Quality of Service using Min-Max Data Size Scheduling in Wireless Sensor Networks

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Summary
Wireless Sensor Networks (WSNs) plays an important role in our everyday life. WSN is distributed in all the places. Nowadays WSN devices are developing our world as smart and easy to access and user-friendly. The sensor is connected to all the resources based on the uses of devices and the environment [1]. In WSN, Quality of Service is based on time synchronization and scheduling. Scheduling is important in WSN. The schedule is based on time synchronization. Min-Max data size scheduling is used in this proposed work. It is used to reduce the Delay & Energy. In this proposed work, Two-hop neighboring node is used to reduce energy consumption. Data Scheduling is used to identify the shortest path and transmit the data based on weightage. The data size is identified by three size of measurement Min, Max and Medium. The data transmission is based on time, energy, delivery, etc., the data are sent through the first level shortest path, then the data size medium, the second level shortest path is used to send the data, then the data size is small, it should be sent through the third level shortest path.

Keywords:
Scheduling, Wireless Sensor Networks, Data Size, Time Synchronization, Energy.

1. Introduction

The wireless network is processed at the local and global levels. Monitoring and communications are easy and many smart gadgets are connected with sensors. The sensor nodes are worked with the help of hardware devices. The sensor nodes are distributed randomly and thousands of nodes are connected to the sink. Data sharing is easy and communicate anywhere because the wireless network is location independent. WSN technologies are easy to transfer the file from one device to another [2].

A sensor network is made up of several sensor nodes that are compactly located inside or around the phenomena. It is not necessary to engineer or predetermine the location of sensor nodes. This allows for random deployment in difficult-to-reach areas or disaster relief missions. However, using self-organizing sensor network protocols and algorithms is required. Sensor networks are also distinguished by the sensor nodes' cooperative effort[3]. WSNs Architecture is shown in Fig.1.

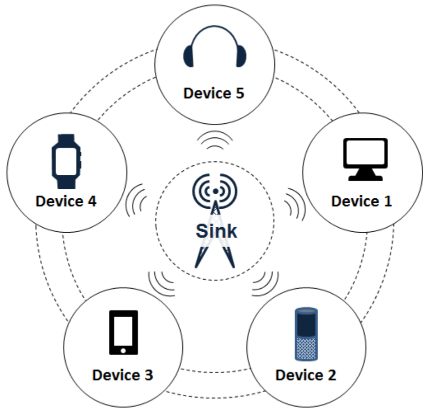

Fig.1 WSN Architecture

The WSN devices are user-friendly and monitor the weather conditions, health, agriculture, traffic, etc., It can identify forest sensors, and surveillance for any place.

A set of network features should follow during transmitting a movement is known as Quality of Service [3]. The goal of QoS is to transfer data quickly and meet the requirements of WSNs. Many updated strategies for QoS have been created in WSN research. However, there are several issues with QoS, including Delay, Jitter, and Data Loss.

A wireless Sensor Network is made up of hundreds or thousands of sensor nodes spread across different geographic regions. As a result, WSN QoS support should be able to scale up to a high number of sensor nodes. WSNs have many of the same QoS concerns as traditional networks, but they also face unique challenges. This work focuses on analyzing and proposing approaches for enhancing QoS in scalable WSNs [4].

Due to their restricted radio capabilities, sensor nodes have a limited broadcast range. As a result, data must be conveyed to the sink through intermediate nodes. In addition, instead of a single long connection, a multi-hop routing to the sink node may be more advantageous. The field of sensor network quality of service (QoS) is still

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mostly uncharted territory. Because sensor deaths and replacements make determining the optimal number of sensors that should be sending data at any given time impossible [3], this is an exciting field for research.

The quality of service (QoS) as defined by several technical communities refers to the user's or application's perception of quality. The QoS is a measure of the network's service quality to the end-user or application. It is a set of critical parameters that the network must handle while transferring data packets. In other words, Quality of Service (QoS) is a measurable service provided to network applications. Packet loss, bandwidth, end-to-end delay, and other factors can all affect QoS. The QoS approaches are divided into two categories: network resource reservation and network traffic classification. The handshaking protocol is used in the first technique to reserve network resources in each node along the path from the source to the destination. The traffic classification method divides packets into several service classes based on the application requirements [5].

Unavailability of processing and/or communication resources may have an impact on network QoS. For example, many nodes that want to send messages over the same WSAN must compete for the limited bandwidth available on the network. As a result, some data streams may incur significant delays, resulting in poor QoS [6].

2. LITERATURE SURVEY

Sapan Parikhet et al. suggests that network traffic is one of the most important factor determining the Quality of Service of a network. WSNs have a limited amount of bandwidth accessible to them. For the same information, it would be suggested by author to reduce network traffic from the sensor node to the sink node. Data transmission requires less energy, communication is faster, and the available bandwidth is more effectively utilized. The benefit of lowering packet size is additive when data packets are routed through several intermediate nodes. The packet header and payload are the two fundamental components of a data packet. The address of the sensor node, the timestamp, and error correction information are all included in the packet header. The payload is the actual data gathered as a sample by the sensor (sensor) node.

WSN's QoS may be improved and maintained using the Timestamp Optimization Technique. Analytical and mathematical models are used to describe the proposed method. For the scheme's applicability in networks, assumptions are made [7].

This paper by K. Nagarathna et al. proposes a delay-based routing scheme that takes propagation delay into account when formulating a technique for delay compensation in large-scale wireless sensor networks. This technique's main purpose is to handle energy issues, time synchronization, and routing issues in wireless sensor networks [8].

In this study, we look at how to extend the lifetime of a wireless sensor network while maintaining a high level of reliability. This is accomplished by simultaneously scheduling active sensor sets and determining data routing paths [9].

A Min-Max (MM) technique has been presented as a solution to this problem. The Min-Max (MM) method is used to prevent packet loss in unbalanced or overloaded networks. When an Access Category (AC) has a low priority bandwidth, a Min-Max is also used on the network. Data transmission, on the other hand, necessitates basic bandwidth allocation[10].

Linear task grouping, task duplication, and migration are all used in the suggested scheduling method. As a result, inter-task communication costs are decreased. Meanwhile, communication medium contention reduces local communication overhead. Experiments and comparisons using both randomly generated application graphs and graphs of real-world applications show that the suggested task mapping and scheduling scheme outperforms previous approaches in terms of schedule quality and cost, as measured by the deadline missing ratio, schedule length, and total application energy consumption [11].

3. PROPOSED METHODOLOGY

Cluster Formation

The cluster is formed dynamically in the proposed system. The clusters are formed with a two-hop intermediate node using Min-Max Data Size-based Scheduling Algorithm. The Cluster is formed with the help of neighboring nodes identifying the nearby nodes and connected into the cluster. The cluster is formed with two-hop neighboring nodes. Then select the Cluster Head (CH) using nodes distance and energy calculation shown in Fig. 2.

The cluster head is selected using the node's energy and distance and neighboring nodes are connected to the Cluster Head using two-hop neighboring categories using Eq. 1.

$$D_{sum} = min\{X_{ac} + X_{cb}, X_{ad} + X_{db}\} \qquad (1)$$

Proposed two-hop distance estimation Method shown in Eq. 2.

$$D_{size} = \frac{1}{\theta_{deg}} \int_{\pi\frac{\theta_{deg}}{2}}^{\pi} \sqrt{X_{bc^2} + X_{cb^2} - 2X_{ac} cos\theta_c X\theta_c} \qquad (2)$$

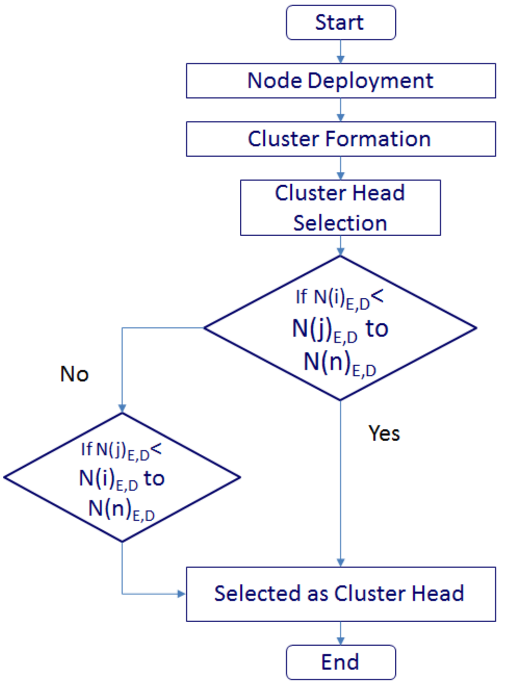

Fig. 2 Cluster Formation Flowchart

2.1 Data Size identification

QoS is affected for delay and also Delay is based on data transmission. In this work, Data is divided into three categories, such as Minimum, Maximum and Medium. The minimum identification is based on data size, which is not greater than medium.

The Minimum size of data is identified Using Eq. 3.

$$Data_{Min} = Data_{Size\ j} < Data_{Size\ i\ to\ n} \quad (3)$$

The Maximum size of data is identified Using Eq. 4

$$Data_{Max} = Data_{Size\ i} > Data_{Size\ j\ to\ n} \quad (4)$$

The Medium size of data is identified Using Eq. 5

$$Data_{Med} = \begin{cases} Data_{Size\ i} > Data_{Size\ j\ to\ n} \\ Data_{Size\ j} < Data_{Size\ i\ to\ n} \end{cases} \quad (5)$$

Here i and j is considered as data and n is considered as number of data is shown in Fig.3.

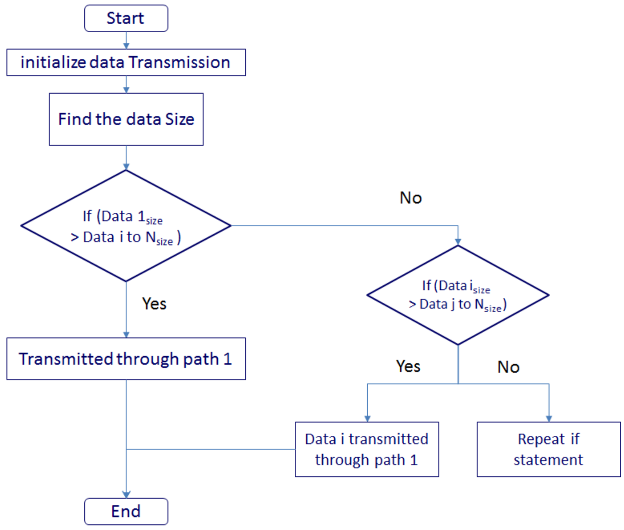

Fig. 3 Scheduling Flowchart

Scheduling

Here the data size is large, the data are sent through the first level shortest path, then the data size medium, the second level shortest path is used to send the data, then the data size is small, it should be sent through the third level shortest path.

The purpose of the proposed work is time synchronization. The data size is identified into three categories. Minimum, Maximum, Medium

Minimum<= Medium shown in Eq. 6.
Medium<=Maximum shown in Eq. 7.
Maximum = High shown in Eq. 8.

$$\min(\tau) = Min(\textstyle\sum_{a=1}^{j-1} pa) \quad (6)$$

$$\text{med}(\emptyset) = Med\left(\frac{\sum_{a=1}^{j-1} Pa_E}{(j-1)Pi}\right) \quad (7)$$

$$\max(\rho) = Max\left(\max_{1\le a\le j-1}\left(\frac{Pi}{Pa}\right)\right) \quad (8)$$

Time scheduling is important to avoid data latency. When the data size is large, that takes several seconds to transmit the data. At the same time, other data should be in a queue. In the proposed work, the path is selected into a different category, the large size data are transmitted through the shortest path, so the time will be reduced for transmission, the shortest path queue is based on the data size and the second level shortest path is used to send the medium size data. The large size, medium size data and small size data are transmitted as soon as possible in this approach.

For assumption
The large data size = 1000 kb
Medium data size = 500 kb
Small data size = 250 kb
The data are identify using

Data transmission Shortest path1 < 500kb

Data transmission Shortest path2 < 250kb

Data transmission Shortest path1 > 250kb

Here, the paths are ready to transmit the data at any time, the data are commonly transmitted through the shortest paths. Then the shortest path is identified using algorithm.

Algorithm:

START
//load configuration file
Load_config()
//Define the resource of the network.
i.e. Bandwidth, Memory and Processor
B=100, M=500 and P = 1000 *// set the Quality of Service for each Task*
FOR hi IN list(l) *//Calculate the Task bandwidth resources*
//Calculate the Task bandwidth resources
bi = (wi * B) / ∑ wi
mi = (wi * M) / ∑ mi
pi = (wi * P) / ∑ pi *//For the important Task, set min-rate*
IF hi is important
THEN
qi_min-rate = bi
For the not important task,
set max-rate qi_max-rate = bi
End IF *//Create corresponding QoS queue of the Task*
Create(qi) *// Add Task data flow to the created QoS queue*
Push(hi , qi)

4. PERFORMANCE ANALYSIS

Parameters	*Values*
Number of nodes	100
Number of sink nodes	1
Number of mobile nodes	5
Number of clusters	5
Network Area	100m* 100m

The Average Dissipated Energy (ADE) is calculated by the Eq. 9.

$$ADE = \frac{Eni - Enf}{N(D)} \quad (9)$$

Where N(D) is the total number of data items transferred by the corresponding user to the neighbor nodes in the network shown in Fig.4, and Eni is the opening energy and Enf is the final energy of the corresponding node.

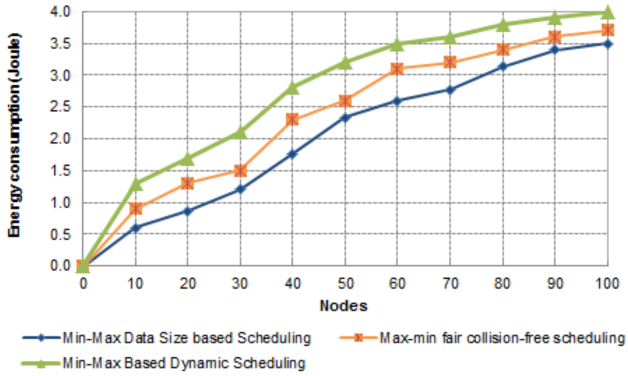

Fig.4 Node versus Energy

Eq. 10 is used to calculate the total number of nodes, data transmission time duration, and delay in the proposed technique.

$$Node_{Delay} = Process_{Delay} + Transmission_{Delay} + Queue_{Delay} + Propagation_{Delay} \quad (10)$$

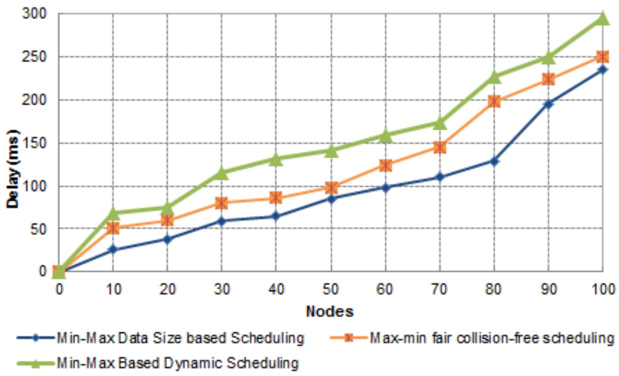

Fig.5 Node versus Delay

The number of nodes and the Packet Delivery Ratio are used to calculate the delivery Proportion. Eq. 11 is used to calculate the number of packets transferred from source to destination through the number of nodes.

$$Node_{PDR} = \frac{Total\ no.of\ packets\ received}{total\ no.of\ packets\ sent} \quad (11)$$

Fig. 6 shows a graphical representation of a mean Packet Delivery Ratio.

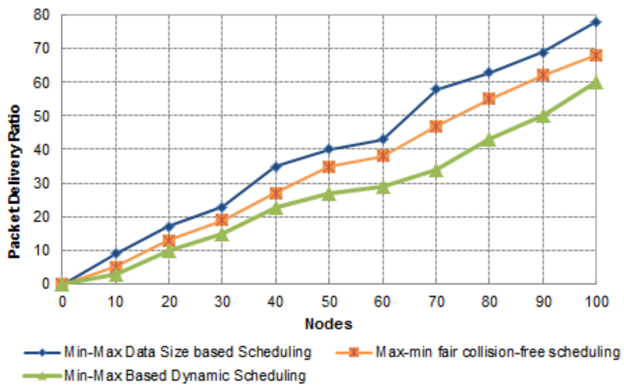

Fig.6 Node versus Packet Delivery Ratio

Eq. 12 is used to calculate throughput. The time interval determines the number of nodes data transfers.

$$\text{Throughput} = \frac{Number\ of\ Nodes}{Time\ spent\ for\ transmission} \quad (12)$$

Fig.7 depicts the suggested technique's nodes and throughput.

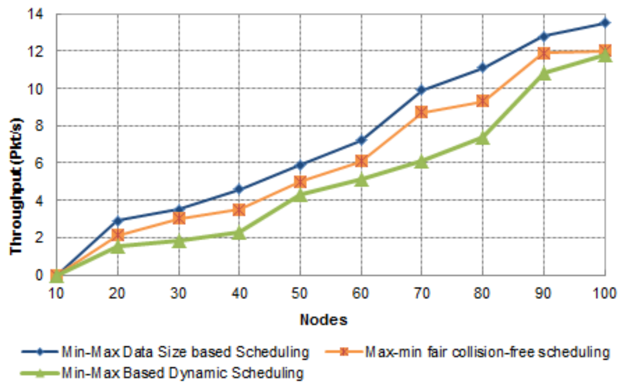

Fig.7 Node versus Throughput

Eq. 13 is used to compute the data transmission speed and energy usage for packet transmission between sources and destinations.

$$Energy\ Consuption = \frac{Total\ Energy}{Number\ \ of\ Packet\ Transferred} \quad (13)$$

As illustrated in Fig.8, the proposed technique saves energy while boosting speed.

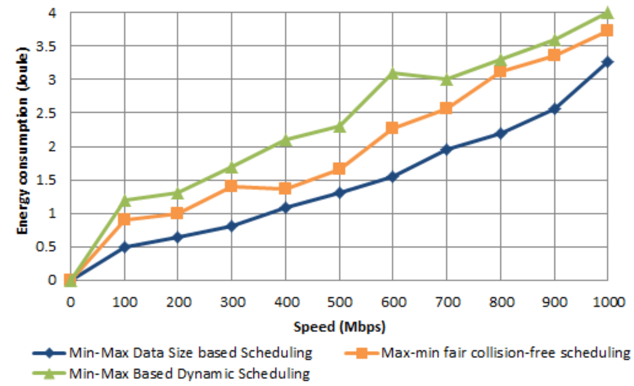

Fig. 8 Speed versus Energy

Eq. 14 is used to compute speed and delay depending on packet transmission speed.

$$Speed = \frac{Distance}{Time} \quad (14)$$

In terms of speed, the new method outperforms the current method in Fig.9. Packet loss and end-to-end delay are reduced using the proposed method.

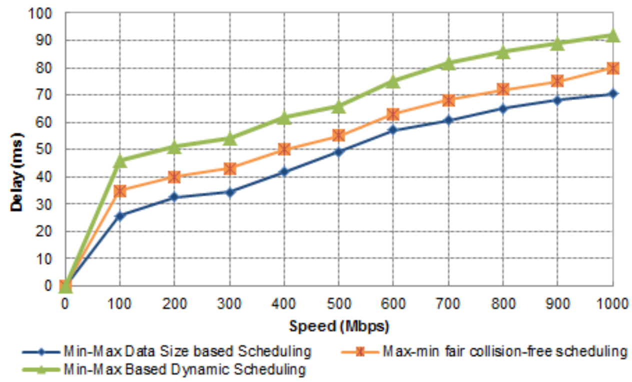

Fig.9 Speed versus Delay

Eq. 15 is used to calculate the packet delivery ratio and speed. From source to destination, the ratio of sent packets to speed is computed.

$$Packet\ Delivery\ Ratio = \frac{\sum(Total\ Packet\ Received\ time)}{Total\ Packet\ Sent\ time} \quad (15)$$

Fig.10 shows how the proposed strategy boosts the Packet Delivery Ratio speed.

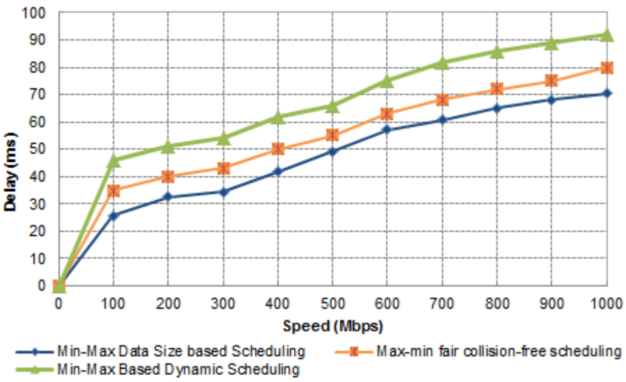

Fig. 10 Speed vs Packet Delivery Ratio

The proposed technique in Fig.11 allows for a high throughput of roughly 1pkt/s while also increasing the network's lifetime according to Eq. 16.

$$Throughput = \frac{sum(No.of\ Packets\ tranmitted*average\ packet\ size}{Transmission\ Time} \quad (16)$$

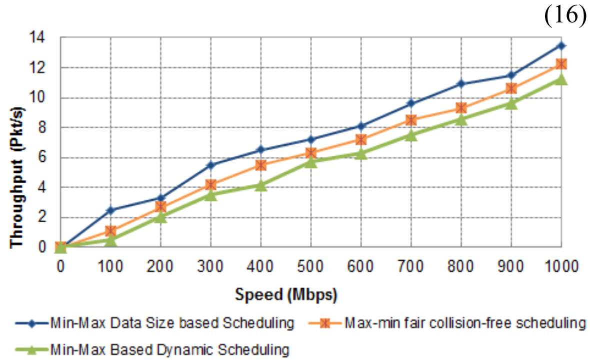

Fig.11 Speed vs Throughput

Conclusion

In this paper, we proposed a Min-Max Data Size Scheduling in WSNs. Firstly in order to define data size for each data packet, Min-Max is derived from Min-Max data. We have proposed the technique based on Min-Max data size based on bandwidth access allocation. The min-data size is sent through third level shortest path. Medium size is sent through second level. Max-data size is sent through first level. Finally the Min-Max Data Size for QoS is developed to transfer the data based on data size. We have scheduled the data transmission and identified the delivery time in WSN.

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