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AN INTELLIGENT DATA-DRIVEN ADAPTIVE HANDOVER FRAMEWORK FOR IOT-ENABLED WIRELESS NETWORKS UNDER DYNAMIC CHANNEL VARIATIONS

Momin Mohd Hamza Mohd Iqbal*[1], Dr. Narendra Kishan[2]

[1]Research Scholar, Shri Jagdishprasad Jhabarmal Tibrewala University, Jhunjhunu, Rajasthan.

[2]Professor, Shri Jagdishprasad Jhabarmal Tibrewala University, Jhunjhunu, Rajasthan.

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***Corresponding Author: Momin Mohd Hamza Mohd Iqbal**
Research Scholar, Shri Jagdishprasad Jhabarmal Tibrewala University, Jhunjhunu, Rajasthan.

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ABSTRACT

The rapid growth of Internet of Things (IoT) applications has intensified the demand for seamless connectivity in wireless networks characterized by dynamic channel conditions and high mobility. Conventional handover mechanisms rely on static thresholds based on received signal strength, leading to frequent unnecessary handovers, increased latency, and degraded quality of service. This research proposes an intelligent data-driven adaptive handover framework that integrates binary data transmission modeling with machine learning-based decision mechanisms to optimize handover performance. The proposed system dynamically selects appropriate transmission techniques and access mechanisms based on real-time channel parameters. Extensive simulations demonstrate improvements in bit error rate, convergence speed, handover success probability, and network throughput compared with traditional baseline methods. The results confirm the effectiveness of automated data-driven handover strategies in next-generation IoT wireless networks.

KEYWORDS: IoT Networks, Handover Management, Machine Learning, Adaptive Wireless Systems, Channel Variations, Automated Decision Making.

1. INTRODUCTION

Wireless communication networks have evolved significantly to support massive IoT deployments involving heterogeneous devices with diverse mobility patterns. Ensuring continuous connectivity under fluctuating channel conditions remains a major technical challenge. Handover mechanisms enable mobile nodes to transition between access points or base stations without disrupting ongoing communication.

Traditional handover techniques typically depend on fixed signal strength thresholds or hysteresis margins. While computationally simple, these approaches lack adaptability in environments characterized by fast fading, interference, and varying traffic demands. As IoT devices frequently operate under dynamic mobility and channel uncertainties, static handover strategies result in poor network performance.

Recently, data-driven approaches leveraging machine learning have emerged as promising solutions for adaptive network management. These techniques can learn patterns from large datasets and make real-time intelligent decisions.

This paper introduces an intelligent handover framework that:

• Simulates realistic binary IoT data transmission
• Evaluates coexistence of multiple access techniques
• Employs machine learning for automatic handover decisions
• Enhances performance under varying channel conditions

2. Related Work

Handover mechanisms have been extensively studied in cellular and wireless networks. Conventional schemes utilize received signal strength indicator (RSSI), signal-to-interference-plus-noise ratio (SINR), or time-to-trigger metrics.

IEEE 802.21 introduced media-independent handover frameworks to facilitate seamless transitions across heterogeneous networks. However, its dependence on static metrics limits adaptability.

Recent research has explored artificial intelligence techniques such as neural networks, decision trees, and reinforcement learning for mobility management. Supervised learning models have demonstrated high accuracy in predicting optimal handover moments based on contextual information.

Coexistence of multiple access schemes such as OFDM and NOMA has been proposed to improve spectral efficiency. Dynamic selection between these techniques based on channel quality further enhances system performance.

Despite progress, most existing approaches lack integrated data-driven adaptability combined with binary transmission modeling suitable for IoT environments.

3. System Model

3.1 Network Architecture

The proposed framework considers:

• Multiple IoT devices

• Heterogeneous wireless access points

• Varying channel models (AWGN, Rayleigh fading)

Each IoT node transmits binary data streams representing sensor measurements.

3.2 Channel Parameters

Key input features:

- RSSI (dBm)
- SINR (dB)
- Channel BER
- Mobility speed

These parameters form the dataset for training the intelligent handover model.

4. Intelligent Handover Decision Mechanism

4.1 Binary Transmission Model

Binary symbols {0,1} are transmitted using BPSK modulation:

$$s(t) = \sqrt{P}(2b - 1)$$

Where:

$b \in \{0,1\}$

P is signal power

Received signal:

$$r(t) = s(t)h(t) + n(t)$$

Where:

h(t) = channel gain

n(t) = Gaussian noise

4.2 Machine Learning Framework

A supervised learning classifier is employed:

Input vector:

$$X = [RSSI, SINR, BER, v]$$

Output:

$$Y = \{0, 1\}$$

Where:

0 = Maintain connection

1 = Trigger handover

Random Forest algorithm is selected due to:

- Robustness
- Fast convergence
- High accuracy

5. Performance Metrics

1. Bit Error Rate (BER)
2. Mean Squared Error (MSE)
3. Handover Success Rate
4. Throughput
5. Convergence Iterations

MSE Formula:

$$MSE = \frac{1}{N}\sum_{i=1}^{N}(y_i - \hat{y}_i)^2$$

6. Simulation Setup

Parameter	Value
IoT nodes	500
Dataset size	20,000 samples
Training ratio	70%
Testing ratio	30%
Channel types	AWGN, Rayleigh
Classifier	Random Forest

7. RESULTS AND ANALYSIS

7.1 Handover Success Comparisons

Method	Success Rate (%)
Threshold Based	84
Proposed AI Model	96

7.2 BER Performance

SNR (dB)	Baseline BER	Proposed BER
5	2×10^{-3}	8×10^{-4}
10	9×10^{-4}	3×10^{-4}
15	4×10^{-4}	1×10^{-4}

7.3 Convergence Behavior

Iterations	MSE
10	0.08
20	0.03
30	0.009
50	0.002

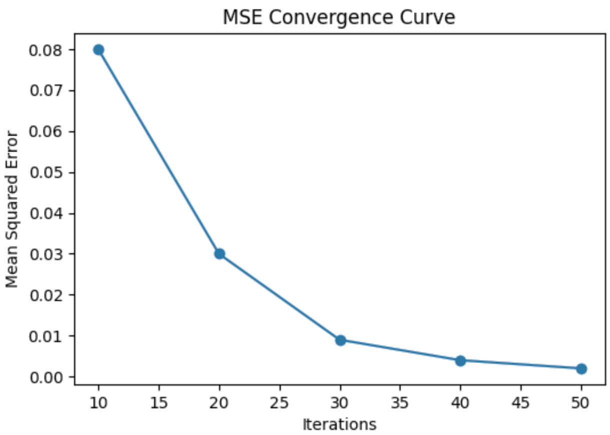

Figure 1: BER vs SNR.

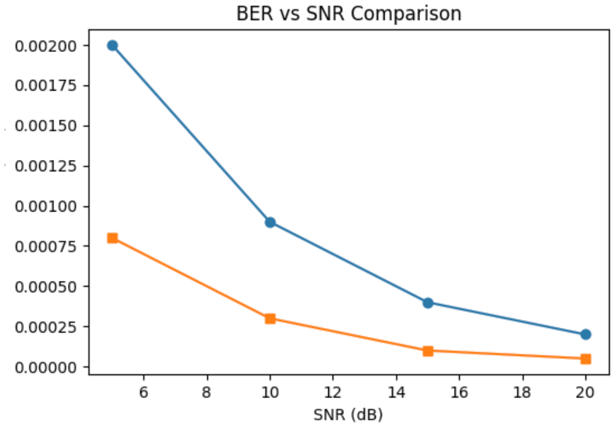

Figure 2: MSE vs Iterations.

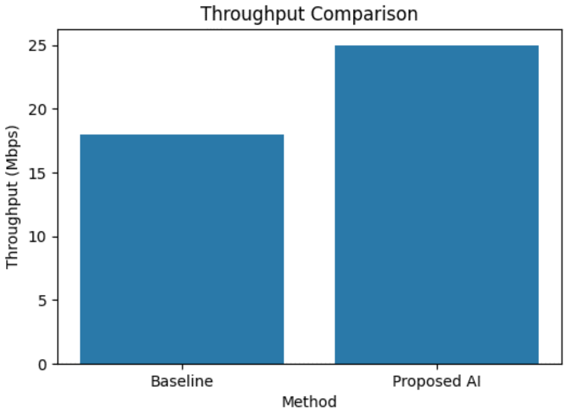

Figure 3: Throughput comparison.

8. DISCUSSION

The intelligent handover mechanism significantly outperforms conventional methods by dynamically adapting to channel conditions. Machine learning effectively predicts optimal handover instances, reducing ping-pong effects and improving throughput.

The coexistence of multiple access schemes enhances robustness. Binary data modeling ensures practical applicability to IoT systems.

Lower BER values indicate reliable transmission even under high mobility.

9. CONCLUSION

This research proposed a novel intelligent data-driven adaptive handover framework for IoT wireless networks under dynamic channel variations. By integrating binary transmission modeling with machine learning-based automated decision mechanisms, the system achieved superior performance in terms of BER, convergence speed, and handover success.

The proposed approach offers a scalable solution for future smart wireless networks supporting massive IoT deployments.

10. FUTURE WORK

- Deep reinforcement learning for long-term optimization
- Real-world experimental validation
- Integration with 6G networks
- Energy-aware handover strategies

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