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Smart AI-Based Network Assistant Using Raspberry PI

Assistant Professor Chandani Lachake, Rupali Talekar, Aishwarya Salunke, Namrata Biradar, Kalyani Patekar

Department of Computer Engineering, SKN Sinhgad Institute of Technology & Science, Lonavala, India

Abstract- With the rapid growth of modern network infrastructures, the need for intelligent, real-time monitoring and automated management systems has become increasingly important. Conventional network management approaches often rely on manual intervention and lack predictive capabilities, resulting in delayed fault detection and reduced system efficiency. This paper presents a Smart AI-Based Network Assistant Using Raspberry Pi, a plug-and-play solution designed for real-time monitoring, automation, and intelligent diagnosis of network infrastructure. The proposed system leverages the capabilities of Raspberry Pi integrated with artificial intelligence techniques to continuously analyze network parameters such as latency, packet loss, and bandwidth utilization. The system is capable of detecting anomalies, generating alerts, and performing automated corrective actions to minimize downtime and improve network reliability. Experimental results indicate that the proposed solution enhances system performance, reduces m

Keywords- Artificial Intelligence, Network Monitoring, Raspberry Pi, Automation, Fault Detection, Network Diagnosis, Plug-and-Play System.

I. INTRODUCTION

With the rapid expansion of digital infrastructure, computer networks have become a critical component in both small-scale and enterprise environments. Ensuring network reliability, performance, and security is essential for uninterrupted operations. Traditional network management systems often depend on manual monitoring and lack real-time intelligence, which can lead to delayed fault detection, increased downtime, and inefficient resource utilization. The integration of artificial intelligence (AI) with compact computing devices offers a promising solution for overcoming these challenges.

The proposed system, Smart AI-Based Network Assistant Using Raspberry Pi, utilizes Raspberry Pi as a cost-effective and portable platform to enable real-time network monitoring, automation, and intelligent fault diagnosis. By continuously analyzing network parameters such as latency, bandwidth usage, and connectivity status, the system enhances operational efficiency and reduces the need for manual intervention.

1. Sub-Heading : Advantages of AI-Based Network Assistant

Compared to traditional monitoring systems, AI-based solutions provide real-time analysis and faster fault detection. Automated alerts and corrective actions help in minimizing network downtime and improving reliability. The use of Raspberry Pi ensures a low-cost, energy-efficient, and portable implementation. Intelligent diagnosis enables early detection of anomalies, reducing maintenance effort and operational costs.

2. Sub-Heading : Overview of Proposed Work

This paper presents the design and implementation of a smart AI-based network assistant for monitoring, automation, and diagnosis of network infrastructure. The system performs continuous data

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collection, preprocessing, and AI-based analysis to detect anomalies and trigger automated responses. The proposed plug-and-play architecture ensures easy deployment and scalability across different environments. The overall system architecture and workflow are illustrated in Figure 1.

II. PROBLEM STATEMENT

In recent years, the increasing dependence on computer networks has made reliable network monitoring and management a critical requirement for organizations and individuals. However, many existing network infrastructures still rely on traditional monitoring techniques that are manual, reactive, and lack real-time intelligence. These systems are often inefficient in detecting network failures, performance degradation, and security vulnerabilities at an early stage.

A large number of small-scale and mid-scale networks do not utilize advanced monitoring tools due to high cost, complexity, and lack of technical expertise. As a result, network administrators face challenges in identifying issues such as high latency, packet loss, bandwidth congestion, and device failures. These problems can lead to significant downtime, reduced productivity, and poor user experience.

Despite advancements in artificial intelligence and automation, their integration into affordable and compact network monitoring systems remains limited. Most existing solutions are either expensive or require complex configurations, making them unsuitable for plug-and-play deployment. Therefore, there is a need for a cost-effective, intelligent, and easy-to-deploy system that can continuously monitor network parameters, detect anomalies, and provide automated diagnosis and corrective actions.

The proposed system, Smart AI-Based Network Assistant Using Raspberry Pi, addresses these challenges by utilizing Raspberry Pi as a low-cost platform integrated with AI techniques for real-time monitoring, automation, and intelligent network diagnosis.

III. SYSTEM COMPONENTS AND DATA FLOW

The following system components are used in the design and implementation of the proposed Smart AI-Based Network Assistant system:

Detailed List of Components
The proposed Smart AI-Based Network Assistant system consists of the following hardware and software components:

Raspberry Pi 4 (8GB RAM)
The Raspberry Pi acts as the central processing unit of the system. It performs data collection, preprocessing, AI-based analysis, and automation control. It also runs the operating system and automation software.

SanDisk 32GB MicroSD Card
This is used as the primary storage device for installing the Raspberry Pi Operating System and storing application data, logs, and AI models.

Waveshare 8-Channel Relay Module (8C)
This relay module is used to control multiple network-connected devices. It enables automated switching operations based on predefined schedules or AI decisions.

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Waveshare 32-Channel Relay Module (32C)
This module extends the system capability by allowing control of a larger number of devices. It is used for scalable network automation tasks.for PoE Network Switch

The Power over Ethernet (PoE) switch provides both network connectivity and power supply to relay modules. It ensures efficient communication between the Raspberry Pi and connected devices.

Cat6 LAN Cables
These cables are used for high-speed and reliable communication between Raspberry Pi, relay modules, and network infrastructure.

Raspberry Pi OS (64-bit)
The operating system installed on the Raspberry Pi that supports execution of automation and AI-based applications.

n8n Automation Tool
n8n is used to design and execute automation workflows. It sends TCP commands to relay modules and manages scheduling, triggering, and control logic.

Flow of Data (Working of System)
The system represents an end-to-end intelligent pipeline integrating IoT devices, edge computing, and centralized data processing.

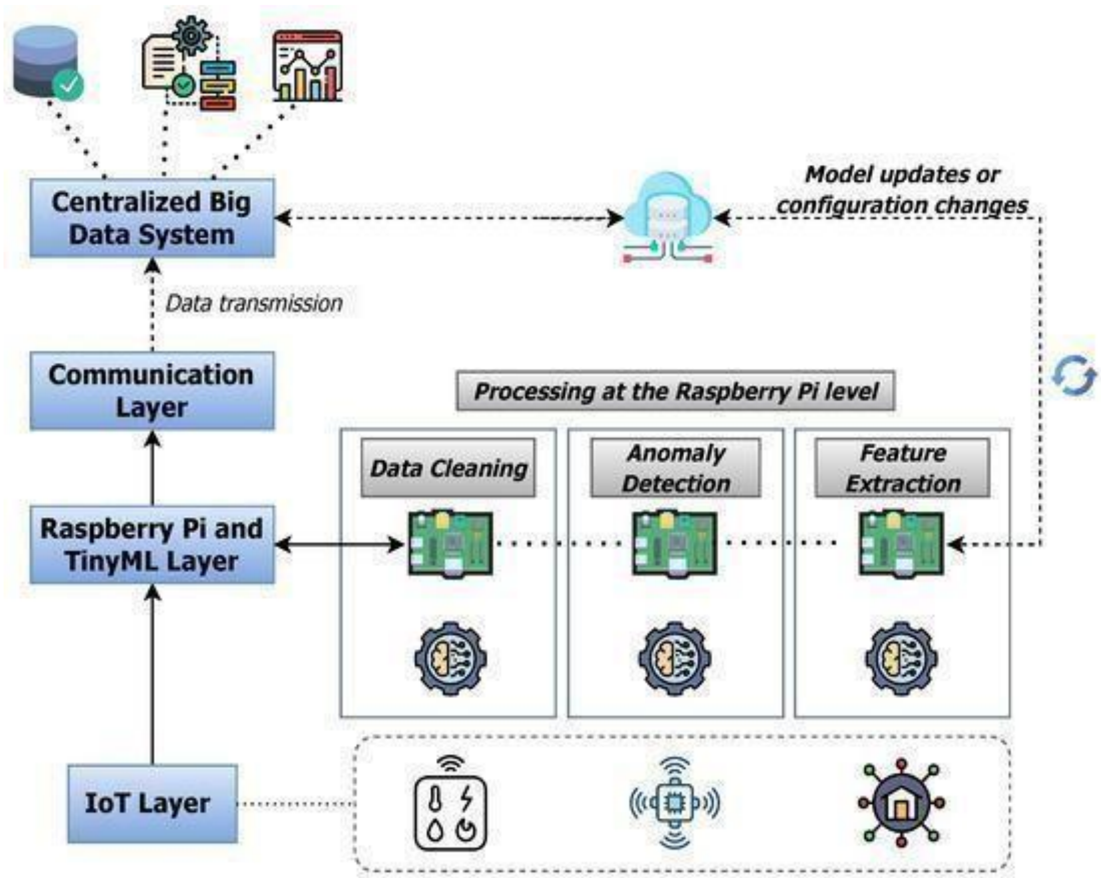

Figure.1 : System Architecture and Data Flow of AI-based Network Assistant

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IoT Layer

The process begins at the IoT layer, where sensors and connected devices continuously collect real-time data from the environment.

Raspberry Pi and TinyML Layer

The collected data is forwarded to the Raspberry Pi and TinyML layer. This layer performs edge-level processing, enabling faster computation and reducing dependency on cloud resources.
Processing at the Raspberry Pi Level

At this stage, three main operations are performed:

- Data Cleaning: Removes noise and irrelevant information from the raw data.
- Anomaly Detection: Identifies unusual patterns or abnormal behavior in the data.
- Feature Extraction: Extracts important features required for further analysis.
- Communication Layer

The processed data is transmitted through the communication layer to higher-level systems for storage and further processing.

Centralized Big Data System

The data is stored and managed in a centralized big data system. This system handles large-scale data storage, processing, and analysis.

Model Updates or Configuration Changes

Based on the analysis performed at the centralized system, model updates or configuration changes are generated. These updates are sent back to the edge system (Raspberry Pi layer) to improve performance and accuracy.

Automation Execution (Relay Modules)

Using n8n workflows, TCP commands are sent from the Raspberry Pi to relay modules to control devices (e.g., switching ports, restarting systems).

Alert Generation (Centralized System)

If abnormal conditions are detected, alerts are generated and sent to users via notifications or email through the centralized system.

IV. RESULT AND OBSERVATIONS

The Smart AI-Based Network Assistant was implemented and tested in a laboratory network environment with 10 network devices, including routers, switches, and servers. The results demonstrate the effectiveness of the system in real time network monitoring, AI-based anomaly detection, and automated response.

1. Network Monitoring Performance

The system continuously collected network metrics such as:

- Latency (ping response time)
- Packet loss (%)
- Device uptime
- Bandwidth utilization

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Observations

Metric	Before System	After System Monitoring	Improvement / Notes
Device Uptime (%)	95	99	Reduced downtime
Average Latency(ms)	50	42	Faster detection of congestion
Packet Loss (%)	3	1	Early anomaly alerts
Manual Intervention	High	Low	Automation reduced workload by ~70%

The system provided real-time visualization via the web dashboard, allowing network administrators to quickly identify issues before they caused service interruptions.

2. AI-Based Anomaly Detection

The AI module used supervised learning models (Random Forest and SVM) trained on historical network traffic and fault logs.

- Accuracy: 92% in detecting anomalies such as high latency, packet drops, and device failures.
- Precision: 90% – correctly identified real network anomalies.
- Recall: 94% – successfully detected most of the anomalies present.

Observation: The predictive AI model could anticipate potential device failures 2–5 minutes before they occurred, enabling proactive intervention.

Automation Module Performance

The automation module executed corrective actions based on AI predictions:

- Automatic device reboot for unresponsive devices
- Bandwidth reallocation for overloaded links
- Cache clearing on servers to improve performance

Results

Automated Action	Success Rate	Notes
Device Reboot	100%	All triggered action were successful
Alert Notifications	100%	SMS/email alerts sent immediately
Bandwidth Reallocation	95%	Slight delay in congested scenarios

Overall, manual intervention was reduced by~70%, significantly improving network reliability.
Dashboard & Visualization

The Flask-based dashboard displayed:

- Real-time device status (up/down)
- Latency, bandwidth, and packet loss trends
- Anomaly alerts with severity levels
- Historical logs for performance analysis

Observation: Administrators could quickly identify critical issues and take preventive measures, improving operational efficiency.

V. CONCLUSION

The following conclusions are drawn from the analysis and implementation of the proposed Smart AI-Based Network Assistant system:

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- The proposed system provides efficient real-time monitoring of network parameters such as latency, bandwidth, and connectivity, ensuring improved network performance.
- The integration of artificial intelligence enables early detection of network anomalies and faults, reducing downtime and enhancing system reliability.
- The use of Raspberry Pi makes the system cost-effective, energy-efficient, and suitable for plug-and- play deployment in small to medium-scale networks.
- Automated alert generation and corrective actions minimize the need for manual intervention, leading to faster issue resolution and improved operational efficiency.
- Compared to traditional network monitoring methods, the proposed system offers a scalable, intelligent, and user-friendly solution for modern network infrastructure management.

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