Relay Nodule Selection using Opportunistic Routing Algorithm in Wireless Sensor Networks

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Abstract

Wireless Sensor Networks (WSNs) finds its applications in several fields like keeping track of hospitals, industries, and military and so on. The sensor nodules of WSNs detect physical measures such as humidity, fire, pressure as well as physical entities such as human or animals. The sensor nodules capture and send the data to a sink nodule. The energy spent in collecting and sending the data to the sink nodule must be such that there are no energy holes. The network is expected to have a high life time as well. One factor that saves energy is the type of routing adopted. In this work a unique routing algorithm is introduced which takes into account the concept of relay nodules to overcome the issue of loss during transmission. i.e using the principle of opportunistic routing theory, relay nodules take the decision based on their distance to sink and the residual energy of each other to forward the packets/data to ensure the minimum cost and power during data relay and to protect the nodes with relatively low residual energy.
Keywords: Opportunistic Routing, Exclusive opportunistic routing

I. INTRODUCTION

Huge numbers of sensor nodules are installed in several application domains whose data is used in critical contexts. Large amount of data is collected from multiple sources through transitional nodules. In addition few sources are duplicated by mischievous attackers that result in false data. Thus for the decision making to be accurate, the presence of malicious nodules are to be identified with high precision. To evaluate the reliability of the nodules a term called “Data Provenance” (pieces of data) plays a vital role.

However provenance management demands for reduced energy-bandwidth requirement and also well-organized storage with trustworthy communication. The main matter of concern here is to extend the life of the network to its maximum and reduce the amount of energy required in a 1D queue network for relaying the data. Using opportunistic routing principle an efficient routing scheme is initiated based on the distance between nodules, distance to the nodule and sink, as well as residual energy among them. Such algorithm provides minimal cost of power requirement to relay the data between nodules.

The chore (a.k.a the task) of developing a routing scheme is multitudinous or in other words needs multifold as it not only demands for a minimal energy route but also in the entire network, craves for a balanced distribution of residual energy. Moreover, untrustworthy wireless links and partition of network leads to loss of packets and redundant transmissions along the same predetermined path.

Retransmission causes significant energy loss. Thus it is appropriate to make trade-off amid slightest consumption and maximum lifetime of the network. 1-Dimensional queue network is intended and established for a wide range of requests. The data gathered by the sensor nodules are passed to relay nodules which further direct it to the sink nodules through the paths that are efficient in terms of energy.

At the end, all the transmitted data reside at the traffic management center which selects the corresponding information as requested by the client network and serves it accordingly. The distance between sensor nodules, and corresponding distance to the sink are all essential factors that determine the efficiency of opportunistic routing scheme.

II. LITERATURE SURVEY

Agnius et. Al has proposed several real world challenges like interference of air, fading in the channel and changes in the environment. In WSN, the sensor nodules communicate with each other, cluster heads communicate with sensor nodules and the other way round, and cluster heads communicate with the base station as well. WSNs are used in critical applications such as military surveillance and non-critical applications such as home monitoring. Several issues come in the way of developing a WSN which include the topology, area of coverage, traffic and flow control, and tolerance to fault, power control, security and type of routing. In WSN, the mode of communication is wireless thus interference and fading are the major issues faced. WSN uses multi-hop communication and single-hop communication. The Efficient routing methods play a vital role in Multi hop communication for WSN.

"Chachulski et al" has proposed that conventional methods preselect the routes before transmission and the actual path is chosen while communicating the packet to nodules. The best intermediate nodule is selected on the basis of a co-ordination protocol. The data is then forwarded thereby increasing the range, reliability and throughput.

"Haitao et al" has proposed ideal techniques for routing. The data in this case is broadcasted thereby causing multiple neighbours to receive the same information. The forwarding nodule is chosen based on the availability of nodules which in turn increases the reliability, throughput and range. To overcome the loss nature of wireless transmission opportunistic routing is introduced. Several opportunistic routing mechanisms are discussed and the best one for WSN is determined.

"Zhong et al" has proposed that in OAPF protocol, as an alternative of broadcasting packet to all the next hops, a set of good hops is chosen such that it reduces redundant transmission. A distance measurement used to decide the next hop is expected any path count (EAX) rather than ETX. Here when the EAX value of a nodule is computed all next hops path is taken into consideration. This also determines the contribution of a nodule in delivering a packet to the destination. OAPF is used in place EX-OR because the number of candidates is reduced in the forwarder set without affecting the performance.

"Xufei Mao et al" has shown how forwarding list is selected and prioritized to obtain minimal cost of forwarding the data. The previous protocols such as ExOR and MORE failed to exploit the benefit of choosing suitable forwarding list that minimizes cost of energy.

"Xufei Mao et al" studied two alternate cases,

1) Each nodule having non-adjustable transmission power
2) Each nodule having adjustable transmission power for each transmission.

Ideal algorithms for choosing the candidates for forwarder list and then prioritizing them are discussed. TOSSIM was used to simulate and analyze the performance of the developed algorithm. It was found that energy consumption in EEOR was lesser than ExOR for random list of forwarding candidates and traditional distance vector routing.

"M. Kurth et al." Proposed that opportunistic routing mechanism has to be used in order to make data transmission more reliable. This protocol chooses a number of next hop relay nodules giving every nodule the opportunity of transmitting the message to succeeding hop. In case of an unstable wireless network the transmission reliability is improved. Appropriate selection of relay nodules helps in reducing signal interference and improving throughput thereby reducing cost of link.

"B. Jeff et al." Has proposed a routing protocol based on a tree structure that reduces the number of hops and helps in saving bandwidth. But the protocol exhibits poor performance in terms of robustness and throughput when there is dynamic change in topology. To solve this issue, a new protocol based on grid structure is established which introduced multiple trees from source to destination such that relay nodules can send information through multiple paths. If the network faces congestion, an alternate path can be chosen to deliver the message. However this structure increases the cost of link and also delay in the network increases.

III. SYSTEM ARCHITECTURE

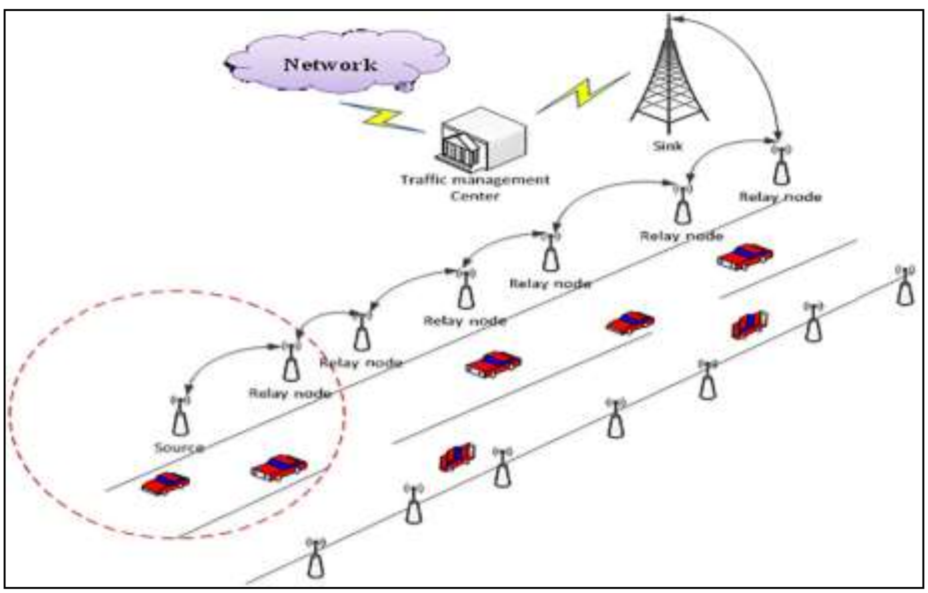

Fig. 1: Relay Nodule Selection using Opportunistic Routing

The above figure gives the complete description about Opportunistic Routing mechanism implementation. Here the data packet propagates from one node to another node based on the power/signal strength available in each of the packet itself. The decision is made based on ExOr routing which is based on Opportunistic routing.

A. *Exclusive Opportunistic Routing (ExOR):*

A solitary ExOR sensor nodule transmits every packet, so that ExOR functions by means of current radios. The vital encounter of understanding ExOR is guaranteeing that the finest receiver of every packet transmissions is forwarded in directive to evade termination. ExOR functions on groups of packets in directive to cut down to the communication expenses of the concurrence. The source nodule comprises in every list of packet applicants forwarders arranged through adjacent to the destination. Reception nodules buffer efficiently established packets besides holds in place of the major part of the consignment.

B. *Energy Efficient Opportunistic Routing (EEOR)*

EEOR is an algorithm which works on the basis of selecting 'forwarders' list and prioritizing the nodules. There are two scenarios for regulating the charge of the nodules during transmission. In first scenario it is presumed the sensor nodules cannot adjust the power available with them. In other case the transmission power can be adjusted by the sensor nodule foreach transmission.

C. *EFFORT*

EFFORT is another opportunistic routing protocol for WSNs. EFFORT protocol is based on the OEC (Opportunistic End-to-end Cost) metric that signifies the expectable end-to-end scarcity vitality price for every data broadcast.
The main components of EFFORT are as follows.

- Method for OEC computation
- Select Candidate and relay priorities
- Data accelerating and OEC is informing.

The primary constituent permits every sensor nodule to estimate its optimum OEC in a discrete way. The Subsequent constituent contracts each sensor nodule placed its optimum progressing group of its neighbors also Authenticate the transmit classification. The next element shows the selected forwarders assistance through Every additional to relay statistics besides modernize the OEC charge subsequently.

IV. METHODOLOGY

In applications like monitoring of the pipeline and electrical power line, 1-D queue network is been used. In traffic monitoring system also, the 1-D (one dimensional) queue networks are used. The sensor will sense the traffic information in their range, and pass it on to the sink. When it is passed, it should be sent through the energy efficient path. D Bruckner, proposes an energy efficient routing scheme ENS-OR for such 1-D networks. It introduces a concept called EEN (Energy Equivalent Nodule). A forwarder list is prepared on the basis of residual energy of neighbors. The nodules in the forwarder list rank themselves based on the distance from the EEN. Using ENS_OR algorithm, the next forwarder relay nodule is selected, and the energy consumption is analyzed under 1D model for a large network

A. *Optimal Energy Strategy*

The concept of EEN based on the transmission distance d_{op} is adopted to ensure least consumption of energy during transmission. But this strategy does not take into consideration the residual energy of nodules. The relay nodules that lie in close proximity to the destination depletes their energy faster as a result of which uneven energy depletion reduces lifetime of network. This also results in partition of network, which leaves significant amount of energy in few nodules that are far away. Thus for large networks the optimal energy strategy is readdressed. The selection of EEN, based on relay priority is explained in the sections that follow.

B. *Forwarder Set Selection for Optimal Energy Strategy*

In the planned technique, large WSNs having uniformly distributed nodules in a 1D queue model, the sensor nodule is positioned at h xh(xh_ M), thus, the optimal transmission distance d_{op} for nodule h is

$$d_{op} = M - x_h / n_{op} = \{(2E_{elec})/[(\tau - 1)\ \varepsilon_{amp}]\} 1/\tau\ .$$

We can infer that energy consumption function has a convex nature w.r.t the number of hops n, optimal distance leads to optimal energy. Consider a nodule h to be sending a packet to the sink, and h+i is the neighbor of h. If this is close to the computed result and possess more residual energy, then h+I can be regarded as a forwarding candidate. Moreover, these eligible candidates rank themselves according to their distances from the EEN and the residual energy of each nodule as

$$P\,(h+i) = \begin{cases} (d_{h+i} - dh) & [1/\,(d_{(h+i)} - d_{op}) + (E_{h+i} - \zeta)] \\ (h+i) \in F\,(h), & -R \leq i \leq R \end{cases}$$

where $d_{h+i} - dh$ shows the distance between h and h+i, Eh+i gives its residual energy of h+I, ζ indicates energy threshold. F(h) (F(h) ⊆N(h)) is chosen to be the forwarding set of candidates of h. The highest priority nodule is the one with highest value of P(h + i). The energy saving strategy thus used is named ENS_OR.

C. *ENS_OR Algorithm*

The selection and prioritization of forwarding candidates is explained in this section. Also the selection of energy saving nodule and relay nodule is described. The data transmitted over the network is classified into two groups

1) Data collected by the nodule itself
2) Data relayed from other nodules

V. Conclusion

The proposed opportunistic routing procedure for selecting relay nodules in WSN to transfer the data from source to sink is superior. The previous approach does not consider the drain rate and other minute details like number of re-transmissions, energy consumed by transmitter circuit, receiver circuit etc. The simulation outcomes demonstrate that, the projected protocol accomplishes superior. In future, the experiment shall be done in real world.

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