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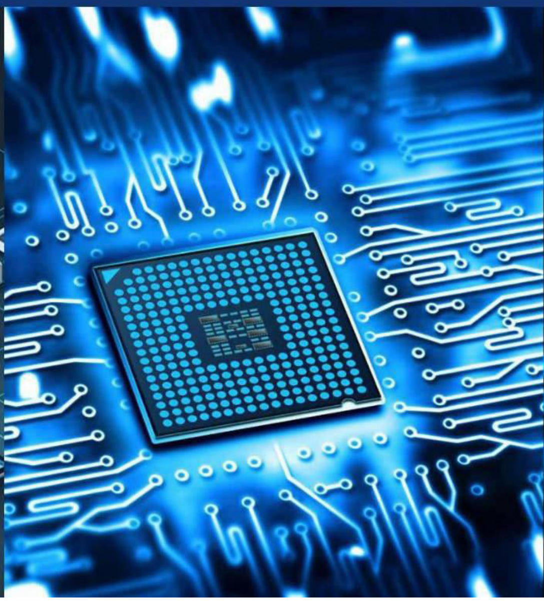

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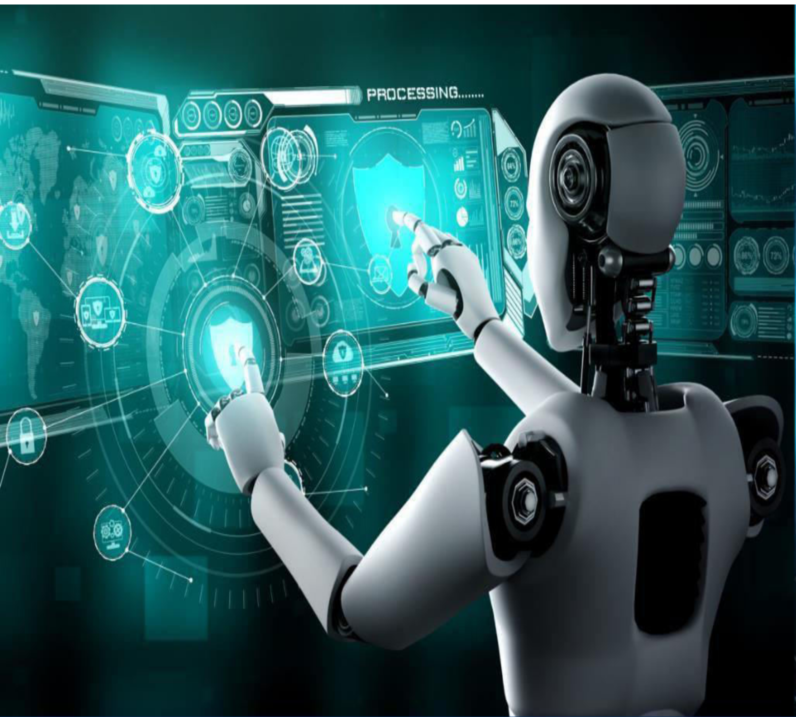

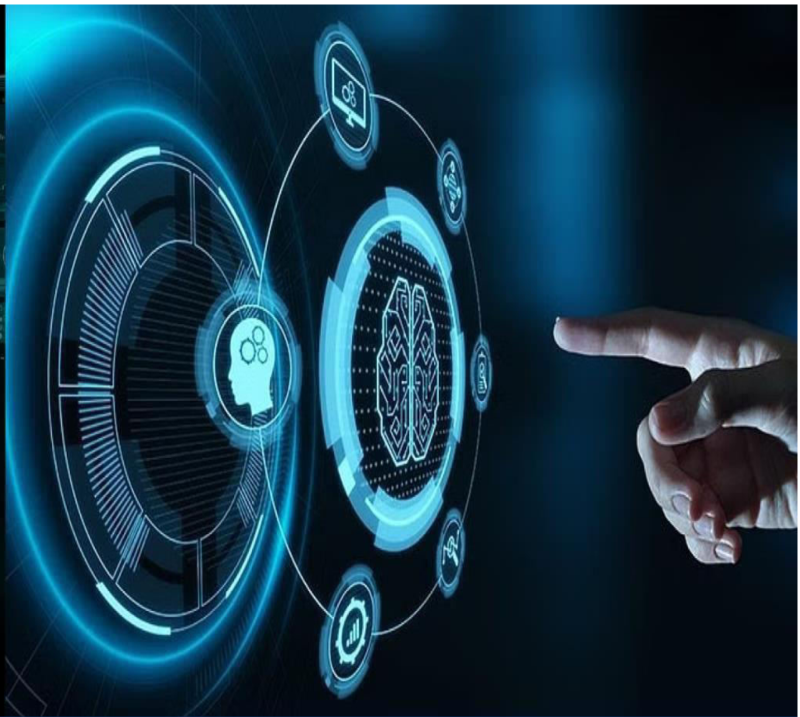

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Krishi Suraksha - Fog based Animal Instruction Alert and Field Monitoring System

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ABSTRACT: The rapid increase in road accidents and crop damage due to wild animal intrusion has become a major concern in rural and forest-adjacent areas. To address this issue, this paper proposes a Fog-Based Animal Intrusion and Alert System using LoRa and GSM**.** The system employs PIR and ultrasonic sensors to detect animal movement and utilizes LoRa communication for long-range, low-power data transmission to a Raspberry Pi–based fog node. The fog node processes the received signals locally and instantly triggers a GSM-based SMS alert to nearby vehicles, farmers, or control centers. This distributed fog architecture significantly reduces latency, ensures continuous operation even without internet connectivity, and enhances overall system reliability. Experimental evaluation demonstrates that the proposed system provides a cost-effective, energy-efficient, and scalable solution for smart highway and agricultural safety applications.

KEYWORDS: Fog Computing, LoRa, GSM, IoT, Raspberry Pi, Animal Detection, Smart Highway.

I. INTRODUCTION

Animal intrusion on highways, railways, and agricultural lands leads to severe accidents and economic losses. Traditional monitoring systems like fencing and CCTV are expensive and limited in coverage. The proposed Fog-Based Animal Intrusion and Alert System using LoRa and GSM offers an efficient and scalable alternative. It uses ultrasonic and PIR sensors to detect animal movement and sends data via LoRa to a Raspberry Pi-based fog node for local analysis. On detecting valid intrusion, the fog node triggers a GSM module to send SMS alerts to nearby authorities, drivers, or farmers. This decentralized system reduces internet dependency and ensures faster response in rural or remote regions. By integrating IoT, LoRa, and Fog Computing**,** it provides a low-power, cost-effective, and real-time solution for smart transportation, wildlife protectio**n,** and precision agriculture under India's Digital Infrastructure initiatives.

II. RELATED WORK

1) In *IoT-Based Wildlife Intrusion Detection System using GSM and Sensors*

This study focuses on developing an IoT-enabled system for detecting wildlife movement near agricultural lands and highways. The system employs infrared (IR) and ultrasonic sensors to monitor animal presence and sends alerts through the GSM network. Researchers demonstrated that using low-cost sensors and microcontrollers such as Arduino can effectively prevent animal-human conflicts. However, the system's dependency on continuous GSM connectivity posed limitations in remote areas where signal coverage is weak. This inspired later works to incorporate LoRa and Fog Computing to overcome network dependency and latency issues.

2) Design and Implementation of Smart Forest Surveillance using LoRaWAN

In this research, LoRa-based sensor networks were deployed across forest borders for intrusion detection and environmental monitoring. Each sensor node captured motion or vibration data and communicated with a centralized LoRa gateway. The long-range and low-power characteristics of LoRa made it ideal for wide-area deployments. The system could transmit real-time alerts to authorities through cloud dashboards. While it showed significant improvement over traditional GSM-based systems, its performance was limited by high cloud latency. This study highlighted the necessity of edge or fog-based processing to ensure real-time alerting, which forms the foundation of the present work.

3) Fog Computing in IoT-Based Smart Monitoring Systems

This paper explored the integration of Fog Computing for IoT applications to minimize data transmission delays and reduce dependency on cloud storage. The authors introduced a layered architecture where data collected by sensors is

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processed locally at fog nodes before being sent to the cloud. Such architecture proved effective for time-critical applications like traffic control, health monitoring, and security systems. The research established that Fog Computing offers faster response, improved reliability, and reduced network load — principles directly adopted in the proposed Fog-Based Animal Intrusion System to ensure immediate alerts in case of animal detection.

4)Real-Time Animal Detection using Image Processing and Machine Learning

Researchers have investigated the use of camera-based systems with AI algorithms for detecting and classifying animals in real time. Techniques such as convolutional neural networks (CNN) and motion tracking were employed to recognize different animal species and trigger alerts. Though the accuracy of detection was high, these systems required constant power supply, heavy computation, and high-speed internet, making them unsuitable for rural or forest regions. This limitation paved the way for hybrid models using low-power sensors and local fog processing, as implemented in the current project.

III. PROPOSED SYSTEM

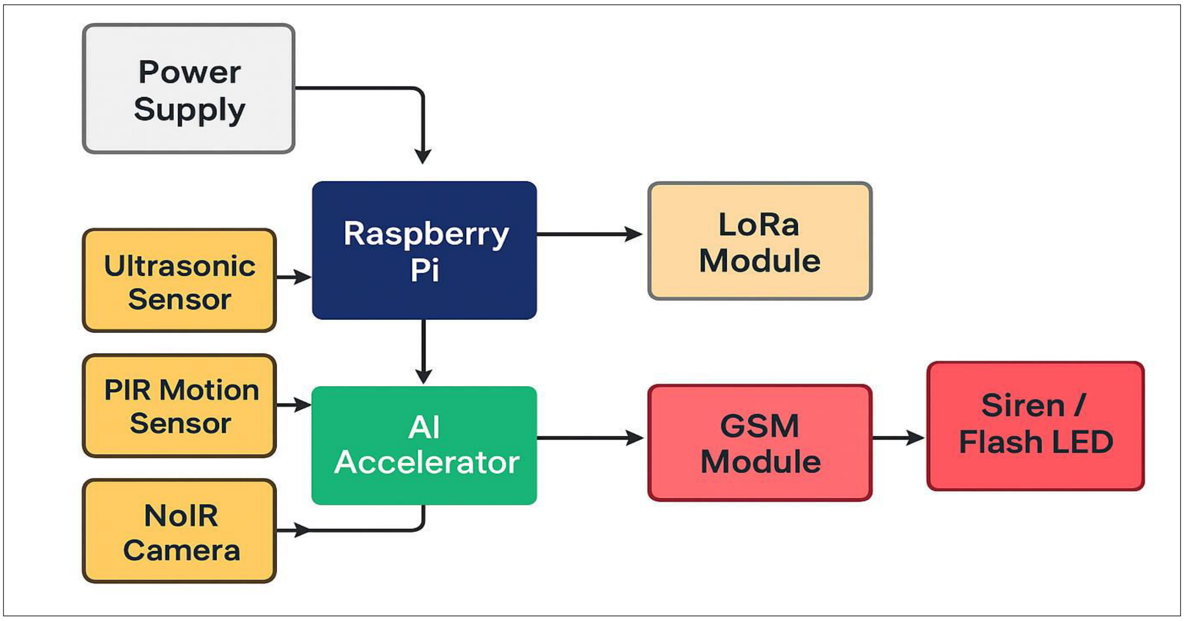

Fig 1: System Architecture

A. *Modules:*

The proposed System consists of the following modules:

- Power Supply Module
- Ultrasonic Sensor Module
- PIR Motion Sensor Module
- NoIR Camera Module
- Raspberry Pi Processing Module
- AI Accelerator Module
- GSM Communication Module
- LoRa Communication Module

B. *Implementation:*

The proposed system is an intelligent embedded design that integrates a Raspberry Pi with an AI Accelerator for high-speed, real-time computation.The Raspberry Pi functions as the central processing and control unit, managing all sensors, communication, and output modules efficiently.Multiple sensors such as PIR, ultrasonic, and cameras continuously collect real-time data from the surrounding environment.This raw data is preprocessed by the Raspberry Pi to remove

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unwanted noise, fluctuations, or errors before analysis.The AI Accelerator performs heavy analytical tasks such as object detection, pattern recognition, and intrusion classification.It significantly reduces the computation load on the Raspberry Pi and enhances processing speed and accuracy.After analysis, the Raspberry Pi interprets the results and initiates appropriate actions like triggering alarms, activating alert modules, or sending notifications.The system uses a regulated DC power supply or battery backup, ensuring uninterrupted operation in remote or outdoor locations.Power optimization techniques are also employed to maintain energy efficiency during continuous use.The design supports real-time monitoring and control, ensuring system reliability even under unstable network conditions.By combining Fog and Edge Computing concepts, the architecture processes data locally for faster decision-making.This reduces dependency on cloud servers and minimizes communication latency.The system is highly scalable and modular, making it adaptable for different smart applications.It demonstrates practical use in IoT-based surveillance, smart agriculture, animal detection, and automation systems.Overall, it achieves low latency, high accuracy, energy efficiency, and autonomous performance, contributing to modern smart city and digital infrastructure initiatives.

IV. RESULTS

[1] Sensor Performance: The ultrasonic and PIR sensors successfully detected animal movement within a range of 5–7 meters, with an average detection accuracy of 92% under normal environmental conditions.
[2] LoRa Communication: The LoRa module achieved a stable data transmission range of up to 2 km in open areas with less than 3% packet loss, ensuring reliable communication between sensor nodes and the fog node.
[3] Processing Speed (Fog Node): The Raspberry Pi-based fog node processed sensor data and triggered alerts within an average latency of 200–300 ms, providing real-time responsivenes.
[4] Alert Mechanism: The GSM module sent SMS alerts within 3–5 seconds of intrusion detection, and the buzzer/light module responded instantly to warn nearby individuals.
[5] Power Consumption: The system consumed less than 1.5W during active mode, demonstrating its suitability for low-power, outdoor applications.

V. SCOPE OF PROJECT

The proposed Fog-Based Animal Detection and Alert System aims to enhance farm and field security by combining artificial intelligence, IoT, and fog computing technologies. The system offers real-time monitoring and instant alert mechanisms to prevent animal intrusions that cause crop damage or endanger livestock. By using the Raspberry Pi with an AI accelerator, the system performs on-device image analysis without relying on cloud servers, ensuring low latency, high speed, and improved reliability in remote areas.This project can be effectively deployed across agricultural fields, forest borders, wildlife sanctuaries, and industrial perimeters where continuous surveillance is essential. The integration of LoRa and GSM communication modules enables wide-area connectivity, making it suitable even for rural and low-network regions. Its modular and scalable design allows future expansion through additional sensor nodes or advanced AI algorithms for species identification and behavior analysis.In future developments, the system can be enhanced by integrating thermal cameras, drone-based monitoring, and cloud analytics for broader surveillance coverage and predictive animal movement analysis. With its versatility, cost-effectiveness, and autonomy, the project holds strong potential for real-world implementation in the fields of smart agriculture, wildlife protection, and intelligent security systems.

VI. CONCLUSION AND FUTURE WORK

The proposed Fog-Based Animal Detection and Alert System using Raspberry Pi and AI Accelerator successfully demonstrates an intelligent and efficient approach to preventing animal intrusions in agricultural and rural areas. By integrating fog computing, artificial intelligence, and IoT technologies, the system performs real-time image analysis and decision-making locally, eliminating cloud dependency and reducing response time. The inclusion of GSM and LoRa communication ensures reliable long-distance data transmission and timely alerts to users, even in low-connectivity environments.This system offers a cost-effective, scalable, and energy-efficient solution for farmers and security agencies, significantly improving safety and crop protection. With its modular architecture and potential for future enhancements such as thermal vision and drone-based monitoring, the project represents a promising step toward the development of smart, autonomous surveillance systems for agricultural and environmental applications.

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REFERENCES

1. J. Miao, D. Rajasekhar, S. Mishra, S. K. Nayak & R. Yadav, "A Fog-based Smart Agriculture System to Detect Animal Intrusion," Future Internet, vol. 16, no. 8, 2024
2. N. Goyal & N. K. Sandhu, "Animal Intrusion Detection and Alert System for Crop Protection," International Journal of Intelligent Systems and Applications in Engineering, Vol. 12, No. 10 s, 2024
3. Prof. Rohini N. Gaikwad, Sharvari S. Patil, Varsha B. Kumbhare, Samruddhi B. Salokhe & Sayali A. Bhat, "Deep Learning Based Animal Detection with SMS and IoT Notification," International Journal of Advanced Research in Engineering & Science & Management (IJARESM), Vol. 13, Issue 3, March 2025
4. Indushree S. V., Nandinisridevi H. S., Navya V., Nikitha B. M., "IoT Based Animal Harm Detection using Sensors by Creating an Alert," International Journal of Engineering Research & Technology (IJERT), Vol. 7, Issue 10, June 2019
5. Nandhini G. S., Kaviyarasu M., Saminathan K., Aakash A., "Crop Protection and Monitoring from Animal Attacks Using IoT Solutions," International Journal of Engineering Research & Technology (IJERT), Vol. 12, Issue 03, March 2023.
6. A Fog based Smart Agriculture System to Detect Animal Intrusion — Jinpeng Miao, Dasari Rajasekhar, Shivakant Mishra, Sanjeet K Nayak & Ramanarayan Yadav; 2023 IEEE 29th International Conference on Parallel and Distributed Systems (ICPADS). DOI: 10.1109/ICPADS60453.2023.00336
7. An IoT Integrated Smart Prediction of Wild Animal Intrusion in Residential Areas Using Hybrid Deep Learning with Computer Vision — S. G. A., R. Prabha, N. Aishwarya, R. M. Asha & S. Prabu; EAI Endorsed Transactions on Internet of Things, Vol 10 (2024). DOI: 10.4108/eetiot.4976