Journal of Theoretical and Applied Information Technology
30th June 2023. Vol.101. No 12

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

NIFR-NODE INTERFERENCE AND FAILURE RECOVERY FRAMEWORK FOR MULTIMEDIA TRANSMISSION IN WMSNs

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ABSTRACT

The proliferation of mobile communication technologies has led to a surge in demand for multimedia services and applications. Wireless sensor networks facilitate the collection and transmission of multimedia data such as audio and video. However, this also results in a significant increase in the volume of multimedia data, which in turn, places a high demand on bandwidth and energy consumption during the process and transmission of such data. To tackle the challenges associated with multimedia data transmission in Wireless Sensor Networks (WSNs), Janakamma et. al proposed a Novel Routing Protocol for Wireless Multimedia Sensor Networks (NRP-WMSN)[12] which improved network performance and achieved high Quality of Service (QoS) for multimedia data transmission. Although the proposed protocols improved performance, they needed to address node interference and node failure(energy hole) in WMSN. To address the limitations of the existing system, this paper proposes a Node Interference and Failure Recovery (NIFR) framework that reduces node interference by selecting an optimal path and also recovers node failure through trust recurrence method. The proposed framework enhances WMSN by addressing the issues of node interference and node failure. The proposed NIFR framework is implemented using NS2 simulation. Empirical results show that the proposed framework improves the performance of multimedia data transmission in WMSN.

Keywords: *Quality of Service, Node Interference and Failure Recovery, Novel Routing Protocol, Wireless Multimedia Sensor Networks, Node Failure.*

1. INTRODUCTION

Wireless Sensor Network(WSN)is integrated with a set of sensors for sensing signals and capabilities of actuating are able to connect communication networks. But communication networks have challenges and issues with the transmission of multimedia content. Many research works are introduced based on multimedia content such as audio, video and images. The discussions encourage new development of architectures and protocols in the processing and transmission of multimedia contents. The development of previous architecture needed to revise for transforming the new era is called Wireless Multimedia Sensor Networks(WMSN) to support multimedia services and applications. Multimedia applications and the ongoing convergence with intelligence technologies widely expand to different services such as monitoring, entertaining training and operating areas of smart home, smart city, healthcare and transportation.

Multimedia services have greatly enriched daily life, with Wireless Multimedia Sensor Networks (WMSNs) facilitating the transmission of videos, audios, and images. To maintain high-quality multimedia data transmission, it is essential to monitor traffic and transmission with Quality of Service (QoS) requirements. However, there is a trade-off between QoS and the recovery of link failure, which has attracted significant attention from researchers and industry experts.

A previous research paper proposed a novel routing protocol that improved QoS. In this research paper, focused on the issues of node interference and node/link failure. The proposed algorithm is a Node Interference and Failure Recovery (NIFR) framework, which reduces node interference by selecting an optimal path and recovers node failure through trust recurrence methods. The proposed framework enhances WMSNs by addressing the issues of node interference and node failure.

The rest of the paper is organized as follows. Section II introduces the related works about the wireless multimedia sensor networks. In section III, the proposed framework design and implementation. Section IV shows the environment for proposed design implementation. Subsequently, simulation results are presented and discussed. Finally, section V concludes research and future enhancements.

2. LITERATURE REVIEW

Muhammad Usman et al Large multimedia data is generated by Wireless Multimedia Sensor Networks (WMSNs), but because of their size, Multimedia Sensor Nodes (MSNs) are unable to store it for long. Mobile sinks can be used to gather this data. However, in order to safeguard the vulnerable WMSN, a safe authentication method is required. A two-layer security scheme for mobile multimedia data collection is proposed in this paper. MSNs are organized into small clusters in the first layer, with a Cluster Head (CH) for each cluster. Before sharing the multimedia data, the CHs in the second layer verify the identity of mobile sinks, ensuring secure data exchange. The simulation results show that the proposed scheme performs better in terms of authentication rate, data freshness, and packet delivery ratio as well as surpassing existing methods in terms of resilience and handshake duration.

Mian Ahmad Jan et al Using long-term deployed wireless multimedia sensor nodes to form a Wireless Multimedia Sensor Network (WMSN), the Internet of Multimedia Things (IoMT) architecture aims to support real-time multimedia applications. The routing protocols need to provide the necessary support in order to guarantee that multimedia traffic in a WMSN will receive an acceptable level of Quality-of-Service (QoS). For a cluster-based hierarchical WMSN, the seamless and authorized multimedia streaming framework (SAMS) is presented in this paper. Secure clusters are formed by SAMS by utilizing authentication at various levels, allowing only authorized nodes to transmit data to their cluster heads. Multimedia traffic may experience excessive packet loss and delay as a result of each node sensing its environment, storing data, and waiting for its turn to transmit. SAMS has a channel allocation method for inter-cluster communication to deal with this problem. In the event of a buffer overflow, a member node can switch to a neighboring cluster head with a channel that is available. The findings demonstrate that SAMS enhances the WMSN's security and provides an acceptable QoS.

Zhenghua Jiao et al Coverage control in Wireless Multimedia Sensor Networks (WMSNs), which are widely used in a variety of fields and require striking a balance between service quality and energy consumption, is the topic of this paper. For WMSN coverage control, we propose an adaptive particle swarm optimization framework. A 3D coverage model that takes into account the sensors' perceptual radii and determines the best projection area for a single sensor is the first step in our strategy. The sensor locations are then optimized using adaptive particle swarm optimization to reduce blind and perceptual overlap in the monitoring area. To reduce the number of active sensors, we present a redundant node sleeping strategy as our final offering. Based on simulations, our method outperforms other solutions in terms of coverage with fewer sensors.

Bassam A. Y. Alqaralleh1 et al The Wireless Multimedia Sensor Network (WMSN) is just one area where the benefits of using sensor-cloud environments are growing. A collection of multimedia sensors is used in WMSNs to gather information about a deployed region. Due to the harsh conditions and energy constraints of the sensors, tracking animals in WMSNs can be difficult compared to traditional object tracking models. Using Energy-Efficient WMSN and Deep Learning (DL), we present a brand-new Reliable Multi-Object Tracking Model in this article. Cluster Heads (CHs) that are efficient in terms of energy are identified using the Fuzzy Logic method. The RNN-T tracking framework, which is implemented by each sensor node and the CHs, is then developed using a Recurrent Neural Network (RNN) with a tumbling effect. After that, the tracking data is sent to the cloud server for analysis. We use real-time wildlife video in a lot of experiments to see how well the proposed model works. The findings show that, in a number of ways, the RNN-T model performs better than other approaches.

Yongkang Zou et al In a wirelessly powered multimedia communication system, the requirements for data latency, system configurations, and traffic throughput are examined in depth in this paper. To begin, a system model with the actual non-linear energy harvesting process and two operation modes is created. The system's effective capacity is determined by taking into account the wireless charging parameter and fixed data transmission rate using this model. The study then takes into account the effective capacity, traffic arrival, and maximum acceptable data latency to investigate the possibility of latency violations. The problem of effectively maximizing capacity is then created from the traffic maximization problem. In addition, the paper suggests both an ideal and a near-optimal approach for determining the wireless charging time and transmission rate configurations of the system. The simulation results provide insight into the system's operation mode selection and confirm the accuracy of the near-optimal solution.

3. PROPOSED METHODOLOGY

3.1 Problem Statement

The problem statement is the increasing volume of multimedia data in Wireless Sensor Networks (WSNs) leads to high utilization of bandwidth and increased energy consumption during the process and transmission of such data. Although Janakamma et.[12] al proposed a Novel Routing Protocol for Wireless Multimedia Sensor Networks (NRP-WMSN) that improved network performance and achieved high Quality of Service (QoS) for multimedia data transmission; the proposed protocols still need to address the issues of node interference and node failure(energy hole) in WMSN. The paper proposes a Node Interference and Failure Recovery (NIFR) framework to reduce node interference by selecting an optimal path and recovering node failure through trust recurrence methods. The proposed framework aims to overcome the limitations of the present-art-of-the-system by addressing the issues of node interference and node failure, which are critical challenges in ensuring high-quality multimedia data transmission in WSNs. This is essential for researchers and industry professionals working on wireless multimedia sensor networks, as it presents a solution to the challenges faced in multimedia data transmission and provides insights into the future development of such networks.

3.2 NIFR Framework

3.2.1 Optimal path selection

In proposed NIFR framework constitutes optimal paths from source to destination node in WMSN. Basically wireless network a have multiple paths between the source and destination, But among the multiple paths the inference model selects optimal paths using NIFR framework. Initially each source node sends RREQ to sensor nodes and destination node gives RREP. Here source node sends clearance signal through the selected path without interference to other sensor node in the network. Now source node initiates multimedia data transmission in WMSN. The interference model improves the network performance.

The reduce node interference is by selecting an optimal path for data transmission. This can be done by selecting a path that minimizes interference from other nodes and maximizes signal strength between the sender and receiver nodes.

3.2.2 Node/Link recovery

It's essential to change failure node behavior in WMSN to improve the performance of multimedia distribution. The proposed NIFR framework change node behavior from failure to normal. To perform this operation in WMSN, implement a reputation sense framework. This framework applied on failure node in the network.

Algorithm 2 Reputation Algorithm
Input Sense Signal
Output Node Status

1. Start
2. Lets take Sense Signal SS, Failure Node FN, Source Node SN, Signal In Reputation SIR, Signal Out Reputation SOR, Sense Time.
3. SN sends SS to FN
4. If(FN receives SS)
5. {
6. SIR = SIR + 1
7. }
8. IF(FN farward SS)
9. {

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

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SOR = SOR + 1
}
Calculate Total Node Reputation TNR
TNR = (SIR+SOR) / ST
If(TNR>= Threshold)
{
FN Change to Normal Node
}
End
```

In Reputation Algorithm which is designed to assess the reputation of nodes in a Wireless Sensor Network (WSN). It takes as input the Sense Signal from the node and outputs the Node Status based on the reputation of the node.

The algorithm starts by taking the Sense Signal (SS), the Failure Node (FN), the Source Node (SN), the Signal In Reputation (SIR), the Signal Out Reputation (SOR), and the Sense Time as inputs. The SN sends the SS to the FN, and if the FN receives the SS, then the SIR is incremented. If the FN forwards the SS, then the SOR is incremented. Next, the Total Node Reputation (TNR) is calculated as the sum of the SIR and SOR, divided by the Sense Time (ST). If the TNR is greater than or equal to the Threshold, then the FN changes to a Normal Node. The Threshold is a predefined value that determines the minimum reputation score a node must have to be considered normal.

The Reputation Algorithm calculates the reputation of a node based on the number of times it has received and forwarded a Sense Signal, and if the node's reputation score is above a certain threshold, it is considered a normal node. This algorithm helps to identify and isolate nodes that may be malfunctioning or interfering with the network, ensuring that the network operates efficiently and effectively.

4. RESULTS ANALYSIS

The proposed Node Interference and Failure Recovery framework for WMSN is implemented using Network Simulation(NS) version 2.35. The simulation results show the performance of NIFR for multimedia data transmission. The comparative results discussed in below sub sections.

4.1 Simulation Environment

Table 1 given the environment for network simulation for the empirical study.

Table 1: Simulation Environment

S NO	Network Parameter	Network Value
1	Type of Channel	WirelessChannel
2	Radio-Propagation	Propagation/TwoRayGround
3	Network Interface	WirelessPhy
4	Interface Queue Type	DropTail
5	Model of Antenna	OmniAntenna
6	Length of Queue	50
7	Routing Protocol	AODV
8	Number of Nodes	75
9	Data Rate	2MB
10	Basic Rate	1MB
11	Total Simulation Time	50

The WMSN simulation design is based on the detailed network parameters that are provided in Table 1. For WSN deployment, two-ray ground radio propagation is utilized. The proposed mechanisms are evaluated by comparing various performance metrics. The delay, throughput, and packet delivery ratio are the metrics that are used to evaluate the improved performance. The NIFR framework is compared to the various previous mechanisms, such as the Smart Greedy Forwarding framework based on throughput and energy-awareness (SGFTEM)[11] for effective performance in WSN, the Adaptive Greedy Compass Energy-aware using Multi-path (AGEM) approach[13], the Two-Phase Greedy Forwarding (TPGF)[14], and the Novel Routing Protocol for Wireless Multimedia Sensor Networks (NRP-WSN)[12].

4.2 Performance Metrics

Performance metrics are used to evaluate the simulation results. The purpose of each metric is described here.

Table 2: Performance Metrics

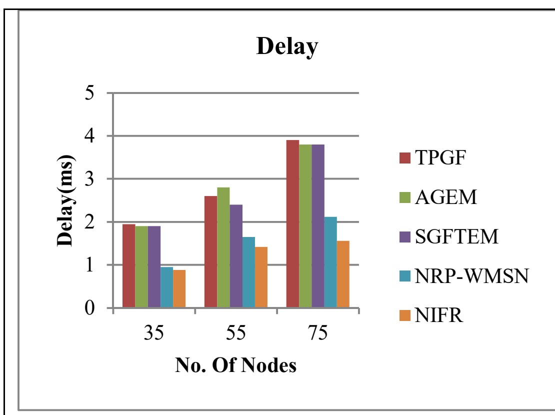
S No	Metric	Description
1	Delay	The time difference between packets received time and packet sent time.
2	Packet Delivery Ratio (PDR)	It is the performance measure used to know the ratio between number of packets received and the number of packets sent.
3	Throughput	The rate of data transferred successfully in network from source to destination.

As shown in Table 2, three performance metrics are used to evaluate the proposed work in this paper. They are PDR, throughput, and delay.

Table 3: Delay

No. Nodes	Delay				
	TPGF	AGEM	SGFTEM	NRP-WMSN	NIFR
35	1.95	1.9	1.9	0.95	0.88
55	2.6	2.8	2.4	1.65	1.42
75	3.9	3.8	3.8	2.12	1.56

As shown in Table 2, it is evident that there is significant performance improvement between existing system and proposed framework in terms of end to end delay performance.



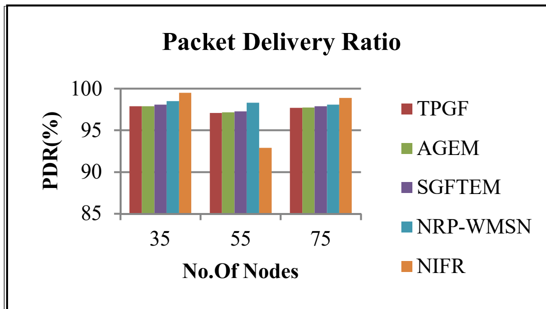
The comparative performance results of the proposed framework WMSN network delay are depicted in Figure 4. The X-axis represents the number of nodes, while the Y-axis represents the network delay in milliseconds. When compared to the system's current state, the empirical results demonstrated that the proposed NIFR framework performed better. From 35 to 75 nodes, the proposed framework demonstrated significant improvements in performance. The proposed framework gradually reduces and minimizes network delay, even though it initially has a high level.

Packet Delivery Ratio

Table4: Packet Delivery Ratio

No .of Nodes	PDR				
	TPGF	AGEM	SGFTEM	NRP-WMSN	NIFR
35	97.9	97.9	98.1	98.5	99.5
55	97.1	97.15	97.3	98.3	92.9
75	97.7	97.75	97.9	98.1	98.9

As shown in Table 3, the results revealed that the proposed system has significant performance improvement over existing system in terms of packet delivery ratio.



The empirical results of the NIFR framework and the current mechanisms of TPGF[10], AGEM[11], and SGFTEM[1], NPRWMSN are depicted in Figure 2. The number of nodes on the X-Axis increased from 35 to 75. The PDR percentage is shown on the Y-axis. When compared to other WMSN approaches with a comparable number of nodes, the PDR of the NIFR network is higher. Similar trends can be found in existing mechanisms, but the NIFR framework outperforms TPGF, AGEM, SGFTEM and NIFR in terms of performance, according to the results.

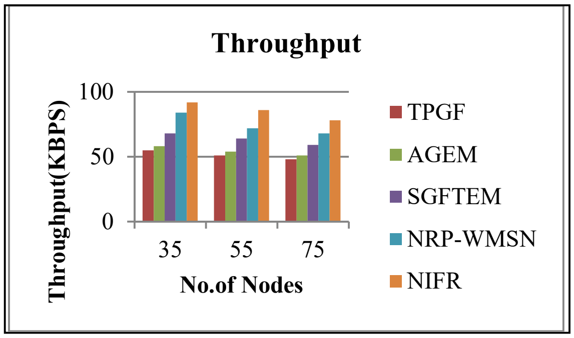
Table5: Throughput

No.	Throughput

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

of Nodes	TPGF	AGEM	SGFTEM	NRP-WMSN	NIFR
35	55	58	68	84	92
55	51	54	64	72	86
75	48	51	59	68	78

As shown in Table 4, the throughput performance of existing and proposed frameworks is provided. The proposed framework shows significant performance improvement over the existing one.



The proposed framework throughput performance is depicted in Figure 3 along with the communication range of the respective nodes. The NIFR framework's throughput and performance. The number of nodes recorded on the X-axis, which ranges from 35 to 75. On the Y-axis, the number of bytes received at the destination node is taken. In terms of kilobytes, the NIFR framework demonstrated a significant improvement in performance. Using the NIFR framework, the WMSN network's destination node received 92 kilobytes, compared to 68 kilobytes for SGTEM[11], 58 kilobytes for AGEM[13], 55 kilobytes for TPGF[14], and 84 kilobytes for NPR-WMSN[12] respectively.

5. CONCLUSION

Due to the rise of mobile communication technologies, the demand for multimedia services and applications has increased significantly. Wireless sensor networks enable the collection and transmission of multimedia data, such as audio and video. However, the surge in the volume of multimedia data has resulted in a high utilization of bandwidth and increased energy consumption for data processing and transmission. This paper proposes the Node Interference and Failure Recovery (NIFR) framework, which employs a node reputation method and optimal path selection to address node failure and reduce node interference. The proposed framework fulfills the improvements required by WMSN. NS2 simulation is utilized to implement the proposed framework, and empirical results indicate that the NIFR framework enhances the transmission of multimedia data in WMSN.

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