International Journal of Science, Strategic Management and Technology
Volume **02** Issue **04** April-**2026** | ISSN: **3108-1762 (Online)** | Impact Factor: 3.8
An International, Peer-Reviewed, Open Access Scholarly Journal Indexed in recognized academic databases

Intelligent Network Signal Strength Optimization using Machine Learning and Real-Time Analytics

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https://doi.org/10.55041/ijsmt.v2i4.381

Cite this Article: Ganesh, P. S., Mohamed, I. R., Suriya, V. & Eekash, E. (2026). Intelligent Network Signal Strength Optimization using Machine Learning and Real-Time Analytics. International Journal of Science, Strategic Management and Technology, *02*(04). https://doi.org/10.55041/ijsmt.v2i4.381

Abstract: The growing reliance on wireless communication has made network signal strength essential for seamless connectivity. However, users often experience issues such as weak signals, interference, and network congestion, especially in indoor and dense environments. This paper proposes a Network Signal Strength Optimization App that uses Artificial Intelligence (AI) and Machine Learning (ML) to monitor and analyze key parameters like RSSI, SNR, and Latency in real time. The system provides personalized recommendation, predictive insights, and signal heat maps to improve connectivity. The proposed solution enhances user experience, ensure reliable network performance, and offers a scalable and efficient approach to modern wireless communication challenges.

Keywords: Artificial Intelligence (AI), Network Signal Strength, Signal Optimization, Wireless Communication, Machine Learning (ML), Real-Time Data Analytics, Received Signal Strength Indicator (RSSI), Signal-to-Noise Ratio (SNR), Network Latency, Wi-Fi Optimization, Cellular Network, Predictive Analytics, Signal Heat map, Smart Network Management.

1. Introduction: The rapid growth of wireless communication and mobile device usage has increased the need for stable and high-quality network connectivity. However, users often face issues such as weak signals, interference, and network congestion, especially in indoor and densely populated areas. These challenges affect the performance of real-time applications like video streaming and online communication. To address these issues, the proposed network signal strength optimization app utilizes Artificial Intelligence (AI) and Machine Learning (ML) to monitor and analyze key parameters such as RSSI, SNR, and Latency connectivity. This solution enhanced user experience, ensures reliable network performance, and offers a scalable approach to modern wireless communication challenges.

2. Objectives of the Study:

The main objectives of this research are as follows:

2.1. To develop an intelligence mobile application that monitors and evaluates network signal strength in real time using key performance metrics such as RSSI, SNR, and Latency.

2.2. To apply Artificial Intelligence (AI) and Machine Learning (ML) techniques for analyzing network behavior and predicting signal fluctuations.

2.3. To provide personalized optimization recommendations such as optimal device positioning, switching between Wi-Fi and cellular network, and minimizing interference.

2.4. To design a real-time signal analysis system that continuously tracks network conditions and alerts users about connectivity issues.

2.5. To create location-based signal strength heat maps using crowd-sources data to help users identify high and low connectivity zones.

2.6. To enhance overall user experience by ensuring stable, high-speed, and reliable network connectivity for modern applications.

2.7. To reduce network inefficiencies by optimizing bandwidth usage and minimizing unnecessary data consumption.

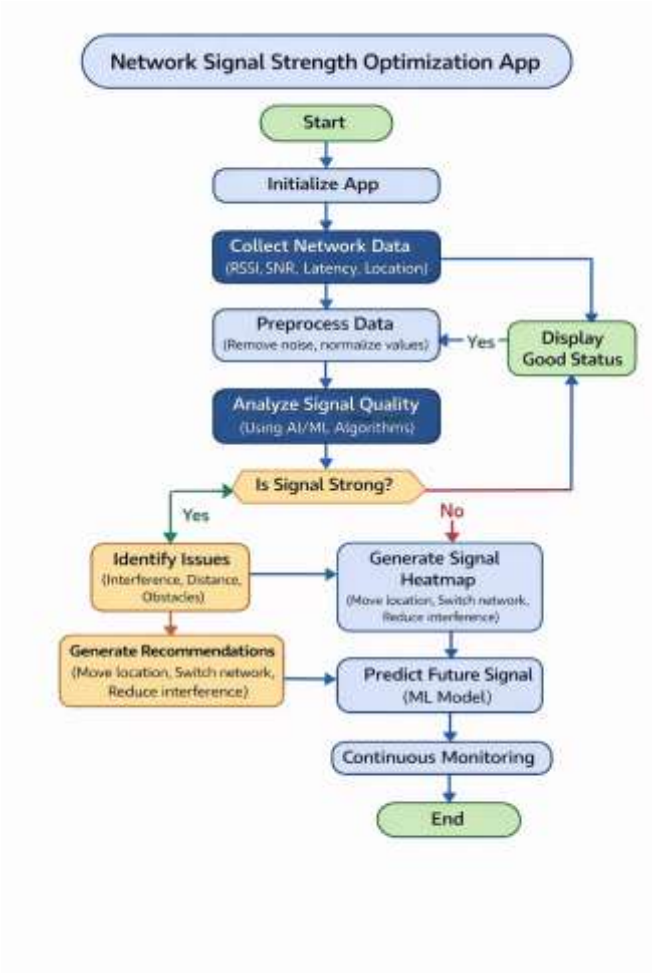
2.8. To develop a scalable and user-friendly interface that can be easily integrated into smartphones and other smart devices.

2.9. To support adaptive decision-making through predictive analytics for proactive signal optimization.

2.10. To evaluate the performance of the proposed system in real-world scenarios and compare it with traditional network troubleshooting methods.

3. Concept: The proposed Network signal Strength Optimization App monitors and analyzes network performance in real time using parameters like RSSI, SNR, and Latency. It applies Artificial Intelligence (AI) and Machine Learning (ML) to evaluate signal quality and provide smart recommendations such as optimal positioning and network switching. The system also uses visual heat maps and predictive analytics to help users identify weak signal areas and improve connectivity efficiently.

4. Flowchart



5. Applications of the Proposed System:

5.1. Improve mobile network signal strength in weak coverage areas

5.2. Helps user find best location for strong connectivity

5.3. Useful for travelers to avoid network issues

5.4. Assists telecom companies in network analysis

5.5. Enhances performance of online apps (calls, streaming, gaming)

5.6. Supports smart city and IOT connectivity optimization

6. Frontend and Backend Development:

6.1. Frontend Development

The frontend of the Network Signal Strength Optimization App is designed to provide an intuitive and user-friendly interface for real-time interaction and visualization.

6.1.1. Technologies Used:

- **Mobile:** React Native
- **Web:** HTML, CSS, JavaScript

6.1.2. Key Features:

- Real-time display of signal parameters (RSSI, SNR, Latency)
- Interactive signal strength heat maps
- Dashboard with network status (Good/ Moderate/ Poor)
- Smart recommendations UI (move location, switch network, etc.)
- Graphs and analytics for performance tracking
- Alerts and notifications for weak signals

6.2. Backend Development:

The backend handles data processing, intelligent analysis, and system logic for optimizing network performance.

6.2.1. Technologies Used:

- **Programming:** Node.js
- **Frameworks:** Express.js
- **Database:** Mongo DB

6.2.2. Core Functionalities:

- Collect and store network signal data from users
- Process data from users Artificial Intelligence (AI) and Machine Learning (ML) models Analyze signal quality and detect issues (interference, congestion)
- Generate personalized optimization recommendations
- Create and update signal heat maps using location data
- Perform predictive analysis for future signal trends

6.2.3. API Integration:

- REST APIs for communication between frontend and backend
- Integration with device sensors and network APIs

5. Image Representation

8. Conclusion:

The proposed Network Signal Strength Optimization App present an effective and intelligent solution to common wireless connectivity such as weak signals, interference, and network congestion. By Leveraging Artificial Intelligence (AI) and Machine Learning (ML), the system is capable of analyzing key capable of analyzing key network parameters in real time and providing accurate, user-specific optimization recommendations. The integration of features such as signal strength heat maps, predictive analytics, and continuous monitoring enhances the overall user experience by ensuring stable and reliable connectivity. Additionally, the use of location-based and crowd-sourced data contributes to improved network awareness and efficient resource utilization. Overall, the proposed system offer a scalable, cost-effective, and use-friendly approach to optimizing wireless network performance, making it highly suitable for modern communication environment and future smart network applications.

9. Future Enhancements

9.1. Advanced AI Models

Integrate deep learning techniques within Artificial Intelligence (AI) and Machine Learning (ML) for more accurate signal prediction and optimization.

9.2. 5G and Beyond Support

Extend compatibility to advanced networks such as 5G and Future wireless technologies for improved performance.

9.3. Automatic Network Switching

Enable fully automated switching between Wi-Fi and cellular networks based on real-time signal conditions.

9.4. IOT Integration

Connect with smart home and IOT devices to optimize network performance across multiple connected systems.

9.5. Enhanced Heat map Accuracy

Improve Signal mapping using large scale crowd sourced data and advanced location tracking techniques.

9.6. Energy Efficient Optimization

Optimize background processes to reduce battery consumption while maintaining continuous monitoring.

9.7. Cloud Based Analytics

Implement cloud integration for large scale data processing, storage, and real time analytics.

9.8. Cross Platform Expansion

Develop versions for web and desktop platforms to ensure wider accessibility and usability.