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Farm Security Agricultural Robot with Plant Disease Detection

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ABSTRACT: The rapid advancement in agricultural automation has led to the development of intelligent robotic systems aimed at enhancing farm productivity and security. This project presents a multifunctional Farm Security Agriculture Robot integrated with Plant Disease Detection capabilities. The robot is designed to monitor the farm environment, detect intrusions by animals or unauthorized persons, and alert the farmer through IoT-based notifications. In addition to security, the robot is equipped with a camera and image processing module that utilizes artificial intelligence to detect early signs of plant diseases, enabling timely intervention. It also includes features such as automated pesticide spraying and fire detection, contributing to crop health and farm safety. This integrated system offers a cost-effective, efficient, and smart solution for modern-day farming challenges, especially for small and medium-scale farmers. Fire sensors detect fire through sudden heat changes, smoke, or infrared/ultraviolet radiation from flames. Integrated into farm robots, these sensors continuously scan the environment. On detecting fire, the system alerts farmers via GSM or Wi-Fi and may even activate extinguishing systems like sprinklers. Including fire sensors in farm robots greatly enhances safety, protects assets, and supports eco-friendly farming by minimizing fire-related harm.

KEYWORDS: Agricultural robot, farming, android operation, automatic and manual operation, power conversion, sensor and Bluetooth operated, system functions.

I. INTRODUCTION

Agriculture remains the backbone of many economies, yet farmers face persistent challenges such as pest infestations, wildfires, animal intrusions, and plant diseases, leading to significant crop losses. Traditional pest control methods involve manual pesticide spraying, which is not only labor- intensive but also hazardous to farmers' health due to chemical exposure. Additionally, delayed detection of fires and animal intrusions often results in irreversible damage to crops. Early identification of plant diseases is another critical issue, as untreated infections can drastically reduce yields. For fire detection, a flame sensor is employed to identify potential fire hazards, triggering instant alerts on the farmer's smartphone. An IR sensor detects animal movements, preventing crop damage from wildlife. The robot also features an ESP32-CAM module that captures live images of plants. These images are processed using a machine learning (ML) algorithm trained to recognize common plant diseases, providing farmers with actionable insights for timely intervention. This project combines IoT, robotics, and AI to create a cost-effective and scalable farming assistant. By reducing dependency on manual labor and improving monitoring efficiency, the Smart Agriculture Robot aims to enhance crop protection, optimize resource usage, and increase agricultural productivity. Farms are vulnerable to fire hazards, particularly during dry seasons when vegetation is flammable. Early fire detection is critical to prevent serious damage to crops and the environment. Fire sensors detect fire through sudden heat changes, smoke, or infrared/ultraviolet radiation from flames. Integrated into farm robots, these sensors continuously scan the environment. Animal intrusion is a common issue in farming, often resulting in damaged crops or irrigation systems. Traditional solutions like fences or scarecrows are often ineffective. Animal sensors, using infrared or motion detection technologies, offer a smart alternative. These sensors can detect animals and respond by triggering lights, sounds, or alerts to the farmer. Though agriculture has embraced various technological advancements, security remains a key concern due to large, isolated farm layouts. Farms are prone to theft, animal attacks, fires, and unauthorized access. The Farm Security Robot provides real-time monitoring using various sensors like motion detectors, cameras, and gas or fire sensors. Some versions also feature night vision and AI-based intrusion





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detection. These robots reduce the need for human monitoring, cut costs, and offer a robust layer of protection for crops and assets.

II. PROBLEM STATEMENT

Modern agriculture faces several critical challenges that impact productivity, safety, and sustainability:

Manual pesticide spraying: exposes farmers to harmful chemicals, is time-consuming, and leads to uneven chemical distribution.

Wildfires: in farmlands often go undetected until significant damage occurs due to a lack of real-time monitoring.

Animal intrusions: (e.g., wild boars, birds) destroy crops, but traditional scare methods are ineffective.

Plant diseases: are typically identified too late (via visual inspection), causing preventable yield losses.

Labor shortages : In rural areas make it difficult to monitor large farms efficiently.

These issues demand an automated, intelligent, and cost-effective solution to enhance precision, reduce risks, and improve crop management.

III. DESIGN METHODOLOGY AND WORKING

The proposed farm security and plant disease detection system is a multi-functional robotic solution developed to enhance modern agricultural practices by integrating automation, artificial intelligence (AI), and Internet of Things (IoT) components. The core of this system is the Arduino Uno microcontroller, which acts as the central processing unit, interfacing various sensors, actuators, and modules to perform real-time monitoring and control operations. This methodology outlines the step-by-step approach followed in the design, development, and integration of each component in the system to fulfill tasks such as animal intrusion detection, fire alert, pesticide spraying, plant disease identification, and wireless control. The system starts with power management, where a battery powers all modules and components. The battery is connected to the Arduino Uno, ensuring a continuous supply of voltage to sensors and output devices. The selection of a reliable battery is critical to provide stable voltage levels, considering the robotic unit will operate in open field conditions, often away from fixed power sources. For security monitoring, the system incorporates an animal sensor, which is typically an IR (Infrared) or PIR (Passive Infrared) sensor. This sensor detects motion or the presence of animals near the farmland. When an animal is detected, the sensor sends a signal to the Arduino Uno. Based on the code embedded in the microcontroller, this input triggers an immediate alert mechanism via a buzzer, which creates a loud sound to scare away the intruder. This real-time response helps prevent crop damage from animal intrusion. Complementing this, a fire sensor is integrated to enhance field safety. The fire sensor, such as an infrared flame sensor, detects the presence of fire or a rapid temperature increase in the environment. Upon detecting fire, it sends a signal to the Arduino Uno, which again triggers the buzzer for immediate warning. Depending on the configuration, the system can also activate a motor pump to spray water or chemical extinguishers on the affected area to control the fire at an early stage.





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Fig 1: Block diagram

IV. COMPONENTS USED

1. ARDUINO UNO



Fig 2:Arduino UNO

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.



Fig 3: DC Motor





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The 300 RPM L-Shape BO Motor Plastic Gear Motor - BO series straight motor gives good torque and rpm at lower operating voltages, which is the biggest advantage of these motors. Small shaft with matching wheels gives an optimized design for your application or robot.

3. Motor drive:



Fig 4: Motor drive

L298N 2A Based Motor Driver is a high power motor driver perfect for driving DC Motors and Stepper Motors (Now find out out a wide range of motors at Robu.in). It uses the popular L298 motor driver IC and has an onboard 5V regulator which it can supply to an external circuit.

4. Bluetooth module:



Fig 5: Bluetooth module

HC-06 is the popular Bluetooth module. This HC06 module is slave mode only. It's very easy to add wireless serial connectivity for your device with this module. Examples for Arduino and other boards are available.

5. ESP32 CAM:



Fig 6: ESP32 CAM





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The ESP32-CAM is a low-cost, compact, and versatile microcontroller module that integrates Wi-Fi, Bluetooth, and a camera, making it an excellent choice for IoT and vision-based applications.

6. R385 6-12V DC DIAPHRAGM



Fig 7: R385 6-12v DC Diaphragm

The R385 6-12V DC Diaphragm Mini Aquarium Water Pump is a great choice for moving different types of liquids. It has enough pressure to work with a nozzle for creating a spray system.

7. BATTERY:



Fig 8: Battery

It has a voltage rating of 3. 7 volts and a capacity of 2600mAh. It is a small, strong battery cell that holds 2600 mAh of energy. You can easily add it to your project to meet the requirements of 3. Requires a 7-volt power supply with a large capacity.



Fig 9: Implementation of the work





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V. SOFTWARE REQUIREMENTS

Arduino IDE: Arduino Integrated Development Environment (IDE) is an open-source IDE that allows users to write code and upload it to any Arduino board. Arduino IDE is written in Java and is compatible with Windows, macOS and Linux operating.

VI. CONCLUSION

The Smart Agriculture Robot presents an innovative and practical solution to modern farming challenges by integrating automation, IoT, and AI technologies. By combining Bluetooth controlled pesticide spraying, realtime fire and animal intrusion detection, and AI-powered plant disease diagnosis, this system significantly reduces manual labor, minimizes chemical exposure for farmers, and enhances crop protection. The robot's modular and scalable design ensures adaptability for diverse farming environments, while its cost-effective approach makes advanced agricultural technology accessible to small-scale farmers. Although challenges such as battery life, terrain adaptability, and sensor accuracy remain, future upgrades like solar power, autonomous navigation, and improved AI models can further optimize performance. This project not only boosts agricultural productivity and sustainability but also paves the way for fully autonomous smart farming, aligning with global efforts toward food security and precision agriculture. By bridging the gap between traditional farming and cutting-edge technology, the Smart Agriculture Robot demonstrates how automation and AI can revolutionize agriculture for a more efficient and sustainable future.

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