Automated Vehicle for Pest Control in Agriculture.

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Abstract - One of the newest industries to employ robotic technology is agriculture. When technology support is used, the ability to cultivate crops with high yield and quality can be improved. Although they cannot be entirely removed, pests can be effectively managed and controlled. Pest damage may be reduced to levels below what is economically feasible. Agriculture automation is accurate and reliable, and it is mostly used in automated farming systems. However, it is not widely known that it has multiple applications in various agricultural operations. As a result, this essay aims to raise profound knowledge of the use of robotics in agriculture. Robots can do one or more specialized tasks, and they typically consist of five fundamental parts: sensors, effectors, actuators, controllers, and arms. Automation is a development that supports sustainable agriculture and food security. Automation is used in weeding, weed mapping, micro spraying, sowing, irrigation, and harvesting. Solar robots with battery inverters might be created in the future.

I. INTRODUCTION

Pests include all organisms that harm our crops, including insects, microorganisms, plants, animals, and abiotic causes. They typically cause nuisances, diseases, and harm to crops. They can also cause property damage or make life unpleasant for people. Depending on the circumstance, insects may be viewed as pests, destructive during some seasons, and beneficial during others. As a result, an insect is typically seen as a pest when it competes with people for resources and when there are a lot of them.

Farming requires a lot of labor and is frequently filled with tedious manual labor. Perhaps one of the most recent industries to adopt robotics and automation equipment is agriculture. The use of equipment in agriculture is limited or applied during certain agronomic practices such as plowing, planting, pesticide application, harvesting, etc., unlike manufacturing and mining industries which adopt new technologies more quickly due to continuous dependence on the machinery throughout the year. Robotics or real-time machines are frequently utilized in plant factory concepts in the present agricultural trend, although these demand significant investment and advanced facilities [1]. Farmers have a significant interest in methods that will make their labor simpler. Numerous labor-saving tools and straightforward agricultural machinery have been created by farmers themselves.

Although highly meticulous, crop cultivation for maximum yield and high-quality food can be enhanced with the use of technology. Global enterprises are increasingly relying on technology, particularly when it comes to agricultural equipment, data collection for surveys, and accessing and obtaining crucial information on their crop land.

Insecticides are crucial to meeting agricultural sector standards and consumer needs. Despite their utility, these pesticides can, through a variety of methods of action, constitute a serious threat to the security of food, the environment, and all living things. Numerous researchers have created quick, affordable, simple, and user-friendly analytical methods for the detection of pesticides in response to concern over the environmental effects of repeated use of insecticides. In this context, optical sensors are regarded as advantageous ways for analyzing pesticides due to their unique characteristics, which include quick detection times, low costs, ease of use, and high selectivity and sensitivity [2]. By categorizing it based on the chemical of the insecticide, current developments in the incorporation of identification elements and optical sensors for insecticide detection are effectively reviewed and appraised in this review.

Fig.1 Automated vehicle for pest control.

II. LITERATURE SURVEY

1. Monitoring the population density of pests is essential for effective crop protection in agricultural and forestry activities, as indicated in Hassan Ahmed, Abdul Shukor Juraimi, and Muhammad Saiful Ahmad Hamdani's paper entitled "Introduction to robotics agriculture in pest control." Farmers have historically been required to conduct periodic surveys of the traps dispersed across the field. This requires a lot of work and time, especially in big plantation regions. A system that could perform tasks automatically, accurately, and more effectively would be very advantageous.

Each trap is correctly installed with pheromones and related chemicals that entice the targeted insects to be collected, depending on the type of insect. Since no insect entering a trap would be able to escape, the pest monitoring equipment will periodically collect surveillance information on each trap and count each individual insect that enters it. Normal intervals between two consecutive surveys should be between 15 and 30 days [3]. This method, however, is expensive and labor-intensive, and all monitoring traps cannot be synchronized to measure the target pest population and, as a result, give poor temporal resolution, making it impossible to accurately monitor the dynamic pest population density. In order to prevent this, a low-cost system using battery-powered wireless visual image sensors that precisely and accurately inspect the insect population density using high resolution image is established. This technology is shown in Fig. 2 and is capable of performing routine automatic pest monitoring.

Fig. 2 Image scanning robot.

2. In their paper titled "Development and Automation of Robot with Spraying Mechanism for Agricultural Applications," Mitul Raval, Supath Mohile, and Aniket Dhandukia proposed a scientific solution to the current risks to human health, such as the use of potentially toxic substances in enclosed spaces. This is done by creating an autonomous robot that may be used in commercial farming applications for disease and pest prevention. The effectiveness of this technology is demonstrated by its capacity to efficiently spray pesticides while being controlled remotely by the farmer and to successfully traverse down the lines of a farm. The plants are consistently sprayed with the pesticide dosages indicated by this spraying method. Wireless services will eliminate and even prevent health issues caused by tiresome employment. Remote sensing, an efficient and health-conscious service, will result in a reduction in the number of resources required [4]. Using live spraying feed, the farmer is expected to wirelessly manage the robot from a distance. This robot is intended to be an all-terrain robot.

3. In their work titled "ARM-Based Pesticide Spraying Robot," Dr. S.R. Gengaje and Snehal M. Deshmukh recommended the execution of the envisioned agricultural robot, which would continuously scan the plant. Robot-mounted wireless camera that records the cropped video and transmits it to the camera station. The person operating the robot at the central station makes all operational decisions. When the user determines that the crop is flawed, the robot will be given instructions, and its kinetic will will be used to spray pesticides over the crop. The RF transceiver will carry out this. In agriculture, robots are employed for industrial uses. Robotics are mostly used in farming to replace human labor in planting, fruit picking, autonomous tractors, and sprayers. Stopping hand pesticide spraying on the actual farm is the major goal. Through the transmission of crop footage to the central station, people will be replaced by robots. Using a real-time processor, central stations keep an eye on robot motion and pesticide application. This will lessen the overuse of pesticides by the plants. The most typical application of these tools is to adapt agriculture to growing populations of people. The ARM LPC2148 can be used to implement the real-time model [5]. The device's benefits include quick speed, great quality, dependability, and affordable storage. The future design of this system will take advantage of robot intelligence. The pesticide tank capacity is increased in accordance with the farm area.

4. In controlled conditions, such as greenhouses, robots have been used to harvest cucumbers, strawberries, and tomatoes as well as to graft plants. In contrast to controlled situations like greenhouse effects, Jinlin Lin and Tony Ein's study focuses on the precise piloting of agricultural robots in open fields. This robot monitors the field using a camera and image processing methods. Three guiding lines—one for left crop lines, one for right crop lines, and one for the middle segment—are employed by the robot when determining where to place its guidelines [6]. Prior to determining the lines, the images from the camera are first processed using image processing. Early agricultural robot models exclusively used far field FOV camera setups, which were sufficient for tall plants but insufficient for little plants.

IV. METHODOLGY

This automatic pest repellent consists of two main parts, namely hardware system (hardware) and software system (software). The hardware system consists of a series of sensor circuit system and Arduino Uno microcontroller circuit system. The software is done using C language programming.

In sensing, a thermal camera has been designed to be versatile, capable of being mounted om the robot. The thermal camera scans the crops and detects the pest by a process called thermal imaging. Here the UV radiation from a hot body is used to detect the pest presence in the plant. Mechanical stabilization of the camera improves the quality of the recorded data, resulting in higher precision. Detector of a thermal camera can detect the increased temperature or temperature change by the incoming infrared radiations. IR radiation is part of the electromagnetic spectrum and is beyond the visibility of the human eye. Camera is built to detect and make use of this radiation.

With the help of motors, the rotation is done in 360 degrees. The heights adjustments are also possible as we consider plants of different heights. A tank stores the appropriate pesticide which will not harm the plant. From the tank we attach a tube which will reach the top of the system so that spraying can be done easily. The tank is placed at the bottom of the robotic arm. When the pest is detected by the thermal camera, it triggers the selective spraying of pesticides to the crops where the pest is present.

The following components were made use of during this project:

1. **Arduino UNO83**
   The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Fig. 6 Arduino UNO83.

2. **AMG8833 Thermal Camera**
   Add heat-vision to your project and with an Adafruit AMG8833 Grid-EYE Breakout! This sensor from Panasonic is an 8x8 array of IR thermal sensors. When connected to your microcontroller (or raspberry Pi) it will return an array of 64 individual infrared temperature readings over I2C. It's like those fancy thermal cameras, but compact and simple enough for easy integration.

Fig. 7 Thermal Sensor.

3. **L293D Motor Driver H Bridge**
A H bridge is an electronic circuit that allows a voltage to be applied across a load in any direction. H-bridge circuits are frequently used in robotics and many other applications to allow DC motors to run forward & backward. These motor control circuits are mostly used in different converters like DC-DC, DC-AC, AC-AC converters and many other types of power electronic converter. In specific, a bipolar stepper motor is always driven by a motor controller having two H-bridges.

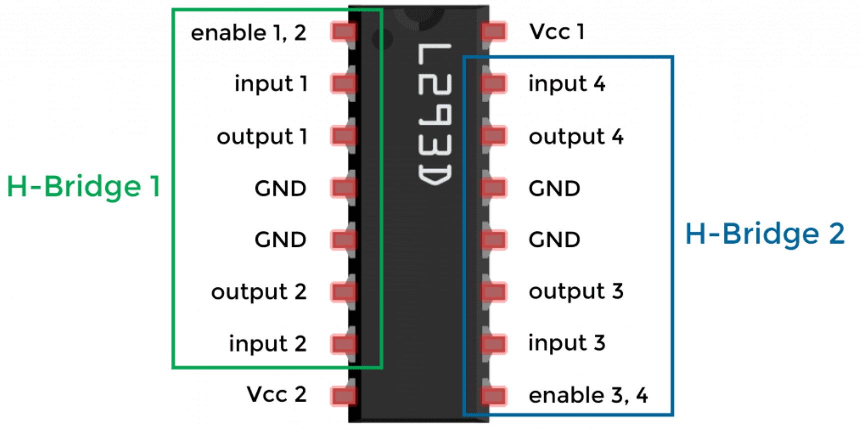

Fig. 8 Motor Driver H Bridge.

4. **Jumper Wire**
Generally, jumpers are tiny metal connectors used to close or open a circuit part. They have two or more connection points, which regulate an electrical circuit board. Their function is to configure the settings for computer peripherals, like the motherboard. Suppose your motherboard supported intrusion detection. A jumper can be set to enable or disable it.

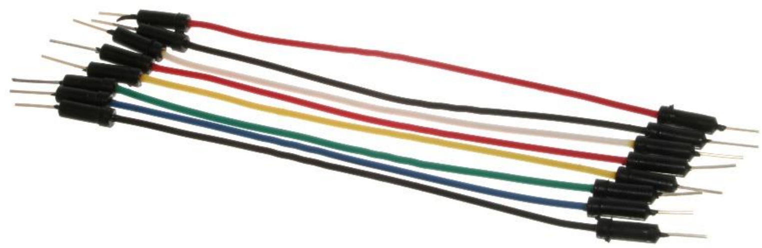

Fig. 9 4. Jumper Wire

5. **Servo Motor**
Micro Servo Motor SG90 is a tiny and lightweight server motor with high output power. Servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds but smaller. You can use any servo code, hardware or library to control these servos. Good for beginners who want to make stuff move without building a motor controller with feedback & gear box, especially since it will fit in small places. It comes with a 3 horns (arms) and hardware.

Fig. 10 Servo Motor.

III. FUTURE DIRECTIONS

Future research and development of automated vehicles for peat control in agriculture should focus on improving efficiency, reducing environmental impact, and enhancing adaptability to different soil and climate conditions. One promising direction is the development of multi-purpose vehicles that can perform multiple tasks, such as cultivation, fertilization, and harvesting. These vehicles can reduce the need for multiple vehicles and increase efficiency. In addition, new sensing and monitoring technologies can be integrated into automated vehicles to improve precision and reduce environmental impact. For example, real-time soil moisture sensors can be used to optimize irrigation and reduce water use in peatlands.

IV. CONCLUSIONS

Automated vehicles have the potential to revolutionize peatland management in agriculture, by improving efficiency and reducing environmental impact. Current trends in the development of automated vehicles for pest control include tracked vehicles and autonomous aerial vehicles. In the above work automated vehicle for pest control in agriculture we used the thermal sensors to detect the pests. In the trial run we observed that it gave good results with respect to thermal sensors. We can also have image sensor in the same setup and we are working on it. Future research and development should focus on improving efficiency, reducing environmental impact, and enhancing adaptability to different soil and climate conditions. The development of multi-purpose vehicles and new sensing and monitoring technologies are promising directions for future research.

V. REFERENCES

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