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GRID-BASED DESIGN FOR DUAL MONITORING APPLICATIONS IN WSN WITH MOBILE SINK

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Abstract: Wireless sensors are used in ample number of applications for sensing different data. They are used in environmental monitoring or event based, but applications requiring both are not very familiar. These kinds of applications require data to be delivered based on the deadline. Such hybrid systems are considered and a method feasible for both is proposed in this paper. Sensors are grouped into clusters and group heads are selected based on some parameters which will help to save energy, balance the network as well as extend the lifetime. The sensors collect data and send to group heads using TDMA and data is collected by mobile sink time slots are allotted for time sensitive event data. The proposed technique is implemented in NS2 and compared with existing algorithms in terms of lifetime, delay etc. The proposed procedure has 15% more lifetime than previous methods.

Keywords: WSN; Fuzzy; MAC; Mobilesink; Routing.

I. INTRODUCTION

. Wireless sensor networks (WSN) have gained popularity due to various applications. Sensors forward the sensed data to the base station (BS). The main concern is limited battery which is difficult to replace due to harsh environmental conditions. Many routing algorithms have been proposed to save energy and extend the lifetime. These algorithms implement clustering, data aggregation etc., to save energy. But in network with stationary sink the nodes near by the sink exhaust battery faster due to high traffic near the sink which will disconnect the network and result in data loss. To solve this mobile sink were designed. Mobile sink helps in collecting data from isolated parts of the target region, reduces the hop counts which in turn save energy.

WSN are deployed to sense periodic data as well as event based. In periodic monitoring sensors are deployed to sense data from the application field and transmit it to the base station at fixed intervals. Where as in event based the sensors report if they sense any specific event according to some predefined value. In [1]–[3] event-based monitoring are implemented. In [4]–[6] virtual grid-based, fuzzy based methods are proposed for periodic monitoring (PM).

But certain applications require both types of monitoring simultaneously. As in temperature monitoring sensors can monitor the temperature periodically and also detect fire. Such applications require different MAC protocol which gives priority to critical event data. In this work a MAC algorithm for such applications is designed which has reserved slots (RS) for sensitive data. Groups are formed and each sensor is assigned a group head (GH). The sensors report to the GH and mobile sink (MS) fetches the data from the GHs and send to the BS on priority basis. The proposed method focuses on reducing the power usage.

Rest of the wok is divided likewise: section II briefs previous works, III explains the proposed work, the results are given in IV and conclusion is given in V.

II. LITERATURE SURVEY

For conserving energy many protocols including bio-inspired algorithms like swarm intelligence have been designed [7]. Many routing protocols for saving energy and reliable data transmission wireless sensor networks for both delay tolerant and delay sensitive applications have been proposed previously [8]–[11]. But very few works like [12]–[14] can be applied to monitor both periodic data and events simultaneously.

In [3][2] a mobile sink-based method for collecting event data is proposed. Here the MS moves only upon the detection of an event, in this way energy is saved. In [15]a distributed method routing protocol using hybrid nodes normal and energy harvesting nodes is proposed which reduces the energy consumption.

In [16] a protocol for target-based applications is implemented, where the sensors collect data and forward it to the gathering points. A delay-aware MS path is formed for data collection from the gathering points. A distributed method for renewal of gathering and target sensing points is proposed along with fault detection and recovery algorithms.

In [12], [14] a method for applications requiring both event based and PM are is proposed which will help in reducing delay. Separate cluster for event detection is formed. But forming different cluster consumes more energy.

In the proposed method the same cluster is used for both event based and PM, which helps in conversing energy. And TDMA slots are allocated to the sensors in a group which will avoid collision.

III. PROPOSED WORK

At first sensors are randomly distributed in application sensing area. Following assumptions are made,

- All the sensors have same and limited energy.
- All the sensors have same communication range
- All the sensors know their locations.

- MS has unlimited energy.

The network is divided into virtual grids as in[17]. The grids are formed depending on the number of nodes. The junction point of the grids is considered as sojourn location for mobile sink stopping point.Group formation, GH selection, MS path formation and proposed MAC are explained in the below subsections.

A. *Forming Groups and Mobile Sink Route*

The sensors in a grid cell are considered as a group and the GH is selected using fuzzy interference system (FIS) [18]. The block diagram of fuzzy inference system is given in fig.1. For selecting the group head remanent energy, number of neighboring nodes and node location are given as input variables and the obtained output is the GH set. All the nodes send the collected information to GH, so the node with high remanent energy, a greater number of neighboring nodes and center in the cell are selected as GH.

- The remanent energy can be calculated as follows,

$$R_a = BE_a - UE_a \tag{1}$$

Here BE is the beginning energy of the node a and UE is the utilized energy.

- Number of neighboring nodes can be calculated as,

$$N_a = \sum_{n=1}^{CR_a} N_n \tag{2}$$

Here N is the number of neighbors in the communication range of a.

The fuzzy values high, medium and low are taken. The GH are selected based on these values. The MS collects the data from the GH so after the formation of GH the path of MS is formed using travelling salesmen problem.

B. *Proposed MAC*

Periodic monitoring data is considered as normal data and event data is considered as sensitive data. The sensors differentiate the data according to the predefined value. Event data is assigned reserved slots. After the group formation the GH assigns TDMA slots to its nodes. During PM the nodes wakes up at the assigned time transmits the data to the GH and sleep the rest of the time, whereas the GH is active throughout its period. In this way energy is conserved and data collision is avoided. When an event is detected, the node informs the GH with eventdect_msg. The GH provides immediate slot access to the node and nodes transmitting PM data are given second priority and wait for their turn. Once all the nodes finish transmitting the data is collected by the MS and forwarded to the BS.

IV. PERFOMANCE ANALYSIS

The proposed algorithm is implemented in NS2 and compared with existing algorithms VGDRA [17], DAEDT [19]. The simulation with different number of nodes and varying communication range in a 250*250m2 target area to evaluate the performance of proposed technique. Table 1 presents simulation parameters.

Table I. Simulation Parameters

Parameters	***Values***
Area	250×250 m^2
Propagation Type	Two-way ground
Sensors	60-260
Initial energy	100J
Transmission	0.02J
Receiving	0.01J

Fig.1 shows graph for average energy consumption of the sensors with varying communication range. The energy consumption of AVG is less when compared to the other two methods. This is due to the distributed selection of GHs and data collection through MS.

Fig.2 shows graph of different communication range versus delay. The proposed method outperforms against other methods for delay. For each grid only one GH is selected which reduces trajectory length of the MS and The MAC protocol reserves slots for sensitive data which will be delivered to the BS fast.

Graph for packet delivery ratio is given in fig.3. Results show that the proposed method AVG provides improved packet delivery ratio among all the simulated methods. Improved Packet Delivery is due to the MAC protocol used which avoids collision of data.

Graph for network lifetime is plotted in fig.4. The proposed AVG has more lifetime when compared to other two methods. The enhanced lifetime is due to distributed selection of GH and consideration of remanent energy in selecting the GH. The use of mobile sink instead of static sink has also contributed in improving the lifetime.

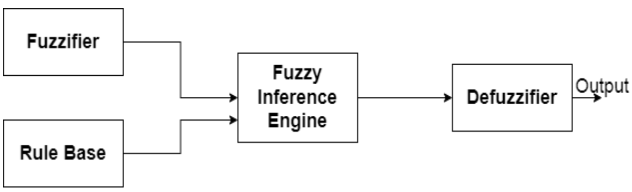

Figure 1. Fuzzy Inference System.

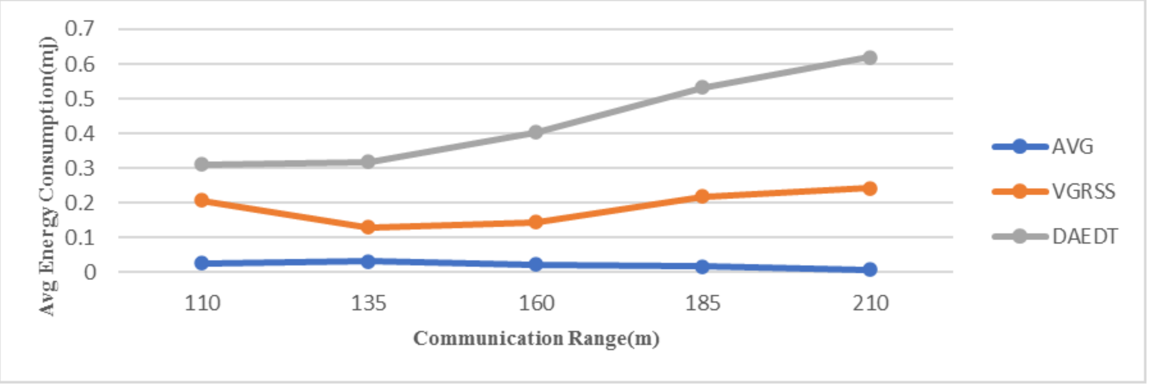

Figure 2. Average Energy Consumption

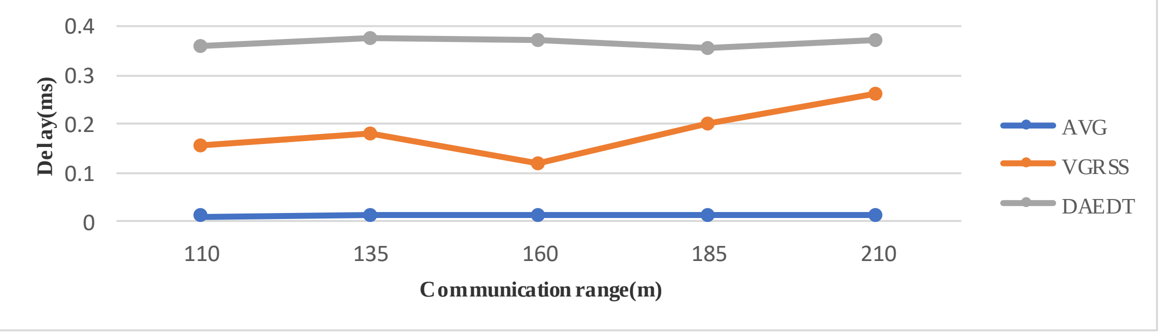

Figure 3. Delay

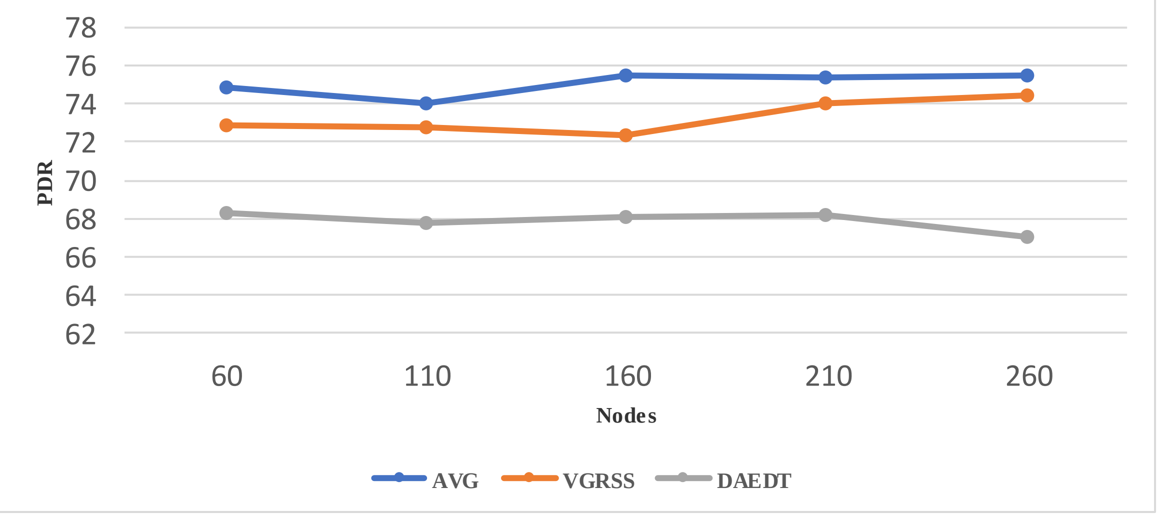

Figure 4. Packet delivery ratio

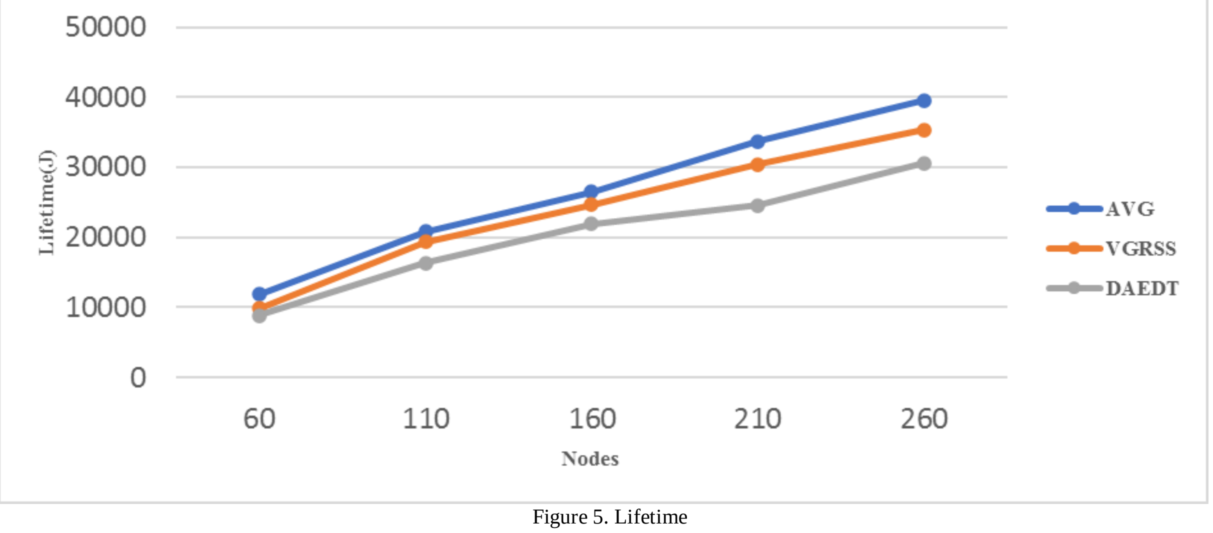

Figure 5. Lifetime

V. CONCLUSION

Mobile sink-based hybrid algorithm for periodic monitoring and event monitoring is proposed. The nodes are divided into virtual grids, the nodes in each grid are considered as a group. The group head is selected using FIS and all the nodes send the collected information to the GH using TDMA. The MS moves to the GH collect the data. The proposed method has reduced delay and better packet delivery ratio which is vital for critical application. Results prove that the proposed technique has reduced energy consumption and improved network lifetime.

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