Project Stage-1 Report

On

Krishi Suraksha-Fog based Animal Intrusion Alert and Field Monitering System

Submitted in partial fulfillment of the requirement for the award of the Degree of

Bachelor of Engineering
In
Electronics & Telecommunication Engineering

By

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Savitribai Phule Pune University

A.Y 2025-26

Certificate

This is to certify that the project entitled **“Krishi suraksha-Fog-based Animal Intrusion Alert and Field Monitering System”** submitted by Sahil Ichake (PRN:72249269D) is a record of bonafide work carried out by them under the guidance of Prof. Dhananjay Poul in the fulfilment of the requirement for the award of Degree of Bachelor of Engineering, in Electronics & Telecommunication Engineering course of Savitribai Phule Pune University in the academic year 2025-26.

Certified by

Prof.Dhananjay Poul	**Prof. Neha Dumne**
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ज्ञानं सविज्ञानम्

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Project Stage-1 Approval Certificate

This is to certify that the project entitled **“Krishi suraksha-Fog-based Animal Intrusion Alert and Field Monitering System”** submitted by Sahil Ichake (PRN:72249269D) is approved for the Project stage-1.

External Examiner	**Internal Examiner**
Name:	**Name:**
Date:	**Date:**

Statement by the Candidates

I wish to state that the work embodied in this project titled **“Krishi suraksha-Fog-based Animal Intrusion Alert and Field Monitering System”** forms our own contribution to the work carried out under the guidance of Prof. Dhananjay Poul, at the Dhole Patil College of Engineering. We declare that this written submission represents our ideas in our own words and where others ideas or words have been included, We have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission.

Sahil Ichake

(PRN : 72249269D **)**

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Sahil Ichake

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Abstract

Agricultural fields are often vulnerable to animal intrusions and unauthorized human activities, which can cause significant crop damage and economic loss to farmers. To address this challenge, a fog-based animal intrusion and field monitoring system is proposed. The system integrates ultrasonic sensors, PIR motion sensors, and a NoIR camera with infrared LEDs to detect movements in the field, even during nighttime conditions. A Raspberry Pi 4 equipped with an AI accelerator processes the captured data using YOLOv5-based object detection, ensuring real-time recognition of animals or human presence at the edge (fog layer) with minimal latency.When an intrusion is detected, the system triggers a siren and flash LED to deter the intruder and simultaneously transmits data via LoRa/Gsm communication to a remote server for storage and monitoring. An instant alert message is sent to the farmer, enabling quick response and field protection. By leveraging fog computing, the system reduces dependency on cloud resources, minimizes communication delays, and ensures reliable operation in rural areas with limited connectivity.This approach enhances field security, crop protection, and farmer awareness while offering an energy-efficient, scalable, and low-cost solution suitable for smart agriculture applications.

Abbreviations

RPI	Raspberry Pi
AI	Artificial Intelligence
ML	Machine Learning:
IoT	Internet of Things
DL	Deep Learning
IR	Infrared

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Agriculture remains the backbone of many economies, providing food, raw materials, and employment to a large portion of the population. However, one of the persistent problems faced by farmers is the intrusion of animals and unauthorized humans into agricultural fields. Such intrusions often lead to severe crop damage, reduced yields, and significant economic losses. In rural areas where manual surveillance is difficult and costly, the need for an automated, reliable, and real-time field monitoring system has become increasingly important.Traditional methods of protecting crops, such as fences, manual guarding, or simple alarm systems, have limited effectiveness. Fences can be damaged, manual guarding requires constant human presence, and conventional alarms are unable to differentiate between harmless movements and real threats. With advancements in sensor technology, artificial intelligence, and fog computing, it is now possible to design intelligent systems that can monitor agricultural fields more efficiently and take proactive actions when threats are detected.

The fog-based animal intrusion and field monitoring system aims to provide a smart, scalable, and cost-effective solution to this problem. The system employs multiple sensors including ultrasonic sensors for distance measurement and PIR motion sensors for detecting movement. A NoIR camera equipped with infrared LEDs ensures visibility even in low-light or nighttime conditions. All these inputs are processed locally by a Raspberry Pi 4, enhanced with an AI accelerator, which runs YOLOv5-based object detection models to accurately identify whether the detected entity is an animal or a human intruder.By adopting a fog computing approach, the system ensures that most data processing is performed locally at the edge, reducing the dependency on cloud services. This not only lowers latency but also makes the system more reliable in rural areas where internet connectivity may be limited or inconsistent. Once an intrusion is confirmed, the system immediately activates deterrent mechanisms such as a siren and flash LED to scare away the animal or alert nearby individuals. In parallel, the system uses LoRa / Gsm communication technology to transmit an alert message or call to the farmer, enabling timely intervention without the need for continuous manual monitoring.

This project highlights the integration of smart sensors, AI-driven analytics, and fog-based architecture to provide a reliable field security solution. In addition to intrusion detection, the system also supports the broader goals of smart agriculture by minimizing crop losses, enhancing productivity, and promoting sustainable farming practices. With its low power consumption, scalability, and ease of deployment, the proposed system is well-suited for adoption in rural farming communities.

1.2 FOG COMPUTING IN FIELD MONITERING :

The Internet of Things (IoT) has revolutionized agriculture by enabling devices, sensors, and actuators to communicate and share data. In a typical IoT-based agricultural system, sensors collect information from the field and send it to a centralized cloud server for processing and analysis. While this approach is effective, it often suffers from drawbacks such as high latency, increased bandwidth consumption, and dependency on stable internet connectivity. These limitations are especially critical in rural agricultural areas where internet access is slow, unreliable, or even unavailable.Fog computing provides an intermediate solution between IoT devices and cloud services by enabling computation, storage, and intelligence at the network edge. In a fog-based system, most of the data is processed locally by edge devices, such as gateways or embedded systems like Raspberry Pi, rather than being transmitted entirely to the cloud. This reduces communication delays, ensures faster decision-making, and allows the system to operate reliably even with limited or no internet access.In the proposed animal intrusion and field monitoring system, fog computing plays a central role. The Raspberry Pi 4 with an AI accelerator acts as the fog node, processing data from the ultrasonic sensor, PIR sensor, and NoIR camera in real time. Instead of sending raw sensor and image data to the cloud, the system only transmits meaningful results, such as intrusion alerts, through LoRa communication to the farmer. This minimizes bandwidth usage while ensuring that the farmer receives instant notifications.By adopting a fog-based architecture, the system combines the benefits of IoT connectivity with the low latency and reliability of local processing. This makes the solution more practical for agricultural applications where immediate responses are essential and continuous cloud access cannot be guaranteed.

1.3 PROBLEM STATEMENT:

Agricultural fields are highly vulnerable to wild animal intrusions and unauthorized human activities, which result in severe crop damage, reduced yield, and economic losses for farmers. Traditional methods such as manual guarding, physical fencing, and basic alarm systems are either labor-intensive, unreliable, or costly to maintain. In addition, IoT-based systems that rely heavily on cloud computing face issues like high latency, unstable connectivity in rural areas, and inefficient bandwidth usage. Therefore, there is a pressing need for a real-time, cost-effective, and reliable monitoring system that ensures timely detection of intrusions and immediate farmer notification using fog-based architecture.

1.Accurate Detection and Classification :

Identifying whether the detected movement is caused by an animal or a human requires reliable sensors and AI models. Ensuring high accuracy across different species, sizes, and environmental conditions is critical.

2. Low Latency and Real-time Response :

Delays in detecting and responding to intrusions can make deterrent actions ineffective. Processing must occur locally at the fog node to minimize latency and ensure real-time decision-making .

.3. Connectivity and Data Transmission :

In rural or remote areas, internet connectivity is often poor or unavailable. The system must rely on low-power wide-area networks (e.g., LoRa) to ensure reliable communication between the field unit and the farmer.

4. Power Efficiency :

Field monitoring systems may need to run continuously in remote farmlands where power sources are limited. Efficient power management is essential for sensors, cameras, and processing units.

5. Farmer Awareness and Usability :

The system should be simple to operate, cost-effective, and provide clear alerts to farmers without requiring technical expertise, ensuring adoption at the grassroots level.

1.4 MOTIVATION:

With increasing incidents of crop damage due to wild animal intrusions and unauthorized human activities, there is a strong need for a reliable, real-time monitoring system in agricultural fields. This prototype provides farmers with immediate alerts when an intrusion is detected, helping them protect their crops, reduce losses, and improve agricultural productivity.

1.5 OBJECTIVE:

1. To design a system capable of continuously monitoring agricultural fields for the presence of animals or unauthorized human intrusions in real-time.
2. To process sensor data locally using fog computing, ensuring low latency and reliable detection even in areas with limited internet connectivity.
3. To provide automated alerts and notifications to farmers when intrusion is detected, enabling immediate response.
4. To safeguard crops and reduce losses by implementing an efficient, cost-effective, and scalable field monitoring solution.

1.6 LAYOUT OF THE REPORT:

A brief chapter by chapter overview is presented here.

Chapter 2: A literature review of different Animal & Field monitoring system

Chapter 3 : In this chapter, block diagram and information of different components are presented.

Chapter 4: In this chapter, conclusion and future scope is presented.

CHAPTER–2

LITERATUREREVIEW

1) **Title: A Fog-based Smart Agriculture System to Detect Animal Intrusion (2023, *arXiv*)**

Author: Jinpeng Miao, Dasari Rajasekhar, Shivakant Mishra, Sanjeet Kumar Nayak, Ramanarayan Yadav

Findings: This paper presents a fog-based smart agriculture system designed to detect animal intrusions in crop fields. Using IoT devices and sensors integrated with fog nodes, the system can process data locally to identify animals and trigger alerts in real-time. The approach reduces latency compared to cloud-only solutions and enhances field monitoring efficiency. By integrating AI models at the edge, the system accurately distinguishes between animals and environmental noise, reducing false alarms. The study highlights the potential of fog computing in improving agricultural security and protecting crops.

2) **Title: Wildlife Intrusion Detector (2024, *IRJMETS*)**

Author: Dr. Manisha G. Shinde, Suhani R. Sinha, Vedika S. Mudaliar, Sushant G.Vidhate

Findings: This paper proposes a wildlife intrusion detection system using IoT sensors and real-time monitoring techniques. The system detects the presence of wild animals near agricultural lands and sends instant alerts to farmers. It emphasizes automated response mechanisms, including alarms and deterrent devices, to prevent crop damage. The study demonstrates that combining sensor networks with cloud and fog computing can improve intrusion management, reduce crop losses, and support wildlife-human coexistence in rural areas.

3) **Title: Fog-based Animal Intrusion Alert & Field Monitoring System (2024, *MDPI Future Internet.***

Author: Published in *Future Internet* (MDPI) – 2024 Edition

Findings: This paper presents a fog-based monitoring system that integrates IoT sensors, edge computing, and cloud services to detect and alert farmers about animal intrusions. The system processes sensor data locally at fog nodes for real-time decision-making and sends relevant data to the cloud for storage and analysis. Using AI algorithms, it can accurately detect animal movements while minimizing false positives. The study highlights the system's efficiency in large-scale field monitoring, energy optimization, and timely alert delivery, demonstrating its practical application in modern agriculture.

4) Title: AI-Powered Cow Detection in Complex Farm Environments (2025, arXiv)

Author:Voncarlos M. Araújo, Ines Rili, Thomas Gisiger, Sebastien Gambs, Elsa Vasseur.

Findings: This study addresses the challenges of detecting cows in complex farm environments using AI technologies, specifically computer vision. The proposed model combines YOLOv8 with the Convolutional Block Attention Module (CBAM) to improve detection accuracy under varying conditions such as complex lighting, occlusions, pose variations, and background interference. The model demonstrated superior performance, achieving 95.2% precision and an mAP@0.5:0.95 of 82.6%. This advancement enhances livestock monitoring, health tracking, and behavioral analysis in smart farming applications.

CHAPTER 3

SYSTEM IMPLEMENTATION

3.1 BLOCK DIAGRAM

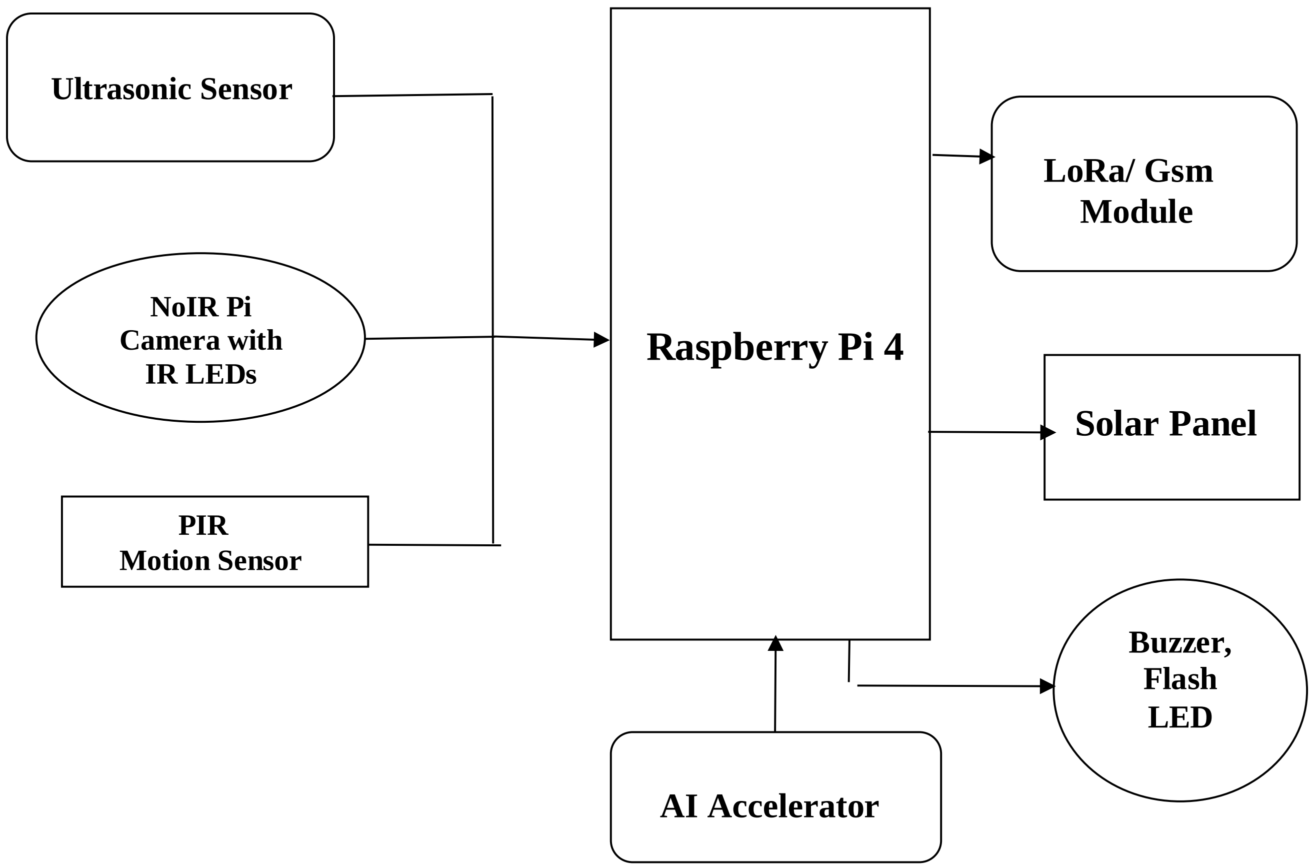

Figure 3.1 : Block Diagram

3.2 WORKING MODE:

This system is an advanced surveillance and monitoring setup using a Raspberry Pi 4 as the central controller. It integrates multiple sensors: an Ultrasonic sensor to detect distance and obstacles, a NoIR camera with IR LEDs for night vision imaging, and a PIR motion sensor to detect movement. The Raspberry Pi runs YOLOv5, an AI object detection algorithm, and communicates with an AI accelerator for faster processing. Detected events trigger a siren or flash LED for local alerts, while data is sent via a LoRa / Gsm module to Firebase for cloud storage. Power is supported by solar panels, ensuring uninterrupted operation, and a Blynk app interface allows remote monitoring and control. This combination enables real-time detection, alerting, and logging in a compact, efficient system.

3.3 FLOWCHART:

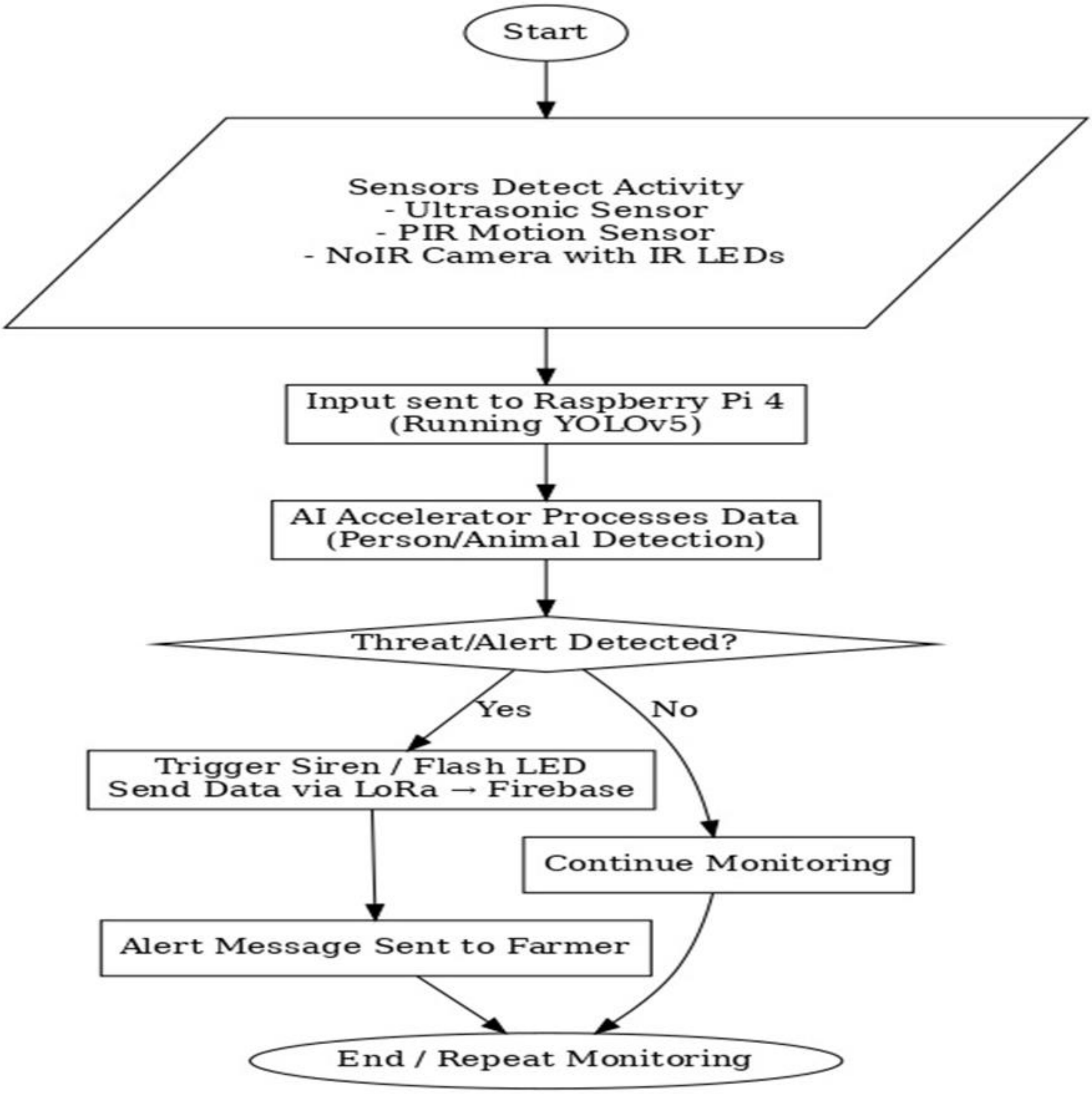

Figure 3.1 : Flowchart

3.4 ALGORITHMS :

Step 1 – Start

Step 2 – The system continuously uses multiple sensors to detect movement or presence:

Step 3 – The sensor data is sent to a Raspberry Pi 4, which is running the YOLOv5 object detection model.

Step 4 –The system utilizes an AI Accelerator (hardware) to rapidly process the sensor input, specifically performing Person/Animal Detection.

Step 5 –The system evaluates the AI-processed data to determine if a predefined Threat or Alert condition has been met.

Step 6 – Threat Detected: Siren/LED triggered; data sent via LoRa → Firebase; Alert Message sent to farmer; monitoring cycle repeats.

Step 7 – No Threat Detected: Continue Monitoring; process repeats.

Step 8 - End

CHAPTER 4

COMPONENTS DESCRIPTIONS

4.1RASPBERRY PI 4:

The Raspberry Pi 4 is a small, powerful computer that offers significant improvements over its predecessors, making it suitable for a variety of tasks, from educational projects to more demanding computing applications. It features a quad-core Cortex-A72 64-bit processor running at 1.5GHz, delivering a substantial boost in processing power compared to earlier models. For memory, the Raspberry Pi 4 comes with different RAM configurations, with the most powerful version offering up to 8GB of LPDDR4 RAM. This allows it to handle more intensive tasks, such as running multiple applications simultaneously, compiling code, or even light desktop computing. Storage on the Raspberry Pi 4 is flexible and handled through a microSD card, which serves as the main storage for the operating system and files. Alternatively, it supports USB booting, allowing external storage devices to be used for even faster performance or more storage capacity. In terms of connectivity, the Raspberry Pi 4 includes dual-band 802.11ac Wi-Fi and Bluetooth 5.0, providing fast wireless internet and peripheral connections. It also comes with a Gigabit Ethernet port for wired network access, offering much faster data transfer rates than previous models.

The Raspberry Pi 4 features two USB 3.0 ports, which provide high-speed connectivity for peripherals like external drives or USB cameras, and two USB 2.0 ports for other devices. It also supports dual 4K displays via two micro-HDMI ports, which makes it suitable for multimedia tasks, digital signage, or even as a basic desktop replacement. It also has hardware video decoding for high-quality video playback. One of the standout features of the Raspberry Pi 4 is its GPIO (General Purpose Input/Output) pins, which enable users to interface with external hardware like sensors, motors, or other electronics. This makes it a powerful tool for prototyping and DIY electronics projects.

Figure 4.1: Raspberry Pi 4

4.2 AI Accelerator :

An AI Accelerator is a class of specialized hardware designed to efficiently expedite the processing of artificial intelligence and machine learning workloads, particularly tasks involving neural networks. Unlike a general-purpose CPU, which is optimized for sequential and varied computing tasks, AI accelerators—such as GPUs (Graphics Processing Units), TPUs (Tensor Processing Units), and dedicated NPUs (Neural Processing Units)—feature massive parallelism and architectural optimizations (like specialized matrix multiplication units) that are ideal for the repetitive, vector, and matrix-intensive calculations inherent in training and inferencing AI models like the YOLOv5 mentioned in the flowchart.

Their primary function is to provide the high throughput and low latency necessary to process large volumes of data quickly, allowing for real-time applications such as object detection, natural language processing, and image recognition to run smoothly and power-efficiently, especially on edge devices like the Raspberry Pi.

Figure 4.2: AI Accelerator

4.3Lora module:

A LoRa module is a compact, integrated hardware component, typically a small board or chip, that acts as the radio transceiver for an IoT end device, like the one connected to the Raspberry Pi in the system diagram. It contains the Semtech LoRa chip and often a microcontroller, enabling it to execute the LoRa (Long Range) spread spectrum modulation technique. The core function of this module is to transform data from the host controller into an encoded radio signal, allowing the transmission of small data packets over a vast range (up to miles) while consuming ultra-low power, which is critical for extending the battery life of remote sensors. The LoRa module works by operating on license-free sub-gigahertz radio frequency bands and communicating with a LoRaWAN gateway, effectively providing the crucial long-distance, non-cellular wireless link necessary for sending alert data to a cloud platform like Firebase

Figure 4.3: Lora module

4.4 POWER SUPPLY

Solar power is an ideal and essential energy solution for remote, fog-based animal intrusion monitoring systems, which require reliable, autonomous operation in off-grid locations. The distributed nature of fog computing, which processes data locally at the network edge (using low-power devices like microcontrollers and cameras), inherently reduces the system's energy needs by minimizing energy-intensive long-range data transmission to the cloud. A solar panel, coupled with a rechargeable battery and charge controller, provides a continuous power supply: the panel charges the battery during the day, which then runs the system—including low-power sensors, the fog processing node, and high-power deterrents like lights or sirens—24/7. This setup eliminates the need for external wiring or battery replacement, making it a cost-effective, sustainable, and low-maintenance solution for real-time wildlife monitoring

Figure 4.4 :Solar Panel

4.5 Noir camera with ir led

A NoIR (No Infrared filter) camera, most famously the Raspberry Pi Camera Module NoIR, is designed specifically for enhanced low-light and night-time imaging. Its core characteristic is the deliberate absence of the infrared cut-off filter found in standard cameras. This filter normally blocks light at wavelengths invisible to the human eye, particularly infrared (IR) light, to ensure natural color reproduction in daylight.

By removing it, the NoIR camera's sensor becomes highly sensitive to these IR wavelengths. When used in conjunction with IR LEDs, which emit light invisible to humans but visible to the specialized sensor, the camera can "see in the dark". The IR LEDs act as an invisible flashlight, illuminating a scene with infrared light. The camera captures this reflected light, producing clear, high-contrast, typically monochromatic (black and white) images or video, making the combination ideal for security surveillance, wildlife monitoring, or other applications where visible light is undesirable.

Figure 4.5: Noir camera with ir led

4.6 GSM Module

The GSM module plays a crucial role in the communication between devices and the GSM network. It is responsible for establishing and maintaining the communication link between the device and the network. The module also handles the encryption and decryption of data, which ensures the security of the communication.

Figure 4.6; Gsm Module

CHAPTER 5

ADVANTAGES AND FUTURE SCOPE

5.1 ADVANTAGES:

1. **Low Latency** : The system processes data locally on the fog node, allowing instant detection of animals and immediate triggering of alarms. This ensures quick responses to prevent crop damage.

2. **Reduced Cloud Dependency** : Only relevant or processed data is sent to the cloud, reducing bandwidth usage and minimizing reliance on internet connectivity. This is useful for remote agricultural fields with limited network access.

3. **Efficient Resource Usage** : By handling data processing at the edge, the system reduces the load on cloud servers and network infrastructure. This leads to faster operations and lower operational costs.

4. **Accurate Detection** : AI/ML models deployed on the fog node can distinguish animals from other moving objects, minimizing false alarms and improving reliability.

5. **Remote Monitoring** : Farmers can monitor field conditions and intrusion events via mobile apps or web dashboards from anywhere. This enhances convenience and field management efficiency.

6. **Scalability** : Additional sensors and fog nodes can be integrated easily without overwhelming the cloud or network. The system can grow as the farm size increases.

7. **Energy Efficient** : Local processing avoids continuous transmission of heavy raw sensor data, conserving power for both sensors and edge devices. This is especially important in off-grid field setups.

8. **Historical Data Analysis** : Cloud storage allows accumulation of intrusion data over time, helping farmers analyze trends and take preventive measures in vulnerable areas.

5.2 DISADVANTAGES:

1. **Limited Sensor Range** : Each sensor can monitor only a fixed area, so larger fields require more devices to avoid blind spots. Inadequate coverage can let animals enter undetected.
2. **Environmental Interference** : Extreme weather conditions like heavy rain, fog, dust, or strong winds can affect sensor accuracy and reduce detection efficiency.
3. **Data Security Risks** : Data transmitted to cloud servers can be vulnerable to hacking or unauthorized access. Sensitive information about farm conditions may be exposed.
4. **Dependence on Technology** : Farmers need to rely on electronic devices for monitoring instead of traditional methods. This may be challenging for those unfamiliar with technology.

5. **Upgradation Challenges** : Outdoor devices are exposed to damage from animals, theft, or accidental impacts. This can increase repair or replacement costs.
6. **Hardware Vulnerability** : The system may only incorporate a narrow range of sensors, which could limit its ability to detect various pollutants accurately. This limitation may prevent a comprehensive assessment of air quality, impacting the overall effectiveness of pollution monitoring.
7. **Limited Battery Life for Wireless Sensors** :Wireless sensors depend on batteries, which require regular replacement or recharging. This adds to maintenance efforts and operational cost. ving or data breaches. If the air pollution monitoring system is compromised, it could lead to unauthorized access to sensitive data or manipulation of reported pollution levels, undermining public trust and safety.

5.3 APPLICATIONS:

1. **Data Analytics & Prediction** : Historical intrusion data is stored and analyzed to detect patterns and predict high-risk zones. Farmers can take preventive measures in advance, like reinforcing fences or placing extra sensors. This predictive approach helps optimize resources and plan farm management effectively. Over time, the system becomes smarter and more efficient at preventing intrusions. .

2. **Automated Deterrent Systems** : Upon detecting an intruder, the system can automatically activate lights, sounds, sprinklers, or other deterrents. This reduces crop damage while minimizing human intervention. Automation ensures timely response, even during nighttime or when the farmer is away. It improves overall efficiency and safety for both crops and farm workers. .

3. **Remote Field Surveillance** : Farmers can monitor large or distant fields from smartphones or computers in real-time. This reduces the need for physical patrolling and allows instant action when an intrusion is detected. Continuous surveillance ensures higher security and peace of mind. It is particularly effective for farms located in remote or hard-to-access areas.

4. **Wildlife Monitoring** : The system can track and record the movement of wild animals near farms or wildlife areas. Data collected helps understand animal behavior, migration patterns, and habitat usage. It is valuable for conservation efforts and reducing human-animal conflicts. Alerts can help prevent dangerous encounters between wild animals and humans.

5. **Crop Protection** : The system monitors agricultural fields continuously to detect animals entering and potentially damaging crops. Using sensors and AI-based detection, it triggers alarms or deterrents instantly. This proactive approach helps farmers prevent significant crop losses. Continuous monitoring reduces dependency on manual patrolling, saving time and labor costs. It is especially useful in large farms where human supervision is difficult.

5.4 FUTURE SCOPE:

In the future, the system can be enhanced with advanced AI and deep learning models to not only detect animals but also accurately identify their species, size, and behavior patterns, reducing false alarms and improving overall detection reliability. Integration with drones can enable aerial surveillance of large and remote fields, providing real-time video feeds, tracking animal movement, and even deploying deterrents in hard-to-reach areas. The system can also be combined with other IoT-based smart farm technologies, creating a fully automated precision farming ecosystem that optimizes crop yield, manages irrigation, monitors soil conditions, and ensures security simultaneously. Predictive analytics using historical data can forecast potential intrusion events based on animal movement trends, seasonal variations, and weather conditions, allowing farmers to implement preventive measures proactively.

Future designs may rely on renewable energy sources such as solar or wind power to make the system self-sufficient and sustainable in off-grid locations. Additionally, the incorporation of enhanced security features, including encrypted communication, tamper-proof sensors, and real-time alert systems, will protect the system from both cyber threats and physical damage. Advanced edge-fog-cloud hybrid computing architectures can further improve scalability, processing speed, and storage capabilities, enabling the system to handle large-scale farms efficiently. With continuous improvements in sensor technology, AI accuracy, and automation, this system has the potential to become a comprehensive solution for modern agriculture, ensuring crop protection, wildlife monitoring, and optimized resource management, while also contributing to sustainable and smart farming practices globally.

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