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Route Max-A Unique Energy Efficient Routing Algorithm in Wireless Sensor Network

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Abstract: In large sensor network, data cannot be synced and needs multi hop routing to reach the destination from source. Selecting optimal routing path itself a big deal for present day sensor network. Most complex form of sensor network deployed in various farms such as military, DMZ regions, agricultural areas, etc. This make sensor networks to take advantage over multihop fashion with limited power backup and memory which in turn derives many security researchers towards WSN routing. In this study, we propose a novel routing protocol called "Route Max" for energy efficient routing in WSN. In order to achieve prolonged battery life and network lifetime, a hierarchical network tree structure is formed. The model is robust during cluster head selection by selecting limited power usage sensors along with sinks using hybrid form map model (combination of closed map and power law escape).

Key words: Route max, routing, WSN, buffer size, nodes, head

INTRODUCTION

Recent advances in cloudification of things, microchip and onboard computers made more attraction towards sensor nodes and sensor networks (Zhang *et al*., 2016; Zhou *et al*., 2016). Sensor nodes are more autonomous integrated environment which can be deployed in any physical factors (Xie *et al*., 2017). Present day sensor networks were more robust and autonomous communication mode through cloud infrastructure was widely used in most of the sensor network (Cheng *et al*., 2016). Communication protocol and routing data packets through the communication protocol was one of the major critical task which a sensor network poses. Existing routing protocol deployed in sensor networks were robust in routing and requires more energy to route the packet (Ye *et al*., 2016; Shahzad *et al*., 2016; Kavitha and Kannan, 2016). Hence, an optimal routing protocol is required to route the data packets from source to destination with minimal energy consumption.

This study proposes such type of minimal energy consumption protocol for sensor nodes and sensor network. The protocol is more precise and efficient in routing the data packets with minimal energy.

Literature review: The literature review of the protocols which were recently proposed by various researchers in energy efficient routing scheme. Huynh *et al*. (2016) proposed the novel cluster based multi hop routing with 80% accuracy in results. The key idea is to use effective tradeoff investigation minimizing end to end delay with energy cost function. The drawback of the method is it works only based on cluster works only for inter cluster level. Wang *et al*. (2016) proposed neighboring based super nodes with 78% accuracy in energy efficieny. The proposed model is effective model for vehicular scenario with Super node based structure. The main challenge is chance for address space problem address space conflicts.

Liu *et al*. (2015), Geetha and Kannan (2017) proposed opportunistic routing protocol with data delay reduction which induces one dimensional queue network with minimum power cost. The demerit of the stated model is energy consumption by differencing the sensor nodes. Shuaib and Aghvami (2009), Lin and Uster (2014) proposed MAC layer based interactive. Here, researcher proposed Uniform energy splitting Routing framework with route composition metrics and Routing loop avoidance and works for IEEE 802.15.4 networks with loop prevention and loop minimization. The drawback of the presented model is assumption of crucial sensor

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characteristics (elements) and chance for deadlock is high (Sageengrana *et al*., 2016). Lin and Uster (2014), Xiong *et al*. (2016) proposed Mixed Integer Linear Programming model and Benders decomposition approach. The performance rate for the presented method Hierarchical network based approach is 76% accuracy with effective utilization of energy and position of sensor nodes and the main challenge is chance for deadlock within the model (Srinivasan and Kannan, 2006).

MATERIALS AND METHODS

In this, a novel route max methodology is proposed by performing two key factors:

- Route matrix table generation
- Hierarchical tree structure

Route matrix table: Route matrix table is most prominent mathematical structure used to form sensor node location in a matrix form. Once the matrix is plotted using location of the sensor nodes, then a communication flow model is built using route matrix table. The route matrix table has an efficiency in selecting the nodes using cluster head principle. Figure 1 shows the clear pictorial view of route matrix table representation in WSN. The route matrix table is formed from the set of nodes and based on the node index, the route information, the table is constructed.

The pictorial view of the route matrix is to represent the sensor node deployment in the location. Suppose the set up for node to select based on the communication flow model created by route matrix model. Based on the route matrix table, the efficiency of the node to be measured. The efficiency of the node to measure by the cluster head selection principle. After select the node and flow of packets information derived with the calculation. The flow of packet information is derived as follows:

$$\text{Packet-flow}(i, e, o, \partial) = \sum_{l}^{\infty} \sum_{\substack{j=1 \\ i \neq d}}^{M} \delta_{i,Sj,d}\alpha(j, e, l, \partial) + v(i, e, \partial) \quad (1)$$

Where:

Packet-flow (I, e, ∂) = The buffered packet rate with end point e, lifetime l at time T

α (j, e, l, ∂) = The leaving packet from each node

v (i, e, ∂) = Arrival packets at each node

Buffer size definition: Buffer size definition is also a major task in routing the data packets. In sensor nodes, the power is a major term which we have to focus on hence, the assignment of buffer size plays a major role in sensor network before deploying routing protocol (Srinivasan and Kannan, 2006; Kavitha and Kannan, 2016). The buffer size is defined based on the average packets generated from various nodes which can be determined by the running application:

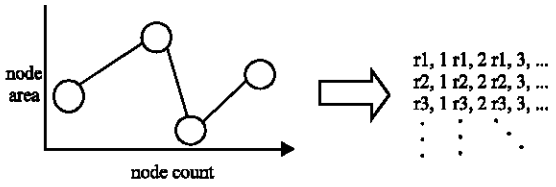

Fig. 1: Route matrix representation for sensor nodes

$$n(j, d, \tau+1) - n(j, d, t) = -\sum_{a=0}^{\infty} \sum_{i=0}^{N} \delta_{i, R_{i,d}} \beta(i, d, a, \tau) \quad (2)$$

From the Eq. 2, the load buffer of packet being routed is distributed along with each nodes, so that, the energy consumption of nodes can be reduced without performance compromises.

Cluster head selection: In WSN, Cluster Head (CH) selection is more challenging tasks. Here, the idea is to use hybrid form map model to combine closed map and power law escape model to select cluster head within the node range. The election includes $f = f_{(m1, m2, d)}: \mathbb{I} \to \mathbb{I}$ the family of maps with the time interval defined uniformly by $f = f_{(m1, m2, d)}: \mathbb{I} \to \mathbb{I}$ where $\mathbb{I} = \{x | x \in [0, 1]\}$.

Lets we take the selection using the power feature in all nodes. The increased order of energy states the power order of 1 and decreased rate of energy states the power order of 0. The initial iteration of the map f represented above forms the initial condition to select the number of cluster heads as defined by $f(X_n)$:

$$x_n = \begin{cases} \dfrac{x_n}{\left(1 - c1 x_n^{m1-1}\right)^{\frac{1}{m1-1}}}, x_n \in [0, d], \\ 1 - \dfrac{1 - x_n}{\left(1 - c2\left(1 - x_n\right)^{m2-1}\right)^{\frac{1}{m2-1}}} x_n \in [d, 1] \end{cases} \quad (3)$$

where, C1 and C2 is:

$$C1 = \frac{1 - d^{m1-1}}{d^{m1-1}}, \; C2 = \frac{1 - (1-d)^{m2-1}}{(1-d)^{m2-1}} \quad (4)$$

The leading selection of increased and decreased order in energy state component can be represented as m1 and m2. The cluster head selected based on order 0 and 1 can be ranges from C1, C2, ..., Cn. The reentry of the traverse to search for cluster head selection is defined as d.

RESULTS AND DISCUSSION

Hierarchical tree structure: One of the most prominent features of the proposed routing protocol is making the sensor network architecture in hierarchical structure. Figure 2a shows the results of the proposed routing protocol whereas the Fig. 2b exhibits the actual setup which is carried out to perform various experiments. Further, the experimentation is iterated to reach over 2500 epoch. For each epoch, the node setup and mobility of nodes are varied. Figure 2c shows the results of the intermediate iterations at the reach of 2500 epoch whereas Figure 2d shows the results of the final iteration with their corresponding node isolation.

From the Table 1 compare with different protocols like LEACH, TEEN, APTEEN with proposed protocol and different features like energy consumption, Hop count, packet lifetime, network model, network type, deployment, QoS property, etc. The proposed protocol is robust and efficient in terms of routing and energy consumption.

Performance analysis: The overall performance analysis of the proposed protocol along with existing protocol were listed and tabulated in Table 1. The packet arrival message process is modified to implement the routing protocol, the packet arrival message includes header information and then the actual packet received from the host. The features identified from the packet arrival message passed to the cluster model in that model we developed a defined buffer size to hold the data. Hierarchical tree structure model was trained with normal traffic patterns which includes various network traffic (In case of heterogenous nodes). Figure 3 and 4a, b shows the plot for the traffic routed using the proposed protocol with the state of the art protocol (Sageengrana *et al*., 2016). Based

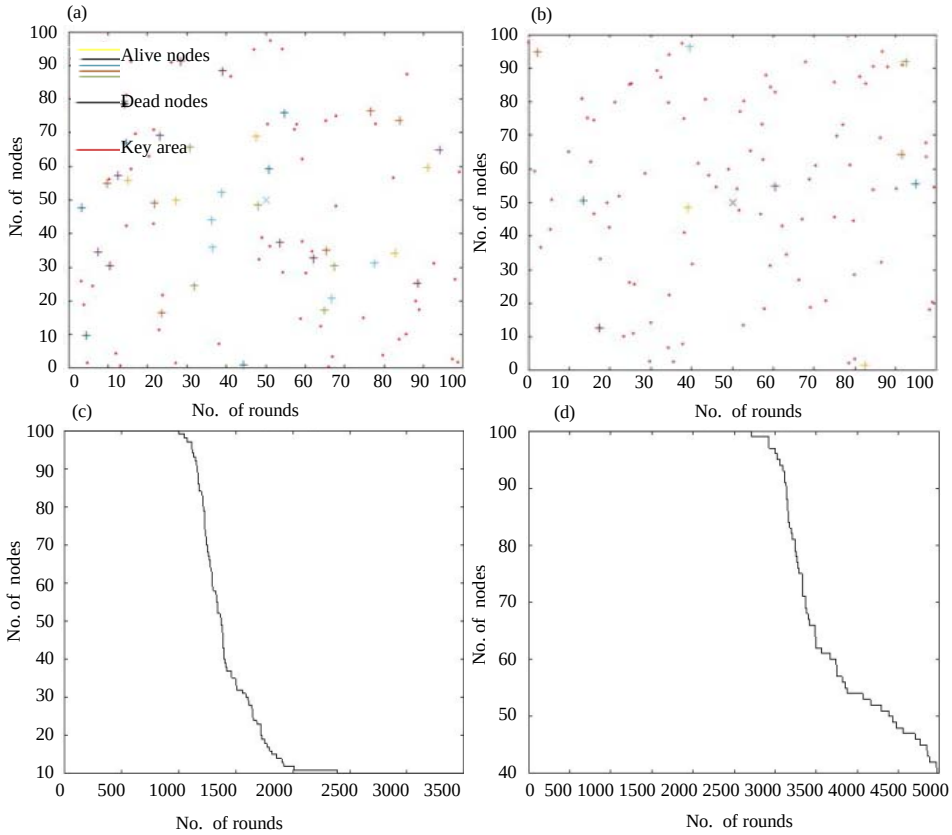

Fig. 2: a) Results of proposed protocol; b) Experimental setup; c) Alive nodes vs. rounds at 2500th iteration and d) Alive nodes vs. rounds at 5000th iteration

Table 1: Performance analysis of energy efficient protocol

Features	Proposed protocol	LEACH	TEEN	APTEEN	Super node
Energy consumption	✓	✓	✓	✓	✓
Packet lifetime	✓	✓	✓	✓	✓
Scalability	✓	✓	✓		
Hop count	✓	✓			✓
Network structure	Hierarchical	Hierarchical	Hierarchical	Hierarchical	Neighbour
Fault tolerance	✓		✓	✓	
connectivity	Bluetooth/Wi-Fi	Bluetooth/Wi-Fi	Bluetooth/Wi-Fi	Bluetooth/Wi-Fi	Zigbee
Data aggregation	✓	✓	✓	✓	
Deployment	Adhoc/Structured	Adhoc/Structured	Structured	Structured	Structured
Data reporting to	Server node	Server node	Server node	Server node	Server node
Network type	WAN	WAN	WAN	WAN	WAN
Network model	Flexible/rigid	Flexible/rigid	Flexible/rigid	Flexible/rigid	Flexible/rigid
Traffic generation	✓	✓	✓	✓	✓
QoS property			✓	✓	

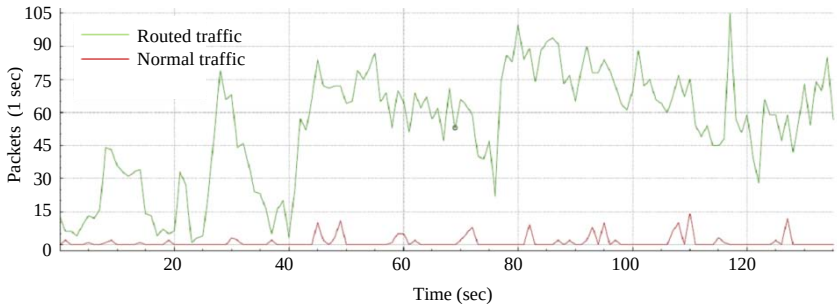

Fig. 3: Routed traffic performance rate with the state of the art routing protocol (Sageengrana *et al*., 2016)

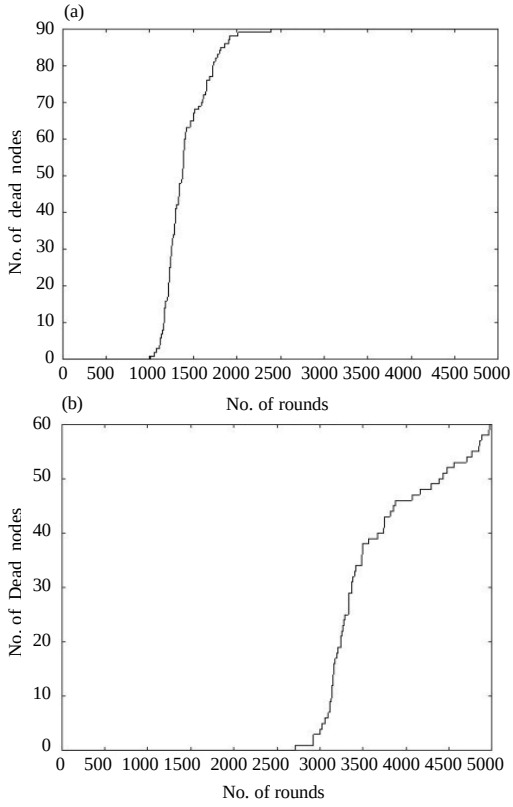

Fig. 4 a): Dead nodes vs. rounds at 1000th iteration and b) Dead nodes vs. rounds at 2500th iteration

on the result the further action is taken in case of the flow rule has to be created with action set to drop or forward for further analysis.

CONCLUSION

Hence, we conclude this study by proposing a novel energy efficient protocol. The protocol is robust and efficient in terms of routing and energy consumption. The proposed protocol outperforms the existing energy efficient protocols. The protocol is robust still it suffers scalability problem in future the security features along with scalability can be incorporated in order to achieve better performance rate.

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