A Beeline Routing Protocol for Heterogeneous WSN for IoT-Based Environmental Monitoring

G.Sahitya 1††, sahitya_g@vnrvjiet.in VNRVJIET

Dr.N.Balaji 2†† narayanamb@rediffmail.com JNTUK, Kakinada

Dr.C.D.Naidu 3†††, cdnaidu@vnrvjiet.in VNRVJIET

ABSTRACT
A wireless sensor network (WSN), with its constrained sensor node energy supply, needs an energy-efficient routing technique that maximises overall system performance. When rumours are routed using a random-walk routing algorithm, which is not highly scalable, spiral pathways may appear. Because humans think a straight line is the quickest route between two sites and two straight lines in a plane are likely to intersect, straight-line routing (SLR) constructs a straight path without the aid of geographic information. This protocol was developed for WSNs. As a result, sensor nodes in WSNs use less energy when using SLR. Using comprehensive simulation data, we show that our upgraded SLR systems outperform rumour routing in terms of performance and energy conservation.

Keywords:
WSN, IOT, Cluster Head, Routing Protocol and sensor node.

1. Introduction

It has recently become an important area of study to design an efficient Wireless Sensor Network (WSN). In other words, a sensor is a device that reacts to and recognizes some type of contribution from environmental or physical circumstances. In most cases, the sensor's output is a signal that is sent to a controller for additional processing. To put it another way, a wireless sensor system is made up of various gadgets that can transmit the data they collect from an observable environment over long distances. As the data travels through numerous hubs, it is linked to various systems, such as remote Ethernet.

There are a large number of base stations and hubs in the Wireless Sensor Network (WSN) (remote sensors). Physical or biological factors like sound, weight, and temperature can be monitored and transmitted through these systems to a primary location. Presently days, Wireless Sensor Network is utilized in a few applications, for example, distinguishing and following troops, tanks on a battleground, process traffic stream on streets, register mugginess and different angles in fields, following work force in structures. A sensor hub incorporates detecting unit, control unit, and handling unit.

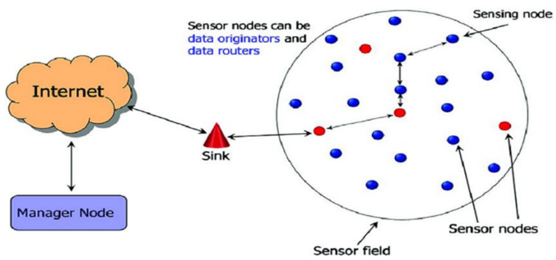

Figure 1 WSN Structure

2. Architecture of wireless sensor network

They are two essential sorts of sensor arrange design which are delegated layered and bunched engineering.

2.1 Layered Architecture

A layered design has a solitary ground-breaking base station (BS), and the layers of sensor hubs around it relate to hubs that have a similar jump check to the base station (BS) as appeared in fig. 2.1.1 Layered structures have been utilized with in-building remote spines, and in military sensor-based framework, for example, the multi-bounce foundation organize design (MINA). In the in-structure situation, BS turns into a passage to a wired system and little hubs structure remote spine to give remote availability

The clients use hand-held gadgets like PDAs to convey to BS by means of little hubs. Brought together Network Protocol Framework (UNPF) is a lot of conventions for complete usage of a layered design for sensor systems

Manuscript received October 5, 2022
Manuscript revised October 20, 2022
https://doi.org/10.22937/IJCSNS.2022.22.10.10

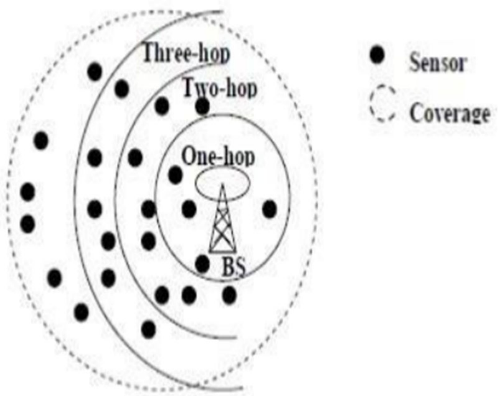

Figure 2.1.1: Layered Architecture

2.2. Clustered Architecture

While high vitality hubs can analyse and convey data, low vitality hubs can be used to detect in the neighbourhood of a target. This design is based on this principle. The sensor hubs were organised into groups as a result of this architecture. There is a leader for each of the groups. To send messages to a BS, which is typically a wired system's passageway, the hubs in each group trade messages with their respective bunch heads. The formation of groups and relegating extraordinary undertakings to bunch heads can enormously add to generally speaking framework

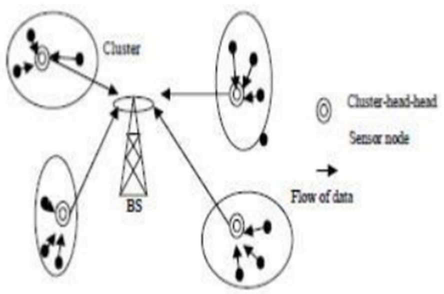

Figure:2.2.2:Clustered Architecture

adaptability, lifetime, and vitality proficiency. Figure 2.1.2 demonstrates this engineering where any message can achieve the BS in at most two jumps. Grouping can be reached out to more prominent profundities progressively. Grouping design is particularly helpful for sensor systems as a result of its intrinsic appropriateness for information combination. (Information total can be seen as a lot of mechanized strategies for consolidating the information that originates from numerous sensor hubs into a lot of significant data. With this regard, information collection is known as information fusion).The information assembled by all individuals from the group can be intertwined at the bunch head and just the subsequent data should be discussed to the BS. Sensor systems ought to act naturally sorting out, subsequently the bunch arrangement and race of group heads must be a self-ruling and an appropriated procedure. Using system layer conventions, which are typically two-layer steering techniques, one layer is used to choose the bunch heads and the second layer is used to direct.

3. Applications of WSN

Fig. 3 Application of WSN

Disaster Relief Operation

Drop the sensor nodes from an aircraft onto the fire in this scenario if it is believed that a natural disaster, such as a wildfire, has affected the area. To come up with effective strategies and procedures for putting out the fire, keep an eye on the data coming from each node and construct a temperature map.

Military Applications

The WSNs are useful in military activities for detecting and observing friendly or hostile movements since they can be swiftly assembled and despatched. By monitoring everything, sensor hubs will conduct reconnaissance in the conflict zone in case extra tools, resources, or ammo are needed. The sensor hubs can discriminate between atomic, synthetic, and organic attacks. The "expert sharpshooter identification framework" is an example of this. It uses acoustic sensors to detect impending firing and prepares a marked sound from an amplifier to assess the shooter's condition.

Environmental Applications

The number of sensor systems used in these applications is enormous. They can be used to monitor and document the growth of mammals and avian species. Through the use of these sensors, it should be feasible to monitor the earth, the water cycle, the soil, the climate, and the precision of farming. They can also be used to identify fire, flood, seismic vibrations, compound/organic episodes, and other disasters. The "Zebra Net" model is a popular one. This framework's objective is to track and keep an eye on the internal and external growth of zebras as well as their interactions with other species.

Medical Applications

In health applications, coordinated patient observation is made possible by WSNs. It is possible to confirm the inner workings and development of animals. There ought to be a way to diagnose. Additionally, they help with the supervision of medical staff and patients, as well as the supervision of drug administration in hospitals. One such is the "counterfeit retina," which helps the patient discern between the presence of light and the growth of objects. They are also capable of counting unique items and finding articles.

Home Applications

As the innovation spreads, it is also being included into our family's appliances for convenient operation. These sensors can be put in vacuum cleaners, microwaves, security systems, coolers, and water monitoring systems, among other things. With the help of the WSNs, the client can control devices locally in an equally shaky manner.

4. Methodology

SLR develops the path in a bounce by-jump approach The primary flaw in RR is that it is unable to guarantee a straight path; there may be much wandering on the road. The shortest distance between two objects is a straight line. We take advantage of the plane's ability to bring two straight lines together. In this manner, the fundamental notion of SLR convention is to maintain the occasion and question ways straight. We select a subsequent jump a hub that lies on the entire line of the way for each advancement. Also, instead of including the bulk of the attended hubs in the parcel payload, simply two jumps of data will be recorded. It rearranges execution in WSN's. We have outlined some crucial suppositions regarding sensor nets. Hubs that make up sensor networks are dispersed randomly or, in some cases, over a very precisely defined zone. In addition to being equipped with short-range communication, hubs are also within the radio range of a few other hubs. A sensor net's large number of hubs all have comparable correspondence intensities. Utilizing a sensor hub's distant correspondence necessitates vitality, a valuable resource that is scarce for sensor hubs. The path is built similarly to RR while using SLR. RR has the drawback of not being able to ensure a straight course; there may be a great deal of wandering. We take advantage of the fact that two straight lines in a plane are more likely to cross than not because the distance between two points is a straight line. As a result, the SLR protocol's main objective is to guarantee that the event and query channels are well defined. The next hop in each step can be chosen from any node on the extended line of the path. In addition, two hops of information are recorded in the packet payload instead of documenting all of the visited nodes. As a result, it is easier to implement in WSNs.

Every node in the basic SLR technique keeps the two variables Flagin and Flagout for each route. Our assumptions lead us to believe that after receiving a route request, nodes can determine the strength of the signal. A node can use the energy-distance model to calculate the distance between itself and the signal sender in order to determine the sender's band. It enables its Flagin if it is inside band, and Flagout if it is in the outside band. When both Flagin and Flagout are enabled, a node will want to be the next hop. After that, each node in the candidate region sets its own Twait timer. In order to calculate the value of Twait, you need use a formula that takes into account the distances between the current node and its parents and grandparents.

$$arg_{Ci}min = \frac{\overline{AB^2} + \overline{AC_i^2} - \overline{BC_i^2}}{2\overline{AB}\,.\,\overline{AC_i}}$$

Firstly, WSN is created with 150 nodes in a network area of 300 × 300 m2 with each sensor node represented by a number.

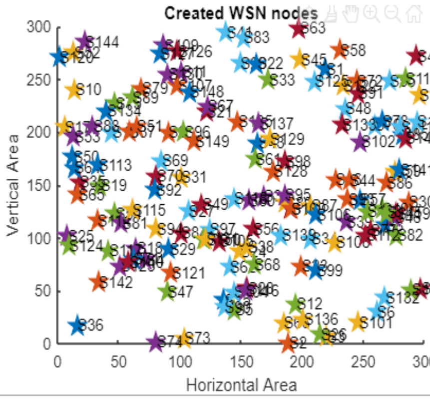

Figure 4.1 Created WSN nodes

Each sensor node is given a communication range of about 50m i.e., the link is established between the sensor nodes only when the sensor node is within its communication range

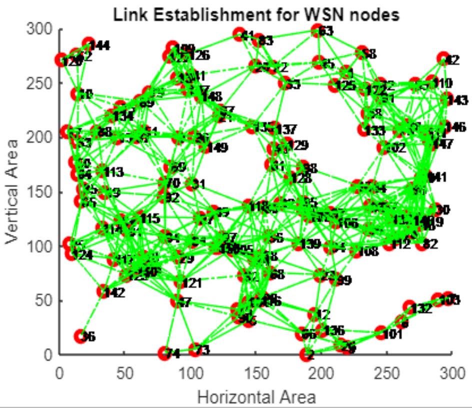

Figure 4.2 Link establishment between nodes

The below figure depicts the coverage area in the form of circle with the radius of about 50m

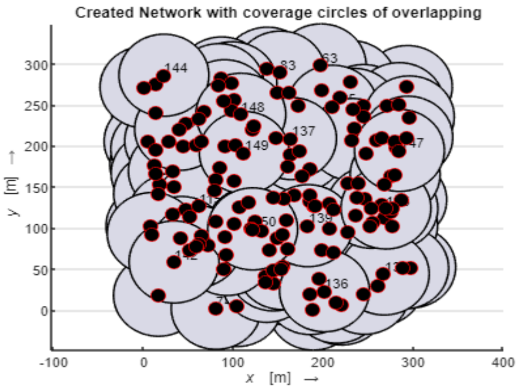

Figure 4.3 Coverage circles for nodes

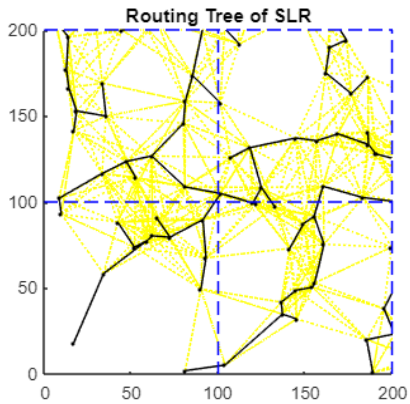

Figure 4.4 Routing Tree of SLR

Successful Path Discovery Ratio: Figure 1 shows the successful path finding ratio for N = 150 when using the following methods: Baseline (SLR), Ideal (RR), Dual (SLR), Dual (SLR/2), and Dual (SLR/2). In any of our 30 tests for the above source-destination pairs, SLR dual way (/2) was deemed successful if it could identify a starting direction with which to construct an efficient path. By multiplying the total number of successful marriages by 10,000, the optimal success rate can be calculated. The ideal success rate curve can then be plotted using this information. The performance of the baseline path discovery ratios is subpar below 70 units.

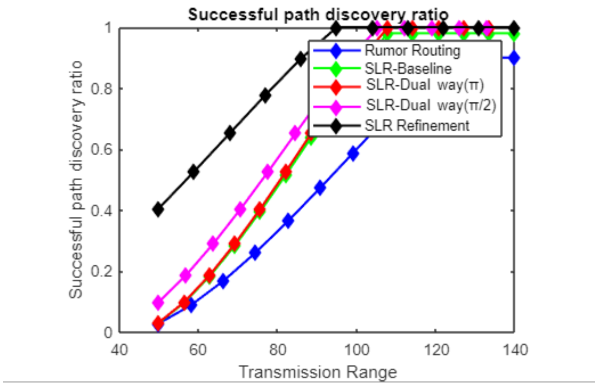

Figure 4.5 Successful Path Discovery ratio

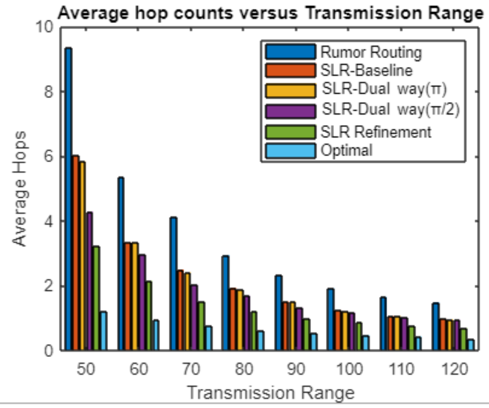

Figure 4.6 Average hop count

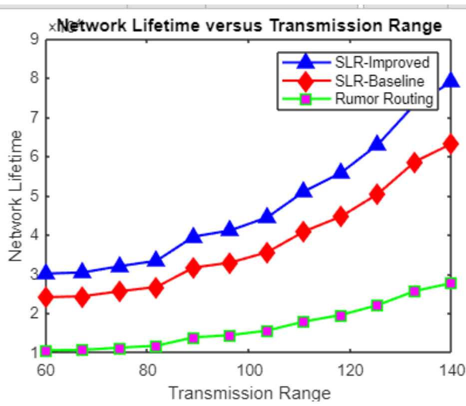

Figure 4.7.Network Lifetime versus Transmission range

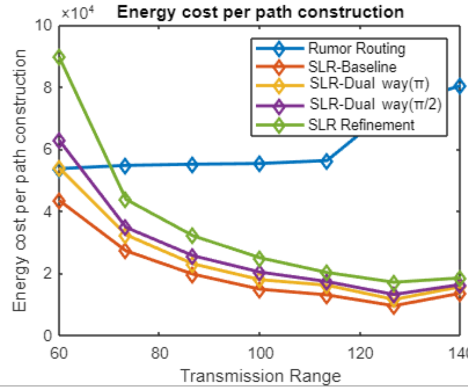

Figure 4.8:Energy Cost per Construction

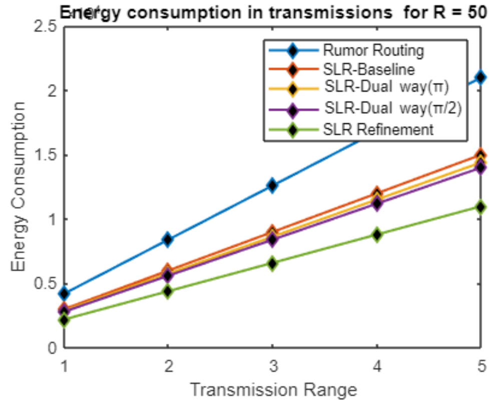

Figure 4.9:Energy consumption in transmissions for R=50

We examined the average number of hops on the best, RR, baseline, dual, and refined SLR paths. It's critical to keep in mind that we are only looking at successful approaches. The information in the figure illustrates how the SLR short-cut ACK works in these four SLR systems. SLR refinement compared to the baseline scheme resulted in relative improvements of up to a quarter of a percentage point (average is 17.27 percent). Because the event and query paths were both straight, SLR's refinement resulted in the shortest hop counts, whereas RR's lengthy meanderings resulted in the longest paths.

Conclusion

New protocols named SLR and outlines for straight pathways without local information for WSNs were created by our team. Since two nonparallel lines collide on a plane, SLR may construct the event and query pathways without the use of geographic information. The SLR and RR routes are both constructed on top of this framework. There is no realistic technique to accomplish optimal routing in energy-constrained networks because it necessitates future knowledge. The energy cost issue with traditional global routing systems has a simple solution: keep the line straight. According to simulation studies, SLR outperforms RR in wireless sensor networks in terms of path discovery success rates and energy savings (WSNs). We've proved these advantages and more.

References

[1] M. T. Lazarescu, "*Design of a WSN platform for long-term environmental monitoring for IoT applications*," IEEE Trans. Emerg. Sel. Topics Circuits Syst., vol. 3, no. 1, pp. 45–54, Mar. (2013).

[2] J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswami, "*Internet of Things (IoT): A vision, architectural elements, and future directions,"* Future Gener. Comput. Syst., vol. 29, no. 7, pp. 1645–1660 (2013)

[3] B. A. Attea and E. A. Khalil, *"A new evolutionary based routing protocol for clustered heterogeneous wireless sensor networks,"* Appl. Soft Comput., vol. 12, no. 7, pp. 1950–1957 (2012).

[4] S. K. Singh, P. Kumar, and J. P. Singh, *"A survey on successors of LEACH protocol,"* IEEE Access, vol. 5, pp. 4298–4328 (2017).

[5] D. Goyal and M. R. Tripathy, *"Routing protocols in wireless sensor networks: A survey,"* in Proc. 2nd Int. Conf. Adv. Comput. Commun. Technol. (ACCT), pp. 474–480 (2012).

[6] T. M. Behera, U. C. Samal, and S. K. Mohapatra, "*Routing protocols,"* in Computational Intelligence in Sensor Networks, vol. 776. Heidelberg, Germany: Springer, (2019).

[7] E. A. Khalil and B. A. Attea, "Energy-aware evolutionary routing protocol for dynamic clustering of wireless sensor networks," Swarm Evol. Comput., vol. 1, no. 4, pp. 195–203 (2011).

[8] S. Wang, J. Yu, M. Atiquzzaman, H. Chen, and L. Ni, *"CRPD: A novel clustering routing protocol for dynamic wireless sensor networks,"* Pers. Ubiquitous Comput., vol. 22, no. 3, pp. 545–559, (2018).

[9] G. Smaragdakis, I. Matta, and A. Bestavros, *"SEP: A stable election protocol for clustered heterogeneous wireless sensor networks,"* Comput. Sci. Dept., Boston Univ., Boston, MA, USA, Rep. BUCS-TR- M. T. Lazarescu, "Design of a WSN platform for long-term environmental monitoring for IoT applications," IEEE Trans. Emerg. Sel. Topics Circuits Syst., vol. 3, no. 1, pp. 45–54, (2013).

[10] A. Whitmore, A. Agarwal, and L. Da Xu, *"The Internet of Things— A survey of topics and trends,"* Inf. Syst. Front., vol. 17, no. 2, pp. 261–274 (2015).