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SIG: A Gossip Based Energy Efficient Routing Protocol for WSN

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ABSTRACT

Wireless Sensor Network (WSN)has a lot of applicability in today's world, whether it is an informative field or other things. To achieve efficient data transmission, many routing protocols have been proposed where energy is always an important issue. This research aims to overcome the drawbacks of a flooding-based routing protocol by proposing a gossiping-based routing algorithm called SIG: Source Initiative Gossiping. We applied this protocol into a network and achieved that SIG is more energy-efficient than Flooding and Gossiping. It consumes about 50% less energy than flooding and 35% less energy than Gossiping. Our results indicate that SIG successfully achieves application reliability requirements in many topologies. We simulated it in MATLAB to achieve a comparing result among Flooding, Gossiping, and SIG.

Keywords –**WSN, routing protocol, flooding, gossiping**

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1. INTRODUCTION

A combination of sensor, microelectronic, and internet communication technologies form a Wireless sensor network (WSN). WSN is widely used in industry, environment monitoring, military, medical treatment, etc. Lightweight sensor nodes, small in size combined extensive monitor system in WSN. The nodes can interconnect with each other and a Base Station (BS) by using their wireless radio [1]. Hundreds of thousands of these sensor nodes make WSN. Each sensor node can process, transmit, sense, position finding system, and mobilize. This allows the nodes to spread their sensed data for visualization, remote processing, storage systems, and analysis [2]. The development of silicon technology improves low power, next-generation, multifunctional, low-cost sensor nodes.[3] The sensors interconnect for transmitting their evaluations wirelessly. Figure 1 shows an example of WSN.

Sensor nodes connect with neighboring nodes so that the transmission power can be reduced; thus, the network reduces expensive repeaters and transmitters used in telemetry systems [4]. Each node in Wireless Sensor Network performs as a router, a data aggregator, and a data acquisition device. The wireless sensor network's embedded construction and distributed nature have many advantages over traditional sensingtechnology. Holding over standard wireless sensing technology, WSN deceits in the pattern of mesh networking. For the pattern of RF communication [5], data of transmission using a mesh

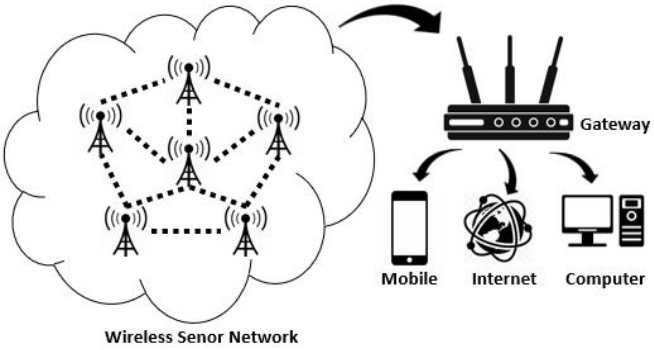

Fig 1: WSN

Network from one point to another takes less energy than direct transmission concerning the two points. Sensor networks can deal better attention than centralized sensing technology. Organizations can deploy more sensors using a wireless sensor network considering node cost advantage and mesh networking than they could by more traditional technology. Increasing the amount of usable data, it decreases the overall signal-to-noise ratio of the system. With this feature, WSN deals with a large number of prospects that were previously unavailable. Routing is a very challenging task because of the distinctive

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characteristic of the network. For determining a path between source and destination based on the request of data transmission, routing is a favorable process. If certain system constraints can be handled in order to adjust to the current network conditions and available energy levels, a routing protocol can be considered adaptive [1, 6]. Capturing the data presented in the system and forwarding it for further processing are the key task of WSNs. Finding energy-efficient protocols is the main purpose of our thesis. Battery-operated wireless sensor nodes are used to detect and collect information from areas with little scope to handle manually to recharge or change batteries. These nodes collect the information and forward them to the network towards the sink node for further actions. We need to consider its energy consumption as a major factor for better functioning and a longer lifetime for a sensing node within the network. But there is not enough study in this area. In the network, the nodes sense and collect information about any moving object or any event that is triggered. The information-carrying network uses a protocol. Theprotocol carries out the general transmission process without any concern for the energy efficiency factor [7]. A major factor in Wireless Sensor Network is Energy dissipation. The energy of the batteries should be saved, with a view to the safe batteries from depletion quickly because batteries can't be replaced promptly [2]. For this, the main objective of SIG is to reduce the cost of routing and enhance the system's lifespan. The main contributions of this work are:

- Analyze the performance of two state-art-of routing algorithms, such as flooding and Gossiping.
- Design and implement a modified routing protocol named Source Initiated Gossiping (SIG).
- Comparative performance analysis of proposed routing protocol with flooding and gossiping routing protocol.

This paper is organized as follows. Section 2. describes the literature review of wireless sensor network routing protocol Section 3 discusses the stepwise operational process of the proposed routing protocol. Section 4 summarizes the performance of the proposed routing algorithm and draws a comparative picture with flooding and gossiping protocol. Finally, section 5 concludes our paper and sheds light on future research directions.

2. LITERATURE REVIEW

A Gossiping mechanism was presented as an upgrade over the basic flooding process [8]. Implosion is a phenomenon in which a node transmits a packet to all other neighbors, who then broadcast the packet to all of their neighbors, resulting in multiple packet replicas. On the other hand, Gossiping does not broadcast a packet to all of its neighbors but to a single one chosen at random, which then forwards the packet to one of its neighbors at random. This procedure is repeated till the final destination is reached [9].

For both sensor and mobile ad hoc networks, Hou and Tipper [10] devised a new sleep management strategy to minimize energy usage. Only a timer was added to each node. When its timer expires, each node uses the probability of gossip sleep to choose whether or not to sleep in the following period. The characteristic of Gossiping allows it to scale to extensive networks, even an unlimited number of nodes in theory. The probability of gossip sleep determines network connection. However, the network's performance is only marginally impacted. Another benefit is that energy consumption is dispersed more equally throughout the network.

Dimikas et al. [11] presented a new gossip strategy that takes advantage of spatial data. The number of iterations required for this gossip technique to settle to a suitably precise calculation is the fundamental challenge with this approach.The authors of [12] demonstrated how to identify the quickest mixing Markov chain by optimizing the neighbor selection probability for each node. However, even an efficient gossip method for sensor node graphs might result in excessive energy use.For WSNs, the authors suggested the Flossiping mechanism [13]. It combines Gossiping on a single branch with regulated random selective relaying with a low probability. The authors suggested this protocol to improve overall performance by allowing each sensor node to choose its own activity in the routing method, resulting in resource-aware routing with zero overhead. Flossiping reduces the number of packets;however it has a longer latency.

In [14], Kheiri et al. proposed LGossiping, an enhanced Gossiping data dissemination strategy that emphasizes node location. This protocol anticipated that each node would choosewhether or not to know the positions of the others. This allowed each sensor to dependably communicate its data to one of its known neighbors, rather than sending data to a neighbor who may or may not be close to the source node, resulting in data loss. Although the latency problem has been addressed to some extent with this protocol, many events still fail to reach the main station.

Yuval Shavitt and Amir Shay [15] provide the Gossip Network paradigm, in which visitors can learn about the status of dynamic networks by talking with other travels via ad-hoc communication. The gossip information is then used by travelers to re-route their route and discover the quickest route to their destination. To decrease the cost of routing protocols, authors in [16] propose a gossiping-based technique in which each node passes a message with a certain probability. With fewer executions, a greater number of nodes get the message, which is dependent on gossiping probability and network architecture.

Because of its simplicity, distributed nature, and robustness in noisy and unpredictable contexts, the Gossip routing protocol for distributed computing in WSNs is appealing [8, 9, 11]. Using a standard randomized gossip

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technique, on the other hand, might result in a large energy loss owing to the recycling of duplicate information.

3. PROTOCOL DESIGN

In this work, we have proposed a new smart algorithm, i.e., SIG (Source-Initiated Gossiping). The protocol is Gossip based. We depicted the flow-chart of the protocol in Figure 2 and the pseudocode of the algorithm in summarize in Algorithm 1.

The protocol SIG works as follows:

Step 1: A source node that generally senses events or queried to broadcast the sensed data will send the data or packet with its identification to a neighbor node selected randomly among its all neighbors. But no node can send a packet to the source.

Step 2: The selected receiver node will transmit the packet to its all-unvisited neighbor nodes. Again, these receiver nodes will transmit packets only to their unvisited neighbor nodes. If any node has not any unvisited neighbor, it can't send any packet.

Step 3: Before transmitting the packet, each node adds its identification address to the packet.

Step 4: If two or more nodes get the packet at the same time and have one or more same unvisited neighbors, the node that has less unvisited neighbors can send a packet to that one or more same neighbor node.

Step 5: When the destination node will send a control message to the source node. The control message contains the received packet's final address (source and sender's identification).

Step 6: After receiving the control message, if the source node senses another event, it will transmit the packet by following the address contained in the control message.

Step 7: After completing the first step every time, the packet will contain the final address in the control message. And no update of the address will occur after the first step.

Algorithm 1:Generate_Consumed_Energy(Graph, IEnergy, noOfNodes)

```
1. Set initial energy of each node to IEnergy
2. Set consumed energy of each node to 0
3. Set visited state of each node to false
4. for p = 1 to noOfNodes
5.     for c = 1 to noOfNodes
6.         if Graph[p][c]=1
7.             Set IEnergy[p] =IEnergy[p]-1
8.             Set IEnergy[c] =IEnergy[c]-1
9.             Set visited state of c node to true
10.        else
11.            Set Energy[p] = Energy[p]-1
12. for n = 1 to noOfNodes
13.    CEnergy[n]=CEnergy-CEnergy[n]
14. Display IEnergy of each n
15. Display CEnergy of each n
16. Set title of graph to title
17. Set XLabel to Node
18. Set YLabel to Consumed Energy
19. Display Bar Chart for Consumed Energy
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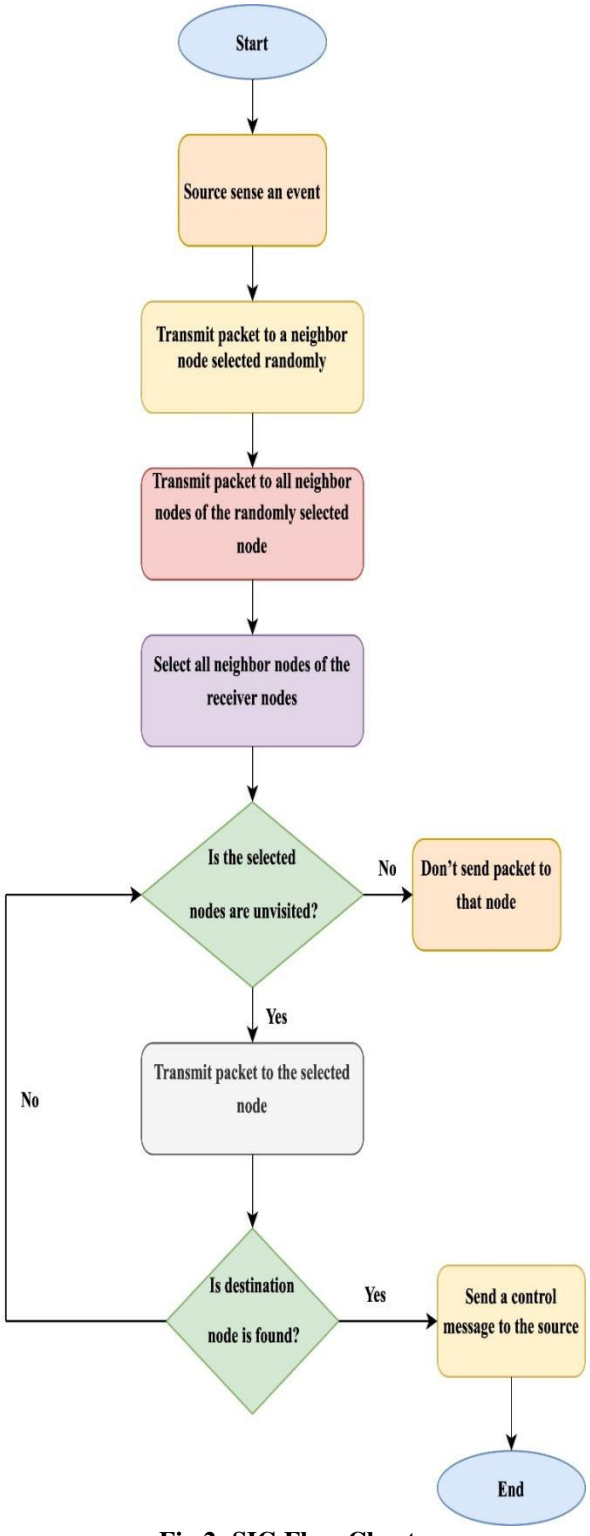

Fig 2: SIG Flow Chart

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4. Simulation and Result Analysis

Comparative analysis of Flooding, Gossiping, and our proposed SIG protocol will be done. The parameter used for this purpose is the energy consumed by the nodes. In addition, MATLAB is used as a simulation tool. Finally, we will consider a network depicted in Figure 3 to evaluate flooding, gossiping, and SIG comparatively. Figures 4 and 5 show the network's routing path using the flooding and gossiping routing protocol, while Figure 6 shows the routing based on our proposed SIG algorithm.

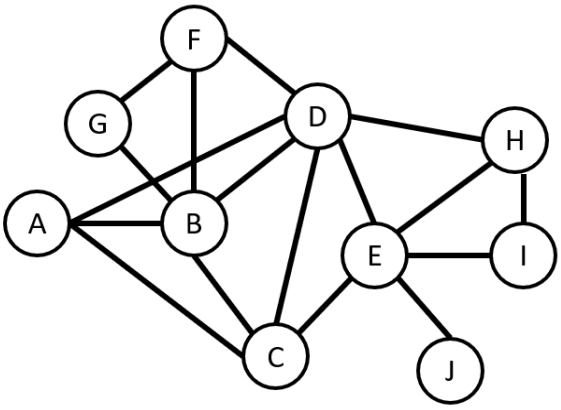

Fig 3: Sample Network

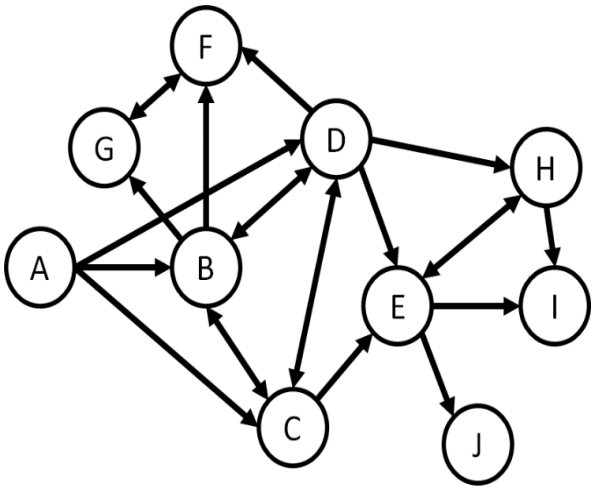

Fig 4: Applying flooding in the sample network

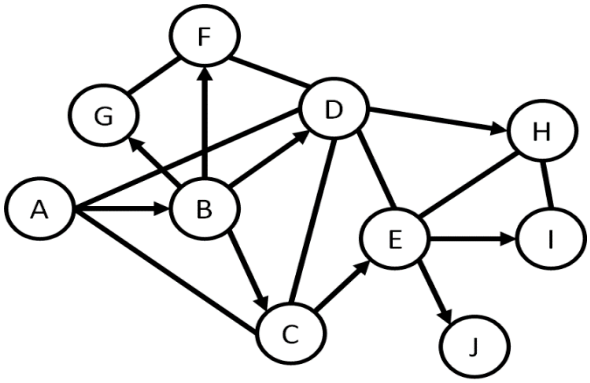

Fig 5: Applying Gossiping in the sample network

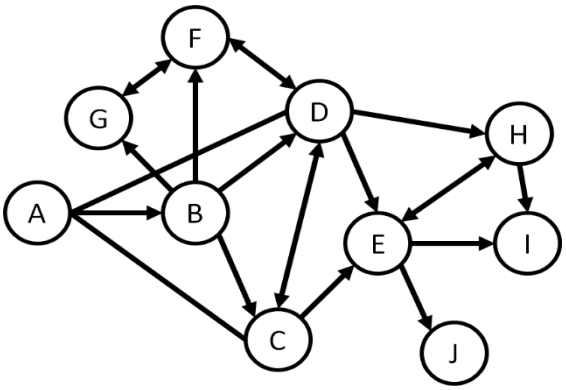

Fig 6: Applying SIG in the sample network

Total energy consumed in each node is considered to be the sum of energy consumed in sending and storing the packets. We consider the same consuming energy in both sending & storing cases for simplifying our analysis. The graph below depicts the energy consumed by Flooding, Gossiping, and SIG. Gossiping consumes about 24% less energy than flooding. But our proposed protocol SIG consumes about 50% less energy than flooding and 35% less energy than Gossiping. The comparative performance analysis is depicted in Figure 7.

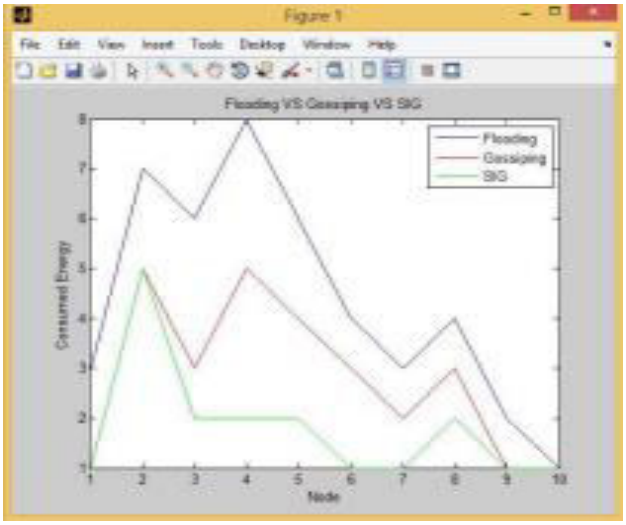

Fig 7: Comparative result of consumed energy

5. Conclusion

This paper presents SIG (Source Initiated Gossip), a protocol that offers reliable broadcast services to resource-constrained sensor networks. We showed that the result of SIG is better than Flooding and Gossiping. SIG is designed to automatically and dynamically adapt itself to any network topology. It removes many problems like an implosion resource blindness. SIG can be used when there isa large number of nodes exist. In order to enhance the efficiency of flood prevention, the system can be integrated with modern space technologies and Geographical Information Systems (GIS). Today, space technologies are considered an efficient tool for risk

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assessment and emergency management systems. The main advantage of SIG protocol is that it is easy to implement and maintain. SIG is also resilient to energy losses and node failures that may be quite prevalent in wireless sensor networks.

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