Congestion Control in Wireless Sensor Networks Using DAIPAS Algorithm

Submitted in partial fulfillment of requirements (**CS G-525**)

To

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Abstract:

Congestion control is an extremely important area in wireless sensor networks (WSN). Sometimes , data traffic becomes greater than the average or individual capacity of the transmission links between sensor nodes . Therefore, special algorithms or protocols need to be established to avoid, detect, and resolve congestion.
This paper deals with Congestion Control in wireless sensor networks. We have come up with an efficient, simple and lightweight algorithm known as DAIPAS algorithm which helps to overcome congestion in minimal time with higher efficiency.

Because of limited capacity of sensor nodes , maintaining or developing the congestion control algorithm becomes a challenging part.

Introduction:

Wireless sensor networks are self-configurable networks. They are infrastructure less networks used to sense temperature, pressure, humidity and other physical conditions. The main part of it is the sink node .The sink node acts as an interface between the user and the sensor nodes. The wireless sensor networks contain thousands of nodes. The basic mode of communication between the nodes is by the radio signals. These nodes are well configured with sensors and computing devices . These nodes contain radio trans-receivers and power components. Although, these nodes are of limited capacity , processing speed and bandwidth. Basically, they are resource constrained.

After the sensor nodes are deployed, they are responsible for self-organizing an appropriate network infrastructure often with multi-hop communication with them. The lifetime of these sensors are high. All the information collected from these sensors can be used for future analysis and prediction purpose. The working mode of the sensor nodes may be either continuous or event driven. Global Positioning System (GPS) and local positioning algorithms can be used to obtain location and positioning.

The Wireless sensor networks can be used for forest fire detection, air pollution monitoring , water quality monitoring , natural disaster prevention , machine health monitoring , pressure monitoring in cars.

Congestion in WSN:

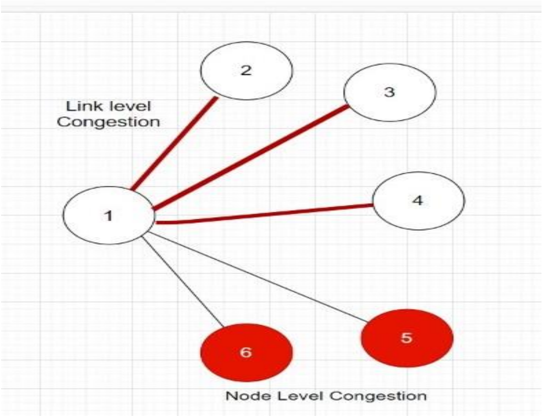
Many wireless sensor network applications require that the readings or observations collected by sensors be stored at some central location. Congestion can occur while collecting the data and sending it towards the central location over the wireless sensor network. Congestion happens mainly in the sensors-to-sink direction when packets are transported in a many-to-one manner. Congestion in WSNs has negative impacts on network performance and application objective, i.e., indiscriminate packet loss, increased packet delay, wasted node energy and severe fidelity degradation.

The purpose of WSN congestion control is to improve the network throughput, reduce the time of data transmitted delay. Under these circumstances, node energy, communications bandwidth, network computing capacity and other resources is generally limited. It is possible to improve the network performance through the protocols design, routing algorithms, data integration and load balancing.

Basically, there are 2 types of congestion:

- **Node level**: When the transmitted data is higher than the receiver node buffer, it leads to congestion.
- **Link level**: When the transmission rate is more than the link capacity, it leads to congestion.

Our main focus is on **Link level Congestion.**

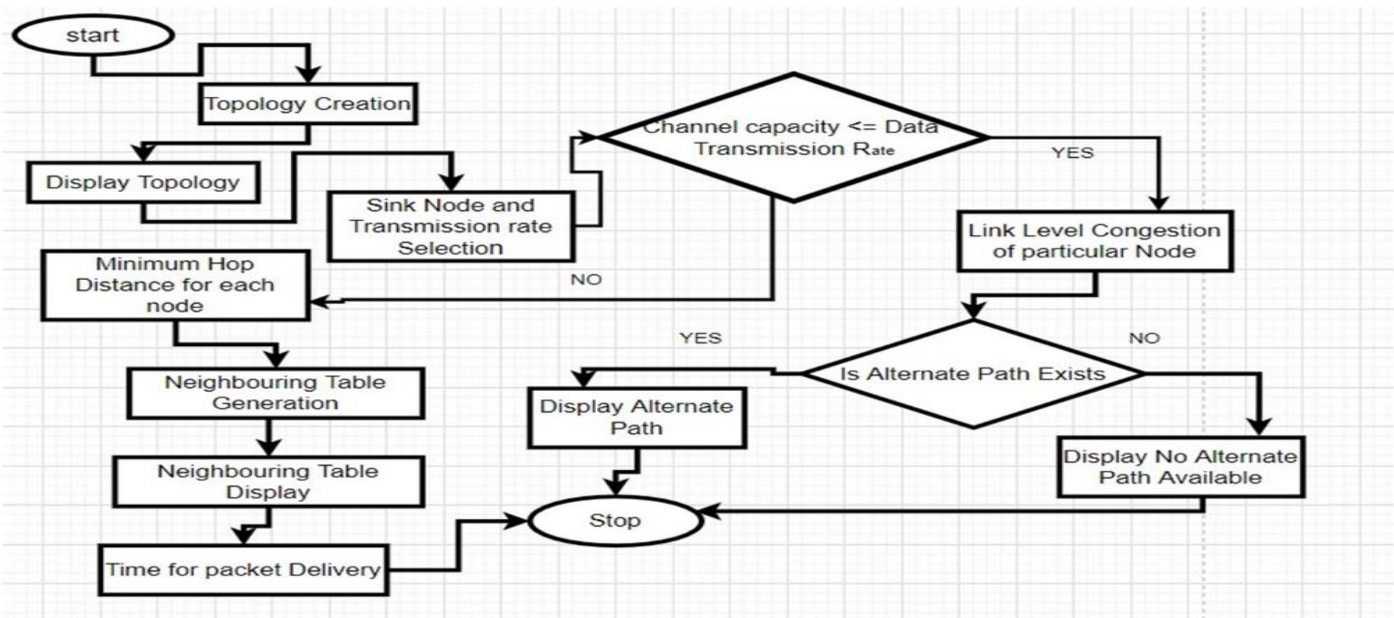


DAlPAS (Dynamic Alternative Path Selection Scheme) can efficiently and adaptively choose an alternative routing path in order to avoid congested nodes, by taking into consideration a number of critical parameters that affect the performance of a WSN while maintaining overhead in minimal levels. DAIPAS also takes into consideration the nodes congestion situation in terms of channels capacity rate.

Demonstration of DAIPAS:

- Select one node among all nodes available in the topology constructed.
- Find the shortest path from each node to the particular sink node.
- Check for congestion by comparing the link capacity with data transmission rate.
- Whenever the link capacity is less than data transmission rate, it indicates congestion in link.
- It dynamically selects one path with no congestion.
- If there is no congestion, generate the shortest path from all nodes to the sink node.
- Also, generate the neighboring table for each node present in the network.

Workflow of our algorithm:



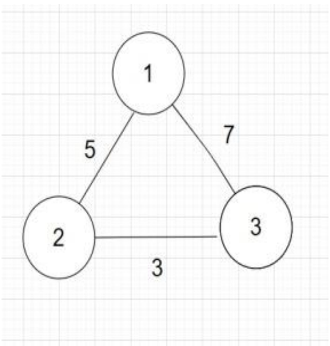
Explanation of the work flow:

First, we create the topology by taking input from the user. Here, the user can select his own topology. Any one node is assigned as the sink node by the user. After this assignment onwards, the core part of DAIPAS algorithm starts. The shortest path to the sink node from every other node is calculated. Transmission rates of each node are also selected by the user.

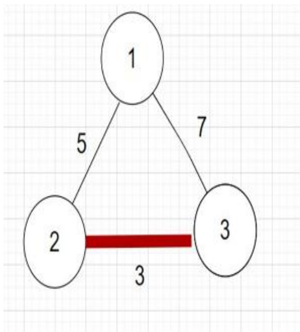
Now, if the channel capacity rate is more than Data transmission rate, then normal execution is carried on. We calculate the minimum hop distance for each node followed by neighboring table creation and its display if the user wants. At the end, we also calculate the time to deliver the data to the sink node.

Now if the channel capacity rate is less than or equal to the Data transmission rate, then its leads to or indicates the LINK LEVEL CONGESTION. Now, DAIPAS searches if there is any alternative path. If no alternative present, then the code displays “All routes are congested, Kindly wait/decrease the transmission rate. Now, if there is an alternative path present, the alternative path is detected and display by our DAIPAS approach.

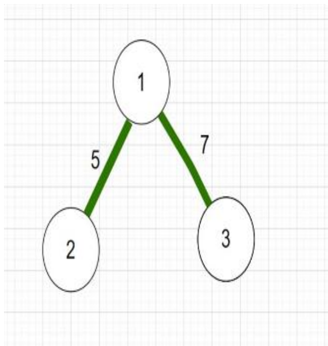
Diagrammatic Representation:



Initial graph



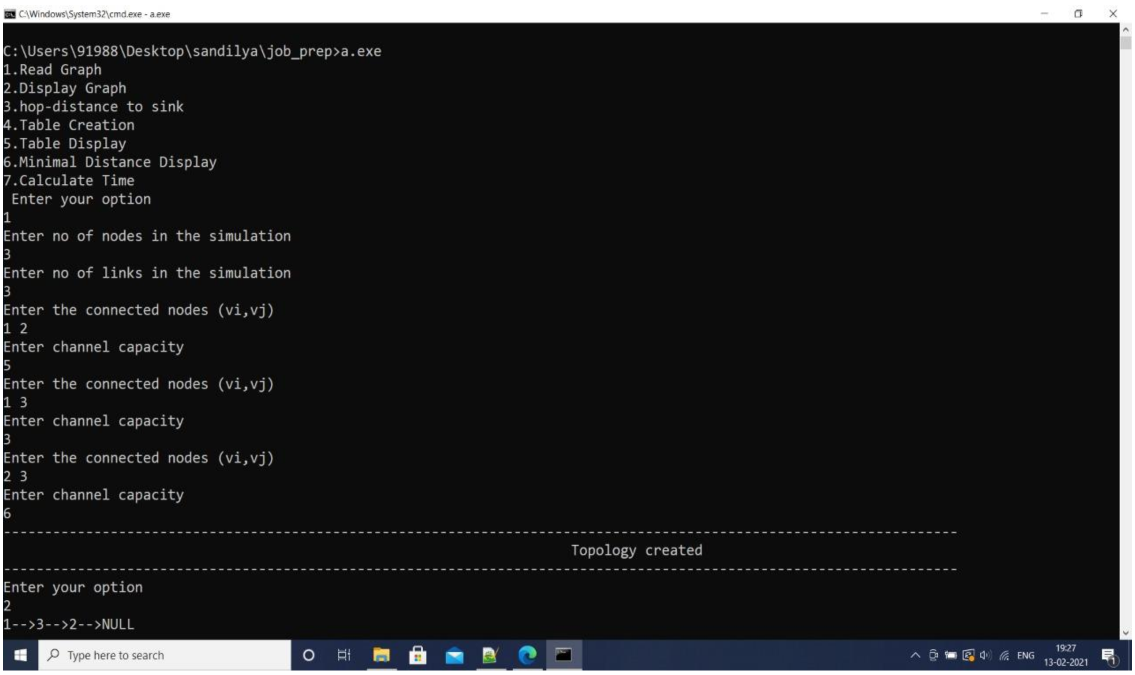
Link 2-3 is congested



Alternative path by DAIPAS(2->1->3)

Results and Output:

Output 1: Topology Creation.



Output 2: Neighboring Table and Delivery Time:

```
C:\Windows\System32\cmd.exe - a.exe
--------------------------------------------------------------------------------------------
                                     DisplayNeighbourTableforeachnode
--------------------------------------------------------------------------------------------
current Node                    Adjacent Node       level
---------------------------------------------------------------------------------------------
1                                       3               0
                                        2               1


2                                       3               0
                                        1               1


3                                       2               1
                                        1               1


Enter your option
6
--------------------------------------------------------------------------------------------------------
                                   Enter the host for shortest path selection
--------------------------------------------------------------------------------------------------------
1
1-->3-->NULL
Enter your option
7
Time to deliver packet from host 1 is 0.124
Time to deliver packet from host 2 is 0.124
Time to deliver packet from host 3 is 0
Enter your option
```

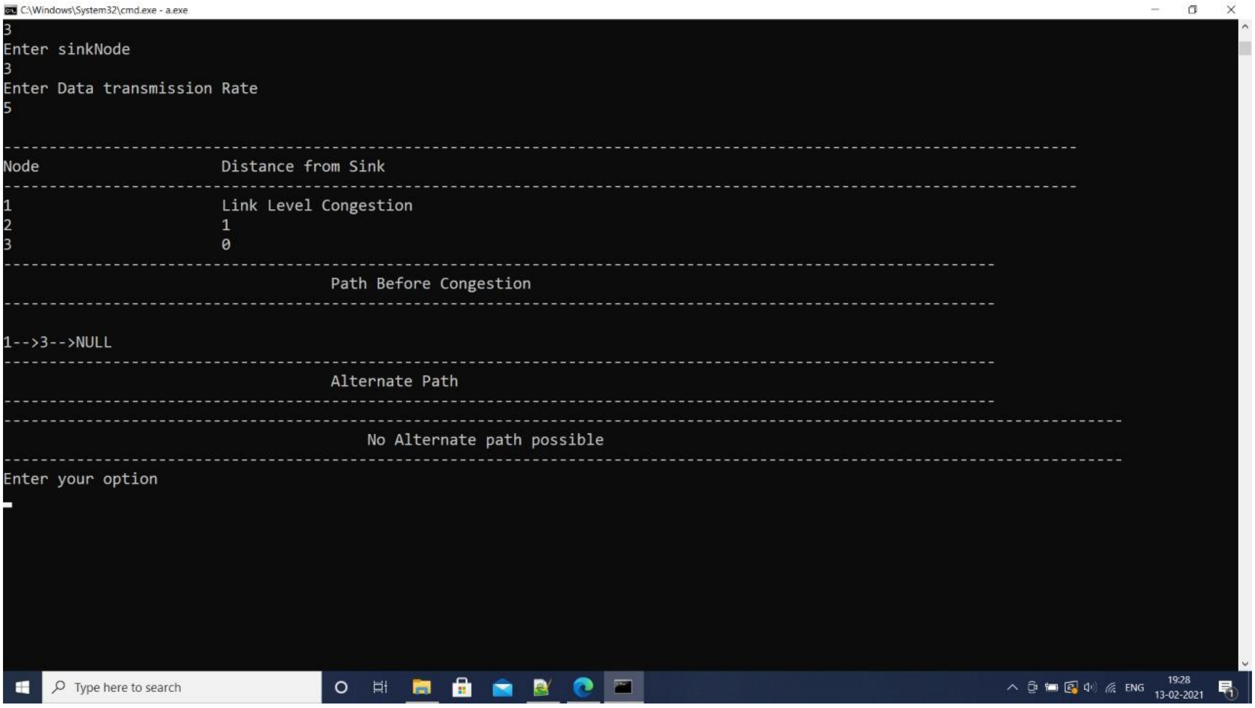
Output 3: Congestion with Alternative Path.

```
C:\Windows\System32\cmd.exe - a.exe
Enter your option
3
Enter sinkNode
3
Enter Data transmission Rate
8
--------------------------------------------------------------------------------------------------------
                                 All Routes are Congested,Kindly wait/decrease transmission rate
--------------------------------------------------------------------------------------------------------
Enter your option
3
Enter sinkNode
3
Enter Data transmission Rate
4

------------------------------------------------------------------------------------------------------
Node                        Distance from Sink
------------------------------------------------------------------------------------------------------
1                           Link Level Congestion
2                           1
3                           0
---------------------------------------------------------------------------------------------
                                    Path Before Congestion
---------------------------------------------------------------------------------------------

1-->3-->NULL
---------------------------------------------------------------------------------------------
                                    Alternate Path
---------------------------------------------------------------------------------------------
1--->2--->3--->NULL
Enter your option
3
```

Output 4: Congestion with no Alternate Path



Conclusion:

In this project, we implemented the Congestion Control and avoidance algorithm called DAlPaS (Dynamic Alternative Path Selection) to maintain robust and reliable data delivery. The strength of the proposed algorithm is that it does the work correctly, with simplicity, and with improved performance.

References:

1. DAlPaS: A Performance Aware Congestion Control Algorithm in Wireless Sensor Networks [2011 18th International Conference on Telecommunications].

2. Congestion in Wireless Sensor Networks and Mechanisms for Controlling Congestion [Raheleh Hashemzehi et.al / Indian Journal of Computer Science and Engineering (IJCSE)].

3. https://www.intechopen.com/books/wireless-sensor-networks-technology-and-protocols/overview-of-wireless-sensor-network.

4. https://app.diagrams.net/ [Used for designing the flow-charts].