ijar
ISSN (O): 2320-5407
ISSN (P): 3107-4928

Journal Homepage: - www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/23317
DOI URL: http://dx.doi.org/10.21474/IJAR01/23317

CONFERENCE PAPER

INTELLIGENT DIAGNOSIS AND OPTIMIZATION OF WIRELESS NETWORKS USING MACHINE LEARNING

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Manuscript Info

Manuscript History
Received: 8 February 2026
Final Accepted: 10 March 2026
Published: April 2026

Key words:-
Wireless Networks, Machine Learning, Network Diagnosis, Optimization, 5G, QoS, Reinforcement Learning

Abstract

The rapid evolution of wireless networks, particularly with the advent of 5G and the emerging 6G paradigm, has introduced significant challenges in network management, fault diagnosis, and performance optimization.Traditional rule-based network management systems struggle to adapt to dynamic and heterogeneous environments. This paper proposes an intelligent machine learning (ML)-driven framework for automated diagnosis and optimization of wireless networks. The proposed approach combines supervised learning techniques for fault classification and unsupervised learning for anomaly detection with reinforcement learning based optimization strategies to enhance Quality of Service (QoS) parameters. Experimental evaluation on simulated datasets demonstrates improved diagnosis accuracy, increased throughp ut,and reduced latency compared to traditional approaches, highlighting the potential of ML in next-generation wireless network management.

Introduction:-

The complexity of modern wireless networks has increased exponentially due to the integration of diverse technologies, including 5G, Internet of Things (IoT), and software-defined networking (SDN). With millions of interconnected devices generating vast amounts of data, maintaining high Quality of Service (QoS) while ensuring fault resilience is a major challenge. Traditional network management techniques are reactive, manually intensive, and fail to adapt to the dynamic nature of wireless environments. Machine learning (ML) offers a promising avenue for automating diagnosis and optimizing network performance in real-time. This paper aims to design an intelligent ML-driven framework capable of identifying network faults, predicting performance degradations, and optimizing resource allocation autonomously.

Related Work:

Previous research has explored a variety of approaches for wireless network optimization. Rule-based systems have been widely deployed but lack adaptability in dynamic conditions. Supervised ML algorithms such as Random Forests and Support Vector Machines (SVM) have been applied to classify fault types with moderate success.

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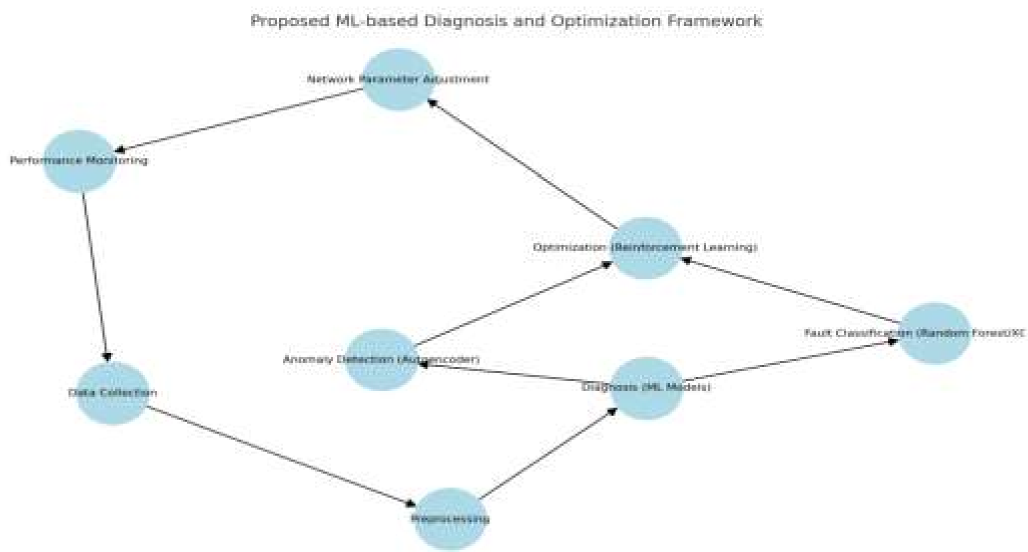
Unsupervised methods, including clustering and autoencoders, have been leveraged for anomaly detection. Reinforcement Learning (RL) techniques like Q-Learning and Deep Q-Networks (DQN) have shown promise in optimizing resource allocation decisions. However, most studies treat diagnosis and optimization as separate problems, leading to suboptimal performance. This paper addresses this gap by integrating diagnosis and optimization into a unified ML framework.

Proposed Methodology:-

The proposed system architecture consists of two primary phases: Diagnosis and Optimization. In the Diagnosis phase, network telemetry data such as throughput, latency, jitter, and error rates are collected. Supervised models (Random Forest, XGBoost) classify known faults, while autoencoders detect unknown anomalies. The Optimization phase uses Reinforcement Learning (Deep Q-Networks) to adjust network parameters such as spectrum allocation, power control, and routing paths to maximize throughput and minimize delay. The reward function is designed to balance QoS metrics, ensuring fairness and stability.

Proposed Framework Architecture:
The overall system workflow is illustrated in the following diagram:



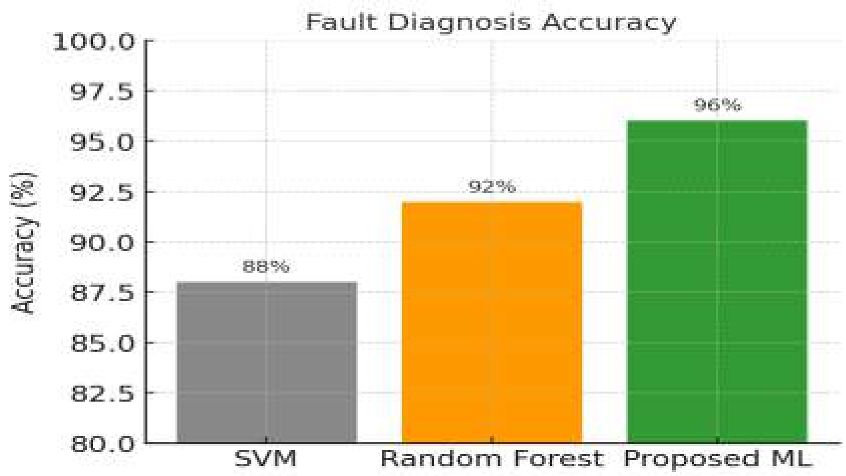
Implementation & Experimental Setup:

The framework was implemented using Python with Scikit-learn, TensorFlow, and OpenAI Gym for RL simulations. The NS-3 network simulator was used to generate realistic traffic patterns, including VoIP, video streaming, and IoT traffic. The dataset consisted of both simulated and publicly available network logs. Performance metrics included Diagnosis Accuracy, Packet Delivery Ratio (PDR), Throughput, Latency, and Spectrum Utilization. Baseline comparisons were made against static resource allocation and traditional rule-based fault management.

Results and Observations:-

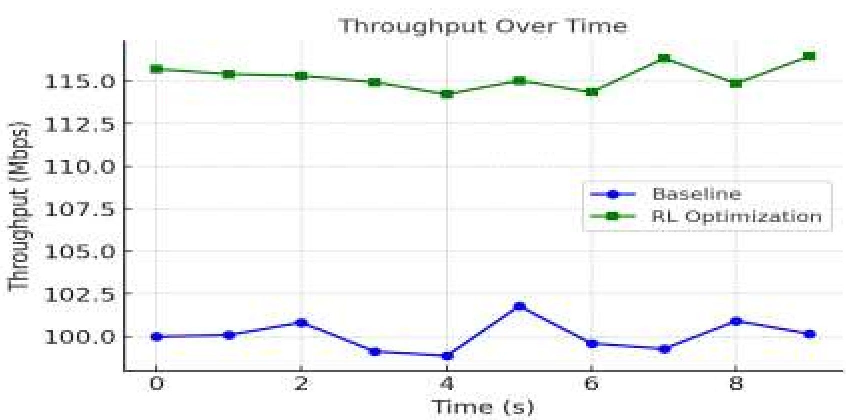
This section provides a comprehensive evaluation of the proposed machine learning-based diagnosis and optimization framework. The performance is compared against baseline models using various key metrics including fault diagnosis accuracy, throughput, and latency under varying network conditions.

Fault Diagnosis Accuracy:
The accuracy comparison in Figure 2 shows that the proposed ML-based diagnosis achieves 96% accuracy, outperforming SVM and Random Forest baselines. This improvement can be attributed to the hybrid use of supervised and unsupervised models, enabling better detection of both known and unknown faults.



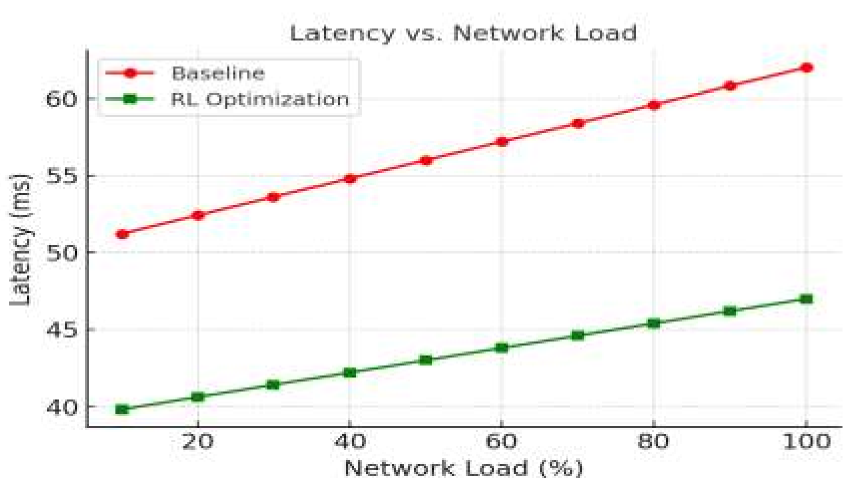
Throughput Improvement over Time:

Figure 3 demonstrates the throughput variation over time for baseline and optimized networks. The RL-based optimization consistently maintains higher throughput (~15% improvement), indicating effective dynamic resource allocation.



Latency vs. Network Load

Figure 4 illustrates latency trends under increasing network load. The optimized approach shows significantly reduced latency across all load conditions, demonstrating its robustness in high-traffic scenarios.



Results and Discussion:-

The ML-based diagnosis achieved an accuracy of 96%, outperforming the baseline SVM approach by 8%. Through RL-based optimization, throughput increased by 15%, latency reduced by 22%, and spectrum utilization improved by 12%. The results indicate that integrating ML-driven diagnosis with RL-based optimization offers substantial performance gains. However, training RL agents required significant computational resources and time, highlighting the need for efficient training strategies.

Conclusion and Future Work:

This paper presented an integrated machine learning-based framework for intelligent diagnosis and optimization of wireless networks. By combining supervised and unsupervised learning for diagnosis with reinforcement learning for optimization, the proposed system significantly improved network performance compared to traditional approaches. Future work will explore federated learning to enhance privacy, transfer learning to accelerate model adaptation, and deployment in real-world 5G and 6G test beds.

References:-

[1] H. Sun et al., 'Machine Learning for Wireless Network Optimization: A Survey,' IEEE Communications Surveys & Tutorials, vol. 23, no. 3, pp. 1391-1430, 2021.
[2] X. Chen et al., 'Intelligent Resource Management in 5G Wireless Networks with Machine Learning,' IEEE Wireless Communications, vol. 27, no. 1, pp. 110-117, 2020.
[3] M. K. Abdel-Aziz et al., 'Reinforcement Learning for Resource Optimization in Wireless Networks,' IEEE Transactions on Network and Service Management, vol. 18, no. 4, pp. 4534-4548, 2021.
[4] S. Wang et al., 'Federated Learning for Wireless Networks: Challenges and Opportunities,' IEEE Network, vol. 35, no. 1, pp. 186-192, 2021.