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Literature Survey On Krishi ರಕ್ಷಕ – The AgriFusion

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Abstract: This literature review examines the integration of artificial intelligence (AI), sensor networks, and IoT technologies in modern agriculture, with a focus on weed detection, animal intrusion prevention, irrigation automation, and soil health monitoring. It analyzes recent journal publications (2020–2025) that utilize deep learning models such as CNN and YOLOv5/YOLOv8 for real-time object detection, along with smart sensors for environmental data collection. Mobile applications and microcontrollers like Raspberry Pi and NodeMCU are also evaluated for automation and farmer interaction. The review highlights the limitations of existing systems—including poor cross-domain performance, reliance on internet connectivity, and lack of regional language support—and identifies the need for an integrated, edge-based, multi-functional solution like the Krishi ರಕ್ಷಕ – The AgriFusion project. This study is intended to guide future work on accessible and sustainable smart farming platforms for smallholder farmers

Index words - Weed Detection, IoT in Agriculture, Smart Irrigation, Animal Intrusion Detection, CNN.

I. Introduction

Agriculture plays a crucial role in the Indian economy, serving as the primary livelihood for a large portion of the population. However, modern farming is increasingly challenged by issues such as uncontrolled weed growth, frequent crop damage caused by wild animal intrusion, and inefficient water management due to unpredictable irrigation practices. Traditional methods to address these problems—like manual weeding, blanket spraying of pesticides, or human-based crop surveillance—are labour-intensive, costly, and often environmentally unsustainable.

In recent years, the integration of Artificial Intelligence (AI), Internet of Things (IoT), and image processing technologies has paved the way for smarter agricultural practices. AI models such as Convolutional Neural Networks (CNN) and YOLO object detection are being used to automate weed and animal detection, while sensor-driven systems enable precise irrigation control and real-time soil health monitoring. These innovations promise more efficient, cost-effective, and sustainable solutions tailored to the needs of small and marginal farmers.

This paper reviews related research from 2020 to 2025 covering key areas relevant to this project.

II. Problem Statement

Despite advances in agricultural technology, farmers—especially in rural and semi-urban regions—continue to face persistent challenges such as uncontrolled weed growth, crop loss due to animal intrusion, inefficient irrigation, and poor soil health awareness. Traditional solutions are often labor-intensive, environmentally harmful (e.g., excessive pesticide use), or lack scalability. Moreover, existing smart farming systems tend to focus on isolated problems and rarely offer an integrated solution that combines real-time detection, automated response, and local-language accessibility. There is a critical need for a unified, low-cost, AI-powered system that can assist farmers by automating key agricultural processes—such as weed identification, animal monitoring, water pump control, and soil health tracking—through a single, easy-to-use mobile application.

III. Objectives

- To Detect and classify useful and harmful weeds using AI.
- To Identify animal intrusion (e.g., cows, goats).
- To Monitor soil moisture, pH, NPK, and temperature.
- To Automate irrigation using water pumps.
- To Provide a user-friendly Kannada app for farmers.
- To Offer Companion Planting suggestions for better yield.
- To Create a cost-effective and scalable smart farm system.

IV. Literature and survey

I. Semi-Supervised Weed Detection in Vegetable Fields: In-domain and Cross-domain Experiments

Source: Michigan State University (preprint submitted to IFAC)
Year: 2025

Summary:
This study introduces "WeedTeacher," a YOLOv8-based semi-supervised object detection model. It outperforms other SSOD models in in-domain tasks using a dataset of 19,931 images, but shows limited improvement in cross-domain weed detection.
Drawback:
The system fails to generalize well across domains, highlighting challenges with applying the same model to different crop or field environments.

Comparison: :
Our project uses YOLOv5 in a fully supervised mode for known field conditions, avoiding domain shift issues, and integrates multiple farming features beyond weed detection.

II. Weed Detection and Removal Based on Image Processing

Source: International Journal of Recent Technology and Engineering (IJRTE)
Year: 2020

Summary:
This paper describes an automated weed detection and mechanical removal system using Raspberry Pi and image processing on a moving robot platform. It processes images to detect weed coordinates, which are then used to position a weed cutter.
Drawback:
The approach assumes crops are always larger than weeds and lacks AI-based learning, which may reduce accuracy in varied field conditions.

Comparison: :
While it uses basic image processing and mechanical weed removal, our project upgrades the detection to AI-based classification (YOLO), adds app-based alerting, and includes other features like soil health monitoring and animal intrusion detection.

III. A Comprehensive Review of Weed Detection through Advanced Image Processing and Deep Learning
Source: Global Journal of Research in Engineering & Computer Sciences
Year: 2024

Summary:
This review paper provides a comprehensive overview of image-based weed detection methods using deep learning. It outlines steps from image acquisition to CNN model training and highlights various models like R-CNN, YOLO, VGGNet, and Mask R-CNN used in recent research for weed detection across different crops.
Drawback:
While rich in analysis, the paper is a review with no implemented system or practical testing, and it identifies the lack of large, diverse datasets as a challenge.
Comparison:
Our system builds upon the reviewed technologies and translates them into a working prototype tailored to tomato and chilli crops, integrating camera vision, automation, and local-language app support.

IV. An Animal Intrusion Detection and Repellent System for Farm Safety Using IoT
Source: SSRN (Social Science Research Network
Year: 2023

Summary:
This paper proposes an animal intrusion detection and repellent system using YOLO (object detection), IR sensors, and a sprayer. The system identifies animals using a camera, triggers a relay if intrusion is detected, and notifies both the farmer and forest officer. It uses a YOLO-trained image detection algorithm to distinguish wild and domestic animals and activates a repellent (sprayer) accordingly.
Drawback:
The model is limited to line-of-sight detection (IR and camera range), and it lacks integration with advanced cloud or mobile monitoring platforms.
Comparison: :
While it uses a camera and YOLO like our system, our project additionally integrates a mobile app in Kannada, soil monitoring, and multiple crop support, making it more multifunctional and farmer-friendly.

V. AI-Driven Animal Intrusion Detection System for Agriculture: Real-Time Monitoring and Automated Response Using Deep Learning
Source: International Journal of Innovative Research in Technology (IJIRT), Vol. 11, Issue 12
Year: May 2025

Summary:
This study presents an ESP32-based intrusion detection system using the MobileNetSSD deep learning model for real-time detection of animals via ESP32-CAM. Detected results are sent to Firebase for logging and alerts, and deterrents like buzzers and LEDs are triggered automatically.
Drawback:
While efficient, the system is limited to simple deterrents and cloud logging without AI-based response classification (e.g., wild vs. domestic animal), and lacks mobile app integration.

Comparison: :
Our system uses YOLOv5 for more advanced detection and integrates real-time alerting via a mobile app in Kannada, providing local language support and enhanced multi-sensor control.

VI. A Deep Learning Based Model for Detection and Tracking of Stray Animals in the Fields
Source: Current Agriculture Research Journal (CARJ), Vol. 12, No. 3
Publisher: Enviro Research Publishers
Year: 2024

Summary:
This paper presents an advanced animal detection and tracking system using YOLOv5 and DeepSORT, combined with IoT for real-time alerts. The model achieves over 96% accuracy on various animal species and provides continuous tracking and alerting using video feeds and cloud services.
Drawback:
High hardware and internet requirements may limit real-world adoption in remote rural areas without reliable connectivity.
Comparison: :
Our project aims to be more cost-effective and localized, using edge computing (Raspberry Pi), simplified camera setups, and a regional language app interface to ensure adoption by small and medium farmers in India.

VII. Automation of Water Pump using Sensors
Source: SAMRIDDHI: A Journal of Physical Sciences, Engineering and Technology
Year: 2023

Summary:
This paper presents an automated irrigation system using a soil moisture sensor (LM393) and temperature sensor (LM35) with an Arduino-based PCB to control a water pump. The system intelligently activates the pump based on soil humidity and temperature levels and shuts it down when adequate conditions are met.
Drawback:
The system lacks IoT or cloud connectivity for remote monitoring and relies solely on hardware-based logic.
Comparison: :
Our system adds wireless app control, real-time alerts, and integrates with other agricultural features like weed detection and animal intrusion — making it more multifunctional and farmer-friendly.

VIII. Utilization of Solar Energy for Water Pumping in Agriculture

Source: Journal of Alternative and Renewable Energy Sources (MAT Journals)
Year: 2023
Summary:
This paper proposes a solar-powered water pumping system for irrigation, using two monocrystalline panels, an MPPT charge controller, a 0.65 hp three-phase induction motor, and a vertical turbine pump. The system is automated by an ATmega328p microcontroller and controlled based on soil moisture readings.
Drawback:
No wireless control or app interface is used, and the design is mostly hardware-driven with minimal flexibility for real-time customization.

Comparison: :
While both systems automate irrigation, our project integrates solar-powered irrigation with AI vision, multilingual app control (Kannada), and multiple sensors on a single board.

IX. Enhancing Predictive Accuracy in IoT-Based Smart Irrigation Systems

Source: Engineering Proceedings, MDPI
Year: 2025

Summary:
This paper develops an IoT-based irrigation system using ensemble learning (LRBoost and LR+RF) for water usage prediction. It uses real-time data from multiple sensors and integrates with cloud services to provide dynamic water recommendations with over 96% accuracy.
Drawback:
High hardware and processing power requirements (GPU, 16 GB RAM) make it expensive and potentially impractical for small farms.
Comparison: :
Our system is optimized for affordability and ease of use in rural settings, combining AI for weed and animal detection with practical sensor control and app access in the regional language.

X. Advancing Nature-Based Solutions Through Enhanced Soil Health Monitoring in the United Kingdom

Source: Soil Use and Management, Wiley Online Library (British Society of Soil Science)
Year: 2024

Summary:
This review paper highlights the importance of soil health in nature-based agricultural practices and climate sustainability. It emphasizes integrating biological, chemical, and physical soil indicators into farming systems using both traditional and emerging sensor-based monitoring tools (e.g., IoT, eDNA, ecoacoustics). The study recommends flexible and context-specific soil health frameworks for landowners and researchers.

Drawback:
Although it proposes modern technologies for monitoring, the paper lacks direct application or testing in small-scale, real-time agricultural systems like smart farms.
Comparison:
Your project builds upon this research by applying soil sensors (moisture, pH, NPK, temperature) directly in the field and integrating them into an automated, crop-specific, IoT-connected system, making it more practical and accessible for small and regional farmers.

XI. RESEARCH GAP

While existing studies have made significant strides in automating exam evaluations, several gaps remain:

Lack of Real-Time Weed Detection and Classification: Most current systems either rely on manual weed removal or delayed image analysis. Real-time weed classification (as useful or harmful) using AI is rarely implemented, making immediate and targeted action difficult for farmers.

High Cost and Complexity for Small Farmers: Many existing smart agriculture systems involve expensive hardware (like drones or advanced robotics) and require technical expertise. This makes them inaccessible to small-scale or rural farmers with limited resources and technical background.

Separate Devices for Different Functions: In most research, weed detection, animal detection, irrigation control, and soil health monitoring are handled using separate devices or systems. This increases hardware cost, complexity, and power consumption.

No Integrated Solution in Regional Language (Kannada): Available mobile apps or interfaces are in English or generic formats, which may be difficult for Kannada-speaking farmers to use. This creates a communication and accessibility gap between the system and its users.

Lack of a Multifunctional, Farmer-Friendly Platform: There is a strong need for a unified, low-cost system that combines AI-based weed and animal detection, soil health monitoring, and smart irrigation — all controlled through a simple mobile app in the farmer's native language (Kannada).

XII. CONCLUSION

This literature review explored recent advancements in smart agriculture technologies focused on weed detection, animal intrusion, irrigation control, and soil health monitoring. The analysis of selected journal papers reveals that most existing systems are limited in scope—focusing on a single feature, lacking real-time processing, or being too costly and complex for small-scale farmers. Additionally, regional language support and multifunctional integration are largely absent. These gaps highlight the need for a unified, AI-powered smart farming system that combines real-time weed and animal detection, automated irrigation, soil health monitoring, and a Kannada-based mobile interface. The proposed project, Krishi ರಕ್ಷಕ – The AgriFusion, aims to fill these critical gaps and deliver an affordable, accessible, and farmer-friendly solution tailored for Indian agriculture.

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