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Secured Greedy Geographical Reliable Reactive Routing for WSN

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Abstract: ***Providing secure, reliable and energy efficient communication under fading channels is one of the major technical challenges in Wireless Sensor Networks (WSN). In this paper, we present the Greedy Geographical Routing inorder to increase the resilience to link dynamics for WSNs and also increases the packet delivery ratio , throughput and energy efficiency. Here the main idea is to find the guide path by Greedy Geographic routing , which determines the guide path that has shortest distance to the destination through which the packets are greedily progressed towards the destination. Specifically, we introduce Signature Signing inorder for the secured transmission of the sensed data to the sink. Through extensive simulations, we demonstrate that compared to other protocols such as AODV based R3E, Greedy Geographic Routing remarkably improves the packet delivery ratio and achieves efficient performance , less delay and also lower energy consumption since the overhead is reduced.***

Keywords: Wireless sensor Network, Greedy Geographic routing , Signature signing , fading channel.

1. Introduction

Wireless Sensor Networks are usually described as a network of nodes which cooperatively sense and may control the environment enabling interaction between users or computers and the surrounding environment. A WSN comprises of large number of sensors and one or more sinks where data is collected. Each sensor node has the capacity to sense the physical environment, process data locally, and takes part in data forwarding to a sink, from where data are retrieved by users. WSNs are application specific, thus sensors nodes are furnished with sensors likewise. A few applications e.g. building monitoring oblige a smaller number of sensors that can be put up exclusively. Others e.g. surveillance of a battlefield oblige an extensive number of sensors e.g. thousands or even millions that will be deployed ad hoc .Using a larger number of sensors builds system power and adaptation to non-critical failure. Fig.1 shows how the sensor nodes are composed in a wireless sensor network (WSN). The primary elements of a sensor node are data sensing, local data processing and data forwarding.

A sensor network dependably comprises of spatially distributed autonomous sensor nodes, to helpfully screen physical or natural environmental conditions. These sensors for the most part work on constrained non-rechargeable battery power, and are relied upon last several months or years. Accordingly, a major concern is to maximize the network lifetime, i.e.,enhance the energy efficiency for WSNs. A sensor organize dependably comprises of spatially distributed autonomous sensor nodes, to helpfully monitor physical or environmental conditions. These sensors as a rule operate on constrained non-rechargeable battery power, and are required to last over several months or years. Therefore, a noteworthy concern is to expand the system lifetime, i.e., enhance the energy efficiency for WSNs. Since the sensor node currently has limited processing speed and memory space, it is additionally obliged that the algorithm that keeps running on sensor devices has a low computational cost.

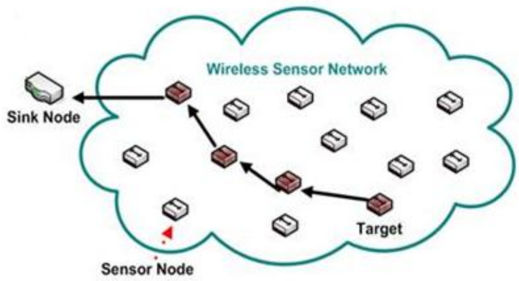

Figure1: Wireless sensor network

Providing reliable and timely communication in WSNs is a challenging problem. This is because, in reality, the link conditions in wireless networks can be highly unreliable because of numerous variables, for example, interference, attenuation, and channel fading [1] [2]. Typically, to forward a packet reliably, it may require retransmissions at each hop, which results in undesirable delay as well as waste of energy.

IWSN applications, such as factory automation, industrial process monitoring and control, and plant monitoring, require reliability and timeliness in forwarding messages among nodes [3]. However, the traditional routing protocols, such as AODV [4], AOMDV [5], and DSR [6], may discover their limits in modern establishments due to the harsh environmental conditions, interference issues, and other constraints [7].

In IWSNs, transmission failures can bring about missing or delaying of process or control data, and missing the process or control deadline is normally intolerable for industrial applications, as it may bring about mayham in industrial automation or perhaps terminate the automation, ultimately resulting in economic losses [8]. The sensed data should be reliably and timely transmitted to the sink node, and the programming or retasking data for sensor node operation, command, and query should be reliably delivered to the target nodes [9]. It is likewise obliged that these networks can work for years without replacing the device batteries [10].

Therefore, the reliability, timeliness, and energy efficiency of data forwarding are critical to guarantee proper functioning of an IWSN. However, one of the significant technical challenges for realization of IWSNs is to provide reliable and efficient communication in dynamic and harsh environments [11], [12]. This is because, in harsh industrial environments, sensor nodes may be subject to radio frequency (RF) interference, highly caustic or corrosive environments, high humidity levels, vibrations, dirt and dust, or other conditions that challenge network performance [9].

Reliable Reactive Routing Enhancement (R3E) was used inorder to increase the resilience to link dynamics for WSNs/IWSNs. This design inherited the advantage of opportunistic routing. R3E was designed inorder to augment existing reactive routing protocols to combat the channel variation by utilizing the local path diversity in the link layer. It has following two disadvantages: 1) broadcasting RREQ to all the nodes induces significant energy cost, which is one of the primary design concerns in WSNs; 2) this may sometime take longer distance, which may increase the delivery delay as well as degrade the energy efficiency [13].

In order to improve the energy efficiency, in this work, we exploit the Greedy Geographical routing provisioning with both end-to-end reliability and delay constraints in WSNs. This is proposed to combat fading channels, thus improving the robustness, end-to-end latency and energy efficiency in wireless networks. The idea behind Greedy Geographical routing is to take advantage of Greedy path selection by involving multiple neighbors of the sender as the helper nodes, into the local forwarding, thus improve the transmission reliability.

- Here we first calculate the distance of each node to the sink, where the node having shortest distance will be choosen as the guide node and thus forms the guide path.
- The nodes which are within the communication range are considered as the helper nodes.
- Based upon application demand, selection of the guide path will be made.
- If the application demand is delay, distance from each node to the sink node is calculated and the node with shorter distance to the sink node would be considered as the next hop or the next guide node to forward the packet.
- If the application demand is energy, distance from each node to the sink node is calculated and the nodes with shorter distance forms the cluster and the node within the cluster which has the highest energy will be choosed as the next guide path.
- Each packet received from network, firstly verification of the signature takes place and it asks for the next node , message along with the signature is sent and the verification process continues.
- Nodes within the communication range of the nodes forms the helper nodes , in case of link failure , the packets will be transmitted through the helper node which is common to both the nodes communicating.
- Here it also illustrates case, where a node is put in sleep, where other alternative node that is some helper takes the job and transmits the data , else the process should have begin from finding new route, hence energy would be saved.

At the network layer a set of forwarding candidates are selected while at the MAC layer one node is chosen as the actual node ie the guide node.

2. Related works

A) Cluster-Based Forwarding for Reliable End-to-End Delivery in Wireless Sensor Networks In the cluster-based forwarding (CBF), a general architectural extension to routing protocols that takes motivation from cooperative communication, and is perfect with most existing routing protocols through deliberately characterized interfaces [14]. So, it is called as "cluster-based" because, in this methodology, groups of nodes collaborate with one another to forward packets. Clusters in CBF are more likened to neighborhoods than to clustering backbones as proposed in ad-hoc networks. Previous clustering techniques for ad-hoc networks cant be utilized as a part of CBF, because selecting clusters is critical to the performance of CBF[15], and wrong clusters will introduce excessive overhead. Therefore, a customized approach is designed in CBF based on an analysis of energy cost.

B) SOAR: Simple Opportunistic Adaptive Routing Protocol for Wireless Mesh Networks SOAR is a proactive link state routing protocol. Each node intermittently measures and disperses link quality regarding ETX. Based on this information, a sender chooses the default path and a list of (next-hop) forwarding nodes that are eligible for forwarding the data. It then broadcasts a data packet including this information [16]. After listening to the transmission, the nodes not on the forwarding list simply discard the packet. Nodes on the forwarding list store the packet and set forwarding timers based on their proximity to the destination. A node closer to the destination utilizes a smaller timer and forwards the packet earlier [17]. Upon hearing this transmission, other nodes will remove the corresponding packet from their queues to avoid duplicate transmissions. Like all the existing opportunistic routing protocols, SOAR broadcasts data packets at a fixed PHY data rate.

C) EARQ: Energy Aware Routing for Real-Time and Reliable Communication in Wireless Industrial Sensor Networks. EARQ estimates the expected values of the energy cost, delay and reliability of a path to the sink node. These values are processed utilizing only information from neighboring nodes. Based on these values[18], EARQ chooses a path that obliges low energy, low delay and provides high reliability. For an even dissemination of energy expenditure, somecases EARQ chooses a non-optimal path in terms of energy expenditure, however can still deliver a packet in time [19]. This work gives a basic rough guess of the minimum delay, given the density of sensor nodes and radio range.

D) R3E: Reactive routing protocols are designed to reduce the bandwidth and storage cost consumed in table driven protocols. These protocols apply the on-demand procedures to dynamically build the route between a source and a destination. Routes are generally created and maintained by two different phases, namely: route discovery and route maintenance. Route discovery usually occurs on-demand by flooding an RREQ (RouteRequest) through the network, i.e., when a node has data to send, it broadcasts an RREQ. When a route is found, the destination returns an RREP (RouteReply), which contains the route information (either the hop-by-hop information or complete addresses from the source to the destination) traversed by the RREQ. This broadcasting nature would sometimes take long time and longer guide path. In addition, if an RREP is lost, the source node probably needs to launch another route discovery process again , which will result in a long routing discovery delay.

3. Main Design

3.1 Architecture Overview

Fig.2 illustrates an overview of the functional architecture of Greedy Geographical Routing, which is a three-tier architecture which increases the resilience to link dynamics for WSNs/IWSN , where the guided path here is selected using Greedy Geographical algorithms based upon delay throughput and energy. Based upon the application demand , the geographical forwarder selector will select the guide nodes and forms the guide path and the packets transmission takes place through that path. Here inorder for the secured data transmission, signature signing is used been. Where each packet is verified for its signature and transmitted along with the message and signature for the next guide node.

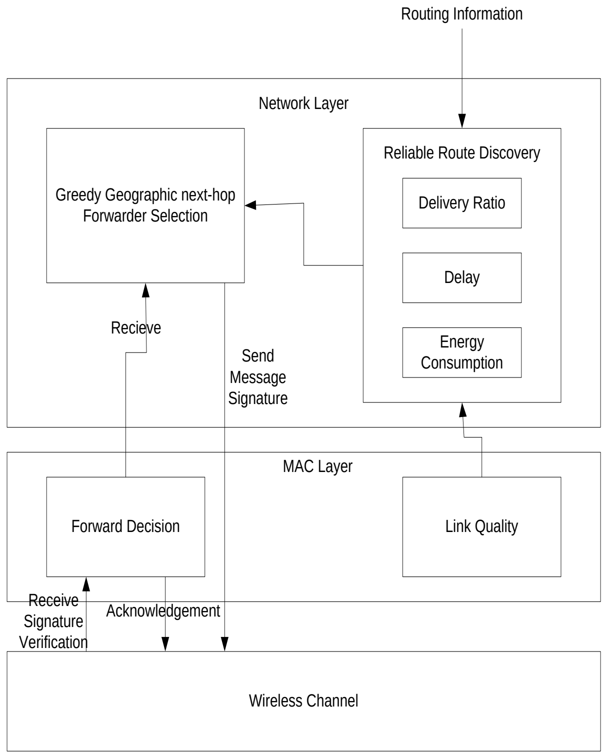

Figure 2: Functional architectural overview of Secured Greedy Geographical Routing.

3.2 Reliable and Secured Guide Path Discovery

If a node has data packets to send to a destination, it initiates a route discovery, which uses Greedy Geographical routing inorder to find the guide path based on application demand. This calculates the distance of each node to the destination based upon the application demand if it is of delay or throughput , it selects the nodes which has very shorter distance to the destination . If the application demand is of energy then the nodes which are having shorter distance to the destination are calculated and they make a cluster, based on which node is having higher energy will be the guide node . The helper nodes here are chosen based upon the nodes which are in common to both the nodes which are communicating.

1. Greedy path discovery based on delay

```
route(sn)
startnode=sn;
guidepath=[];
while (startnode!=0)
{
 N<-
find_Next_Geographic_Short_Distance_Node(startnode,0);
 guidedpath= [ guidedpath startnode->N]
 startnode=N;
}
route along guidedpath.
if any node detects failure assist cooperatively
```

2. Greedy path discovery based on delay and energy

```
route(sn)
startnode=sn;
guidepath=[];
while (startnode!=0)
{
 ListofN<-
find_Next_Geographic_Short_Distance_Node(startnode,0);
 N<- get Node with highest energy
 guidedpath= [ guidedpath startnode->N]
 startnode=N;
}
route along guidedpath.
if any node detects failure assist cooperatively
```

3. Greedy path discovery based on delay, energy and throughput

```
route(sn)
startnode=sn;
guidepath=[];
while (startnode!=0)
{

 ListofN<-
find_Next_Geographic_Short_Distance_Node(startnode,0);
 list of N<- get Node with highest energy
 N<--choose the node with highest throughput so far
 guidedpath= [ guideedpath startnode->N]
 startnode=N;
}
route along gudidepath.
if any node detects failure assist cooperatively
```

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4. Performance Evaluation

4.1 Simulation results

We consider a wireless sensor network with variable number of sensor nodes. These are randomly deployed over an area of 900 m × 900 m. One of the node is taken as source and the remaining nodes are considered as the guide nodes and helper nodes further. The node transmission range is set to 40m. Each sensor node is assigned with initial 100J of energy. The other parameters are transmission power = 0.6W, receiving power = 0.3W, simulation time =10ms

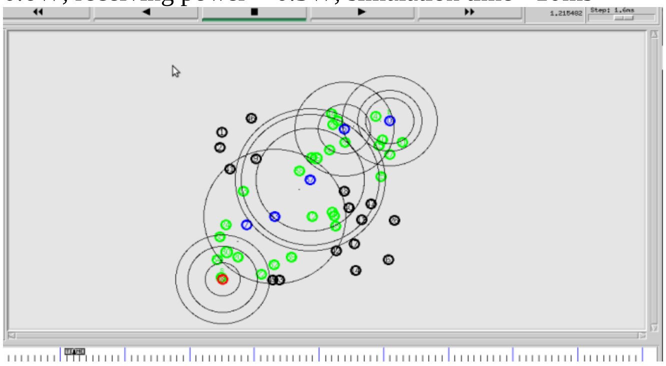

Figure 3(a): Guide path determined for 50 nodes

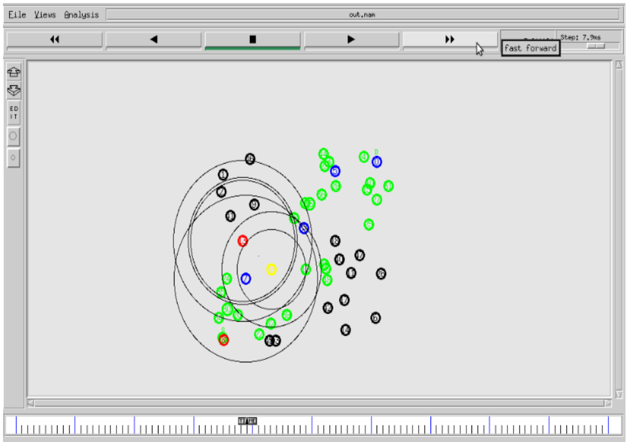

Figure 3(b): Guide path determined for 50 nodes

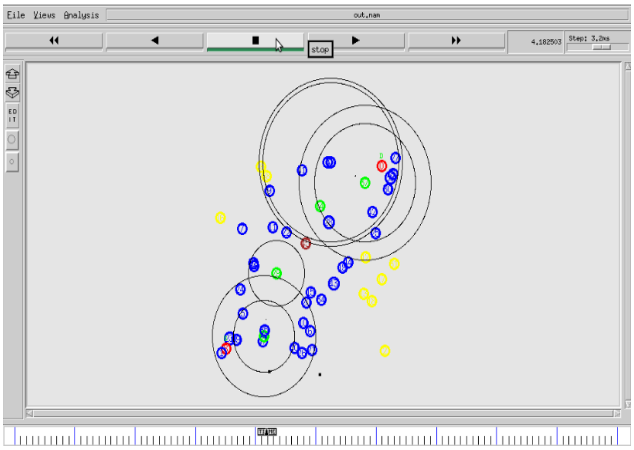

Figure 3(c): Guide path determined for 50 nodes

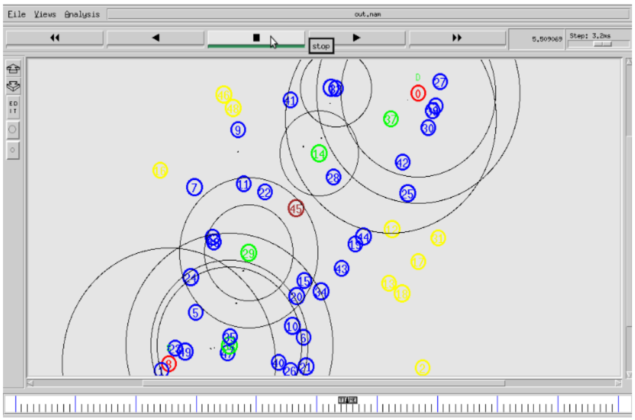

Figure 3(d): Guide path determined for 50 nodes

Fig.3(a) & Fig.3(b) illustrates the guide path determined for 50 nodes , where the number of nodes can be varied later for performance measurement. Here the guide path is determined by using Greedy geographical routing where the nodes which are shortest to the destination are choosed as the guides nodes , and these nodes form the guide path. Red colored node represent the source node and Blue colored nodes represents the guide path been determined, where the green nodes are the helper nodes and the black nodes are the nodes which are not within the communication range of those nodes. In fig.3(b) we have illustrated about the link failure, where the node is represented by yellow color and the helper node is chosen as the intermediate node through which the data flows through to the sink, it is identified by red color.

Fig.3(c) & Fig.3(d) illustrates the rainbow guide path which is determined . Source and destination nodes are represented by red color , where the guide path is been represented by green color , helper nodes are represented by blue color and nodes which are not in communication range are in yellow color. Here we illustrated the case where one of the node is been put in sleep mode , which is been represented by brown color , intermediate node is been choosed inorder to transmit the data which is been illustrated in Fig.3(d).

4.2 Performance Overview

We evaluate the impact of network density on different performance metrics like Packet delivery ratio , delay and throughput.

(a) **Packet delivery ratio:** the ratio of the number of packets received by the destination to the total number of packets sent by the source.

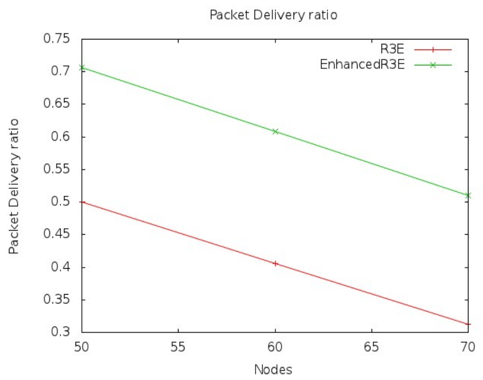

Figure 4: Graph showing comparison of packet delivery ratio between existing and proposed system.

(b) Delay: the time taken for a packet to be transmitted from the source node to the destination node.

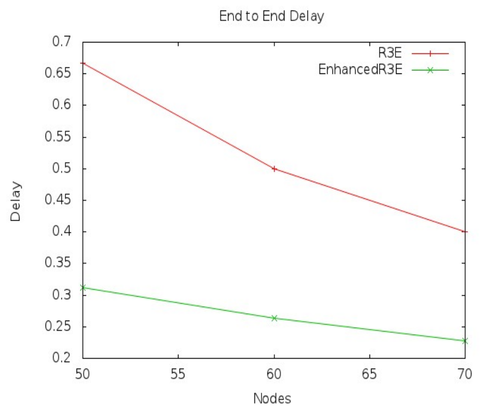

Figure 5: Graph showing comparison of throughput between existing and proposed system

(c) Throughput

Network throughput is the average rate of successful message delivery over a communication channel. This data may be delivered over a logical or physical link, or may pass through a certain network node. The throughput is generally measured in bits per second (bit/s or bps), and sometimes in data packets per time slot or data packets per second.

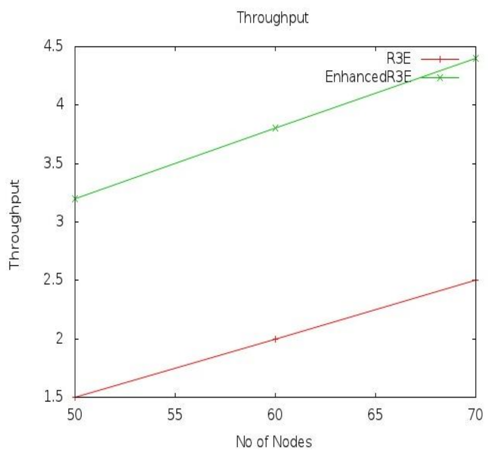

Figure 6: Graph showing comparison of throughput between existing and proposed system.

5. Conclusion

Secure and energy efficient Greedy Geographical routing supporting the dynamic nodes is presented in this project, this protocol improves the overall network performance such as end-to-end delay, throughput and energy consumption. The proposed system is well suited for dynamically distributed Wireless Sensor Networks. The performance of the proposed system is evaluated using the NS2 network simulator and the proposed protocol shows improvement in performance , energy consumption and delay when compare to the existing AODV protocol. In future , load balancing could be bought in and more focus need to be given on the security of the data or the packets tranmitted from source to destination

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