besides the sink relocation theme, the entire operation of the WSNs for surroundings observance additionally desires to incorporate the routing technique for reportage the detected knowledge from the supply to the sink, yet because the energy consumption model. During this section, we'll first in short describe the energy consumption model for message relaying. Then, the energy-aware routing technique that's adopted in the EASR technique are illustrated employing a numerical example. At the tip of this section, some connected analysis works for sink relocation will be self-addressed.

A. *The Energy Consumption Model for WSNs*

In our thought of energy consumption model, we have a tendency to adopt the first order radio model [1]–[3] for later performance simulation. Let $E_{Tx}(k, d)$ denote the overall energy required in a very device node to transmit (and receive) a k-bits length message to (and from) a neighboring device node at distance d away, severally. The energy consumed for message sending $\left(E_{Tx}(k, d)\right)$ are often divided into 2. The first half is that the energy consumed within the transmitted electronic part and is adequate to $E_{ele} \times k$, wherever Eelec denotes the energy consumed for driving the transmitter or receiver electronic equipment. The second half is that the energy consumed in the electronic equipment part and is adequate to $\in_{amp}$ ×k $\times d^n$, where amp denotes the energy needed for the transmitter electronic equipment. Note that, the receiving method performed in a very device node only includes the primary a part of the energy consumption. Summarizing the higher than descriptions, the overall energy consumption for message sending and receiving is as follows.

$$E_{Tx}\,(k, d) = E_{elec} \times k + \in_{amp} \times k \times d^n$$

$$E_{Rx}(k) = E_{elec} \times k$$

Note that, during this paper, we have a tendency to let n =2, Eelec = 50nJ/bit, and amp = 100pJ/bit/m2 in Equations (1) and (2) for later simulation.

B. *Sink Relocation and Related Works*

In general, WSNs is classified into 2 classes, stationary and relocatable WSNs, reckoning on whether or not the nodes are capable of moving or not. once a stationary WSN is deployed in an exceedingly sensing field, every sensing element node locates at a fixed position to perform round-and-round of sensing and message reporting/relaying tasks till a sensing element node (or a portion of the sensing element nodes) drain out their battery energy; then the WSN dies. For the class of relocatable WSNs, sensor nodes or the sink are capable of moving. because the total energy level of a vicinity drops right down to a coffee level state or there are some sensing holes or communication holes within the region as a result of some sensing element nodes debilitating out their battery energy, then some mobile sensors will relocate their locations and move in this region to alleviate the higher than drawback. Although this approach will prolong the network time period of the WSN, the relocating sensors also will consume their battery energy to perform the relocating task. As mentioned antecedently, sink relocation could be a compromise approach for prolonging network time period and also the sensing element nodes stay stationary to conserve battery energy. In the different class of sink relocation, the autonomous sink movement theme [28]–[31], the sink can perpetually collect close device nodes' connected info (such because the residual battery energy) then, supported this info, plan once to maneuver and wherever to maneuver to. within the following, we will introduce 2 sink relocation schemes of this class. Sun et al. [28] projected a mobile sink relocation theme to drive the sink to successive position by taking the conditions of close nodes' residual battery energy for each of the relocating steps, the determination criteria for selecting AN intermediate moving destination area unit as follows. At first, the sink collects the residual battery energy from every device node among the communication vary of the sink. Then, it select the device node within the direction heading to the moving destination and among the transmission vary of the sink, such it's the most residual battery energy worth among the device nodes. Set the intermediate moving destination to be the position of the chosen node and to relocate the sink to the current position. On this fashion, the mobile sink can relocate itself from one intermediate moving destination to the opposite and at last it'll reach the moving destination. At last, because the sink enters to the communication range of the moving destination, it'll move circularly around 6 points at the communication vary border.

III. THE PROPOSED ENERGY-AWARE SINK RELOCATION (EASR) METHOD

In the EASR technique, we have a tendency to incorporate the technique of energy-aware transmission vary adjusting to tune the transmission range of every sensing element node consistent with its residual battery energy. within the case of the residual battery energy getting low when acting rounds of message relaying and environment sensing tasks, then its transmission vary are tuned to be tiny for energy saving. Moreover, the relocating decision created by the sink can take the routing protocol, (which has been delineate within the previous section) as the underlying message routing so as to achieve the benefit of prolonging network life. Note that the underlying message routing technique could have an effect on the performance of the whole operating theme (the sink relocating and also the message routing) significantly because the parameters of the routing rule vary. Although the EASR technique is incorporated with any existing routing technique, we have a tendency to selected the MCP because the underlying routing technique to limit the higher than influence since the sole parameter of the MCP is that the same because the call parameter of the projected EASR method; that's the residual battery energy of the sensing element nodes. The projected EASR consists of 2 components, the energy-aware transmission vary adjusting and the sink relocation mechanism that area unit delineate as
follows.

A. Energy-aware transmission range adjusting

In general, a bigger transmission vary set for a detector node can increase the amount of neighbors and consequently enhance the standard of the energy-aware routing; but, it also bring the disadvantage of longer distance message relaying, which will consume a lot of battery energy of a detector node. On the contrary, for a shorter vary of communication, although it doesn't facilitate an excessive amount of for routing, it will conserve the usage of the residual battery energy. within the projected technique, the transmission vary adjusting can rely upon the residual battery energy of a detector node. we have a tendency to classify detector nodes into 3 sorts by the ’healthy’ state of their battery and adjust their transmission vary consequently. Let B be the battery energy worth once the battery energy is full within the beginning and r (u) denotes the present residual battery energy of a detector node $u \in V$. within the case of $0 \leq r(u) < B/3$ (and $B/3 \leq r(u) < B/2$), then detector node u belongs to sort I (and II) detector node and that we set its transmission range to $\gamma/4$ (and $\gamma/2$), severally, wherever γ denotes the initial transmission vary of a detector node. For the case of $B/2 \leq r(u) \leq B$, the detector node u is incredibly healthy for its battery energy (type III node) and that we set its transmission range to γ (see Fig. 7). Intuitively, a ’healthy’ detector node can adapt a bigger transmission vary to shorten the routing path, whereas a detector node with solely a bit residual battery energy will tune the transmission vary to be little to conserve its residual energy. so associate degree all-mains transmission vary adjusting mechanism will enlarge the life of a detector node and the network life.

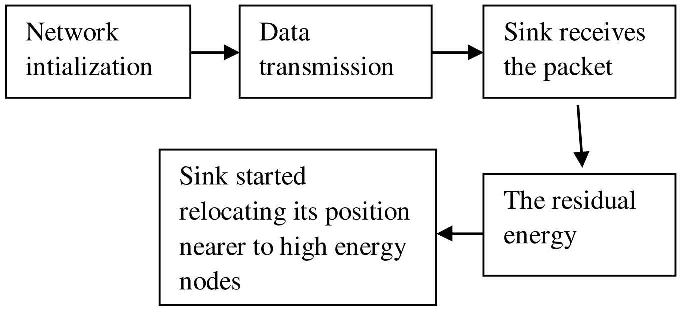

Fig 1Proposed system of sink relocating

B. The sink relocation mechanism

This mechanism consists of 2 components. the primary is to see to trigger the sink relocation by determining whether a relocation condition is met or not. The second half is to see that direction the sink is heading in and the relocation distance moreover. For the relocation condition, the sink can sporadically collect the residual battery energy of each detector node within the WSN. once the collection method is completed, the sink can use the MCP routing protocol to compute the utmost capability path P∗ us with relevance every sensor neighbor u of sink s. for every most capability path P∗ us , we have a tendency to denote the utmost capability worth with relevance P∗ us as c(P∗ us). Let the gathering of the detector neighbors of s be N. Then the relocation condition are going to be met once one amongst the following conditions occurs: (1) once one amongst the capability values c(P∗ us) with relevance the detector neighbor u in N drops below B/2; or (2) the typical residual battery energy of the neighbor set drops below B/2. which means the residual energy of the nearby device nodes of the sink become little or the residual energy bottleneck of some routing ways falls below a given threshold (B/2). Then the sink relocation mechanism are performed to relocate the sink to a brand new position, which can enlarge the network life. In the case of the sink having to relocate, it'll first of all determine the positions of the moving destination. The moving destination has four candidate positions, SC1, SC2, SC3, and SC4, which square measure settled within the right, up, left, and down direction γ distance far from this position of the sink. Let the neighbor set metal with reference to every moving destination candidate S_{ci} $(1 \leq i \leq 4)$ be the gathering of sensor nodes that's settled inside the circle targeted at node S_{ci} with radius γ, severally. Let a weight price Wisconsin that's associated with every neighbor set metal, $1 \leq i \leq 4$ be

$$w_i = \min\left\{\frac{c(p^*_{us})}{u} \in N_i\right\}, where\ c(p^*_{us}) denotes \text{maximum capacity value of } P* us$$

Then, the relocating position $S_{ci}*$ are chosen from SC1 , SC2 , SC3, and SC4 , specified the load worth w_i* with respect to $S_{ci}*$ is that the most worth among WI $(1 \leq i \leq 4)$. Now the sink s can relocate itself to position $S_{ci}*$ Intuitively, the weight worth WI of a candidate position represents the residual energy bound among the bottleneck worth of the routing paths to the sink once the sink relocate itself to the candidate position $S_{ci}*$. so the EASR methodology can drive the sink to the candidate position of the best worth among the four candidate positions by adopting 'healthy' routing ways to transmit the message to reinforce the network period of time. After the sink relocates to the new position, the on top of processes (the residual battery energy grouping, the relocating condition checking) are iteratively performed. within the case of the relocation condition yet again being met, then the relocation process also will be invoked once more.

IV. ANALYSIS

A. Analysis *of prolonging network lifetime by sink relocation*

Generally, not solely the sink relocation could enhance the network period of a WSN, however the underlying network routing protocol and also the applications (abnormal event reportage or constant detected information collecting) running in an exceedingly WSN can all significantly have an effect on the performance of the network period. Thus, the network period modeling of a WSN for sink relocation is extremely sophisticated. during this segment, we will propose a simplified hierarchy network model to represent the logical read of a WSN. Every grid node u in the network represents a gaggle of detector nodes, which are located inside a hoop space focused at the geographical position xu with radius γ .

$$k(u) = \sum_{u \in Nu} r(u)$$

B. *Numerical analysis*

In order to analyze the performance of the EASR theme, we conducted many simulations in four completely different situations which will be delineated later. The compared ways area unit the EASR, ballroom dancing Moving theme [29] and also the stationary sink scheme. The stationary sink theme assumes that the sink is not capable of moving and remains stationary in the slightest degree times. In our simulations, the projected technique and also the alternative 2 compared ways all adopt the MCP [11] routing protocol as
the underlying routing for message reportage. The comparison factor is that the network period of a WSN, that the network lifetime is outlined to be the amount of message reportage rounds performed before the primary sensing element node drains out its battery energy. The simulation atmosphere settings area unit as follows. we have a tendency to assume that the sensing element nodes area unit all stationary after the readying, however the sink is capable of moving except for the stationary sink theme. The transmission vary (γ) of the sensing element nodes and also the sink area unit fastened for the ballroom dancing Moving theme and also the stationary sink theme, while the transmission vary is tunable within the EASR technique, which has been mentioned in Section three. The energy depletion throughout the execution of the message reportage is consistent with the first order radio model.

The four simulation eventualities of one, 2, three and four compared the ensuing network life performance of algorithms by varying the amount of sensing element nodes, the initial battery energy of the sensing element nodes, the dimensions of the simulation areas, and the transmission ranges, severally. In every simulation instance, we conducted the experiment a hundred times then took the average price of the comparison issue (the network lifetime).

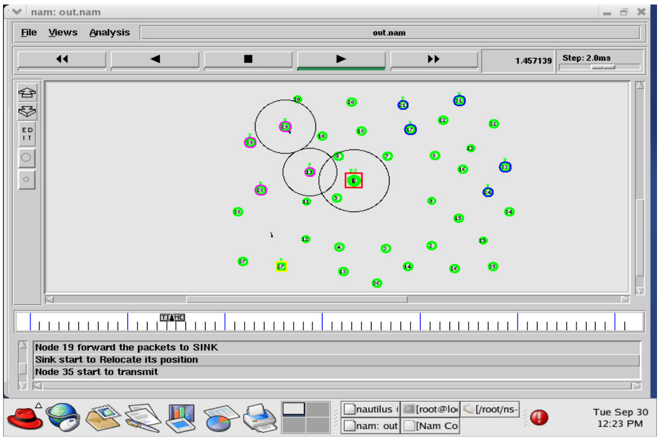

Fig. a Performance of node forward packet to sink

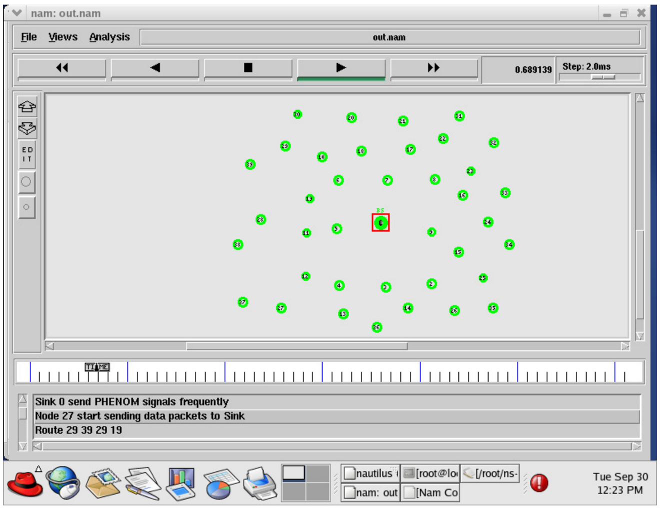

Fig. b Performance of sink send signal frequently

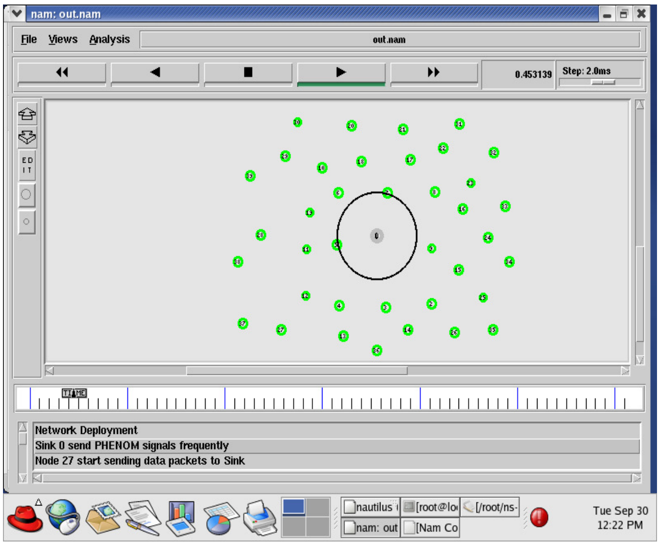

Fig. c Performance of network deployment

The performance results for network time period comparisons when the initial battery energy varied the EASR conjointly outperformed the other schemes because the initial battery energy varied. And as the initial battery energy exaggerated, the gap within the performance results exaggerated between the EASR technique and also the different two compared schemes. during this figure, the stationary sink scheme conjointly has the worst performance results. The network time period comparisons in simulation state of affairs a pair of with varying initial battery energy The network time period comparisons in simulation state of affairs three with varying size of simulation space. when the dimensions of the simulation space and also the transmission range vary, severally. Note that, for every instance of size of simulation space, the amount of nodes varies consequently. For example, the instance of simulation are the variety of detector nodes deployed during this area is capable one hundred conjointly show similar performance results as in simulation situations one and a couple of. Moreover, the network time period exaggerated because the transmission vary increased for the EASR technique and also the different 2 compared methods. Since a transmission vary is setting to be larger, the routing path length are going to be ablated and also the variety of neighbors with relevance the sink will be exaggerated. The amount of residual battery energy within the hot spots for performing the message relaying task to the sink are going to be increased, which could then increase the network time period of a WSN.

V. CONCLUSIONS

The battery energy speed could be depleted of detector nodes will considerably have an effect on the network life of a WSN. Most researchers have aimed to style energy-aware to conserve routing the usage of the battery energy to prolong network lifetimes. A relocatable sink is another approach for prolonging network life by avoiding staying at a particular location for too long which can damage the life of near detector nodes. This approach cannot solely relieve the burden of the hot-spot, however also can integrate the energy-aware routing to enhance the performance of the prolonging network life. In this paper, we've got projected Associate in Nursing energy-aware sink relocation method (EASR), that adopts the energy-aware routing MCP because the underlying routing methodology for message relaying. Theoretical analysis is given during this paper to demonstrate that EASR will prolong the network life of a WSN. In addition, the simulation results show that the EASR methodology outperformed the opposite compared strategies within the network lifetime comparisons beneath four totally different simulation eventualities.

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