



Shortest Path Selection For New Generation Cellular System Using MATLAB

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Abstract: In a wireless sensor network, data routing is implemented based on link comparison. The length, link quality, or residual energy of the node pairs of the investigated links between a sender and a receiver are allowable compared. However, the data transmission path is selected according to the shortest investigated path option. Dijkstra's algorithm can be implemented in MatLab to find the optimal route between two nodes in a graph data structure. Dijkstra's method is implemented in the grShortPath function, which is part of the grTheory Matlab toolbox. The source i and destination j nodes and an E matrix of neighbors are input parameters for the grShortPath function. The shortest path between each pair of nodes in the network is shown in a DSP matrix that is returned. Moreover, it yields a [sp] vector containing the nodes that make up the shortest path between nodes i and j. The grShortPath algorithm must have a precise form to process the E matrix correctly. It consists of three columns: the Euclidean distance in meters between any two nodes in the network that are neighbors is shown in the third column. The other two columns list all of the network's neighbors.

Keywords: Dijkstra Algorithm, shortest Path, Graph theory. Wireless sensor node.

1. Introduction

Recent developments in wireless communication, information technology, and electronics have brought Wireless Sensor Networks (WSN) to people's attention worldwide. WSN is a new technology that can be used in applications like border area surveillance, enemy movement tracking, or fire detection systems when human participation is not feasible [1]. A sensor network generally consists of one or more data sinks or base stations near or inside the sensing region and many sensor nodes densely dispersed in an area of interest. While the sensor nodes work to complete the sensing task and transmit the data that they perceive to the sink(s), the sink(s) sends inquiries or orders to the sensor nodes in the sensing zone. In the meantime, the sink or sinks act as a bridge to external networks, such as the Internet. It obtains information from the sensor nodes, applies basic processing to the gathered data, and then transmits pertinent information (or the processed data) to the users via the Internet for their use or demand [1-3]. These battery-operated WSN nodes are set up to carry out a specific function for months or even years. Using WSN nodes as gateways to other networks and computing and communication resources for complex algorithms is advantageous if more powerful or mains-powered devices are nearby. These sensors are affordable compared to standard, compact and have limited processing and computational power. In wireless sensor networks (WSNs), sensor nodes and motes are tiny devices that can sense, collect, and analyze data while interacting via radio frequency (RF) channels with other nodes linked to the network. It is impractical to replace the energy source once the tiny sensor nodes are deployed since they are typically inaccessible to the user. Therefore, improving energy efficiency is a crucial design factor in extending the network's lifespan. These sensor nodes can sense, measure, and collect data from their surroundings. Then, they send the perceived data to the intended location depending on a local decision-making process [2]. A straightforward formula forms the foundation of wireless sensor networks: Sensing + CPU + Radio = Thousands of possible applications. Many sectors are paying more and more attention to the development of low-cost, low-power, multifunctional sensors. Sensor nodes or motes in WSNs are small and

capable of sensing, gathering, and processing data while communicating with other connected network nodes via radio frequency (RF) channels. Once deployed, the small sensor nodes are usually inaccessible to the user, and thus, replacement of the energy source is not feasible. Hence, energy efficiency is a crucial design issue that needs to be enhanced to improve the life span of the network [3, 13].

In this study, we have specifically designed and implemented the Dijkstra algorithm to select the shortest path in the next-generation cellular system. This algorithm's role in determining the shortest route is of utmost importance for the efficient operation of the next-generation wireless system.

This research is structured into five sections, each serving a specific purpose. In section one, we introduce the work. Section two is dedicated to a comprehensive review of related studies. Section three delves into the methodology and dataset used in our proposed work. Section four presents the results concisely. Finally, in section five, we draw conclusions based on our findings.

2. Related Study

In WSNs and future cellular networks, efficient shortest path selection is essential for effective and lasting operation. The development of these networks will be determined by addressing issues with energy efficiency, dynamic topology, scalability, dependability, and latency using specialized algorithms and cutting-edge technologies. To satisfy the increasing needs of next-generation network applications, future research and development should concentrate on integrating AI, cross-layer optimization, and standardization [2-4]. The following observations were made while conducting this study.

2.1. Energy Efficiency

Due to the low power supplies of sensor nodes and the high operating costs of cellular networks, energy efficiency is crucial in both WSNs and cellular systems [5-7]. Algorithms must minimize energy consumption during data transmission, path discovery, and maintenance. By distributing the energy burden evenly throughout the network, strategies like energy-aware routing and clustering increase the network's lifespan.

2.2. Dynamic Topology

Due to node mobility, fluctuating channel conditions, and node failures, WSNs and cellular networks frequently experience dynamic changes in topology. It isn't easy to keep routes current and effective in such circumstances [7]. On-demand protocols that dynamically find routes and swiftly adjust to changes include AODV and DSR. Reliability and adaptability can be further improved with geographic and multipath routing [8].

2.3. Scalability

It is essential that a system can scale both in terms of node count and network size, particularly for Internet of Things applications and large-scale cellular installations [9]. Ensuring that as the network expands, algorithms maintain their efficiency and do not become a bottleneck. Extensive network management is aided by hierarchical and cluster-based routing technologies, which localize communication and minimize routing overhead [9].

2.4. Reliability and Robustness

Applications ranging from vital infrastructure monitoring to environmental tracking require reliable data delivery. They resolve issues, including varying link quality, interference, and node failures [7–11]. Since traditional algorithms like Dijkstra's and Bellman-Ford are often unsuitable due to their computational and energy demands, protocols explicitly designed for the challenges of WSNs and modern cellular systems, like AODV, DSR, LEACH, and geographic routing, offer more effective solutions [11]. The shortest path selection is crucial for optimizing network performance in wireless sensor networks (WSNs) and new cellular systems, particularly regarding energy efficiency, reliability, and scalability [10,14].

3. Implantation Detail

Data routing is implemented in a wireless sensor network based on link comparison. It is possible to compare the considered links in terms of node pair residual energy, link quality, or length between a sender and a receiver. However, the data delivery path is chosen based on the path with the lowest investigated value [4–9]. Dijkstra's algorithm can be implemented in Matlab to find the optimal path between two nodes in a graph data structure. The grShortPath function in the grTheory Matlab toolbox implements Dijkstra's method [6–11].

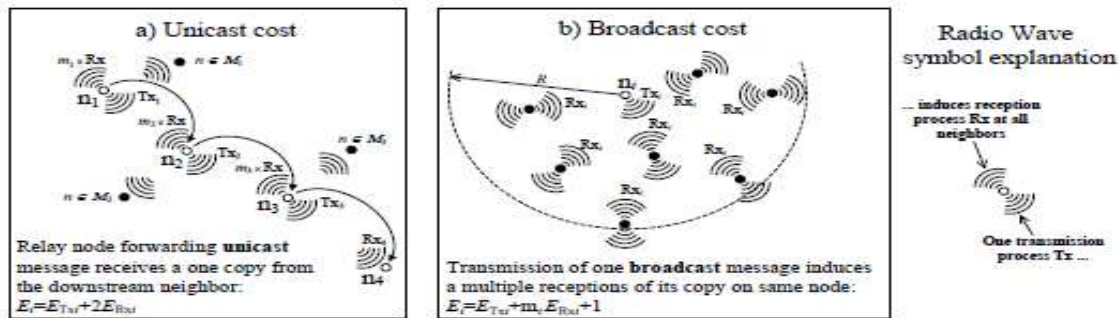


Figure 1. Cluster head to cluster child secure communication layout

3.1. Performance Optimization

In Wireless Sensor Networks (WSNs), shortest path selection determines the most effective way to transmit data from a source node to a destination node while considering the particular difficulties and limitations of WSNs [9, 15].

4. Results and Statistical Analysis

The method should be able to effectively manage deployments of different sizes of networks, from minor to massive. It is fit for non-negative edge weight static or slowly changing WSNs. Computationally demanding for nodes with limited resources [7]. It is helpful for networks with negative weights, however rare in WSNs. It is inappropriate for WSNs due to its higher processing complexity [11]. WSNs can also use the AODV (Ad hoc On-Demand Distance Vector) routing protocol created for mobile ad hoc networks. Route discovery on-demand, which lowers overhead by creating paths only when necessary. It may cause latency when determining a route [8–11]. Figures 2 and 3 display the design network layout with the clustering and highlight the shortest path determined by the grShortPath function.

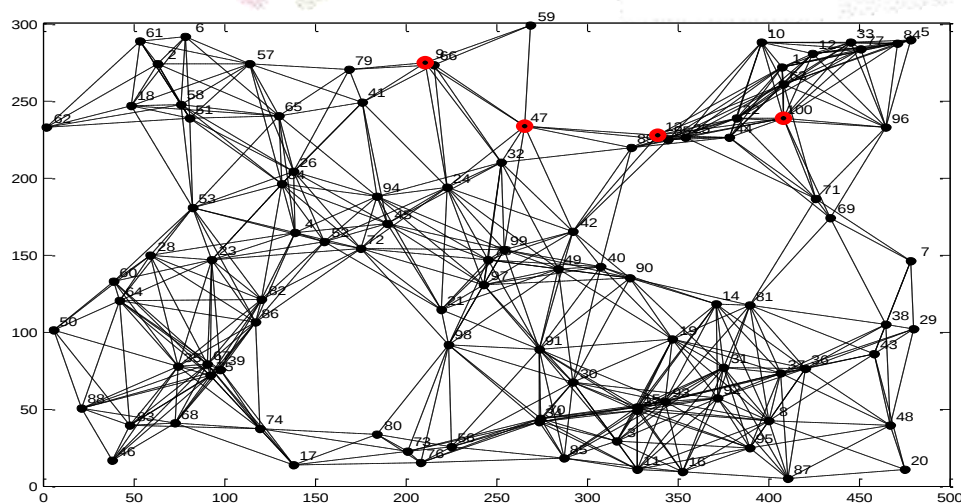
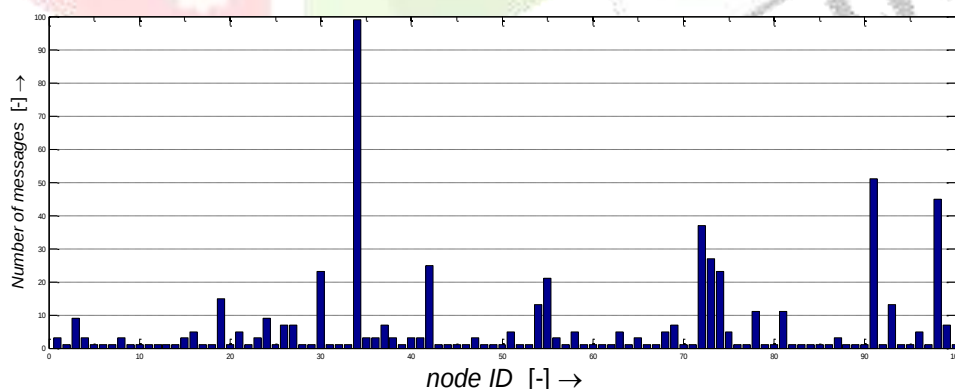


Figure 2- The testing eligibility, tracing, and indexing
 NumNodes = 100, grid: 0, receiver=34, R= 82.4621

Table 1. - Number of clusters for shortest path

Connection Cm	Depth level Lm	Number of nodes	Num Already forward	Num Non-forward	Num-Receive	Delay
2	2	10	3	4	20	8.6986e-04
3	2	10	9	1	86	0.6454
4	2	10	6	4	62	0.7060
5	2	10	8	2	90	0.6454
2	3	15	15	0	188	0.6381
3	3	15	13	2	156	0.4905
4	3	15	12	3	150	0.4652
5	3	15	12	3	150	0.6454
2	4	20	18	2	274	0.4770
3	4	20	18	2	240	0.4852
4	4	20	18	2	240	0.6898
5	4	20	18	2	240	0.4963
2	5	25	24	1	356	0.4902
3	5	25	23	2	300	0.5799
4	5	25	23	2	300	0.6898
5	5	25	23	2	300	0.5799
2	6	30	26	4	388	0.4902
3	6	30	29	1	418	0.5828
4	6	30	29	1	418	0.5828
5	6	30	29	1	394	0.7743

For WSNs and future Cellular networks to function effectively and to last, efficient shortest-path selection is essential [3-6]. The development of these networks will be driven by addressing issues with energy efficiency, dynamic topology, scalability, dependability, and latency using specialized algorithms and cutting-edge technologies. To satisfy the increasing needs of next-generation network applications, future research and development should concentrate on integrating AI, cross-layer optimization, and standardization [2-6]. Figure 2 displays the tracing, indexing, and eligibility for testing. The number of clusters for the shortest path is shown in Table 1.

**Figure 3.** - Number of bits transferred vs all nodes in different clusters.

In wireless sensor networks (WSNs) and novel cellular systems, choosing the shortest path is essential for maximizing network performance, especially for energy economy, dependability, and expandability [4-9]. Because they require a lot of processing and energy, traditional algorithms like Dijkstra's and Bellman-Ford are frequently inappropriate. Instead, more efficient alternatives are offered by protocols like AODV, DSR, LEACH, and geographic routing that are explicitly designed to address the difficulties faced by WSNs and contemporary cellular systems [1-11].

5. Conclusion

A path in graph theory is a set of unique edges and vertices that join two nodes. Numerous pathways may exist that connect a source node to a destination node. The approach adds the edge weight between the nodes to the current distance for each neighbor of the current node to determine a potentially shorter distance. The method updates the distance and moves the updated distance and node pair into the priority queue for additional investigation if this new distance is less than the previously recorded distance to the neighbor node. The proposed algorithm can explore nodes, update distances, and find the shortest pathways from the starting node to every reachable node in the graph by repeating this procedure until the priority queue is empty.

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