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IOT Based Fertilizer Spray Robot

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ABSTRACT: Precision agriculture is a rapidly evolving field that leverages advanced technologies to optimize farming practices. The proposed work introduces an IoT-based fertilizer spray robot Control System designed specifically for Fertilizer Spray Robots, aiming to enhance the precision and efficiency of fertilizer application in agricultural settings. The proposed system integrates Internet of Things (IoT) devices into the control mechanism of Fertilizer Spray Robots, enabling real-time monitoring and responsive control. The key components of the system include sensor nodes, communication modules, and an intelligent control algorithm. The Fertilizer Spray Robot is equipped with sensors such as soil moisture sensors and GPS units to collect crucial data from the agricultural environment. The integration of GPS technology ensures accurate positioning, enabling precise control over the application of fertilizers in specific areas of the field.

KEYWORDS: Agri Robot, Spray Mechanism, Bluetooth Control and Arduino NANO.

I. INTRODUCTION

The accelerated population growth and the continuous shortage of labor in the area of agriculture, are two of the main motivations for the growingly interest in the area of robotics and precision farming. Here, agricultural vehicles play a very important role, and a lot of research activities related to navigation, path planning and control have been increasingly taking place in the past recent years. For instance, presents anew concept with a fleet of small robots providing a solution for soil compaction in a scalable and energy-efficiently manner. In the same line of small vehicles, here we present a controller for a skid-steered robot used for corn seeding tasks. Smart farming and precision agriculture involve the integration of advanced technologies into existing farming practices in to increase production efficiency and the quality of agricultural products.

As an added benefit, they also improve the quality of life for farm workers by reducing heavy labor and tedious tasks."What will a farm look like in 50 to 100 years?" is the question posed by David Slaughter, a professor of biological and environmental engineering at UC Davis. "We have to address population growth, climate change and labor issues, and that has brought a lot of interest to technology."Just about every aspect of farming can benefit from technological advancements—from planting and watering to crop health and harvesting. Most of the current and impending agricultural technologies fall into three categories that are expected to become the pillars of the smart farm: autonomous robots, drones or UAVs, and sensors and the Internet of Things (IoT).Replacing human labor with automation is a growing trend across multiple industries, and agriculture is no exception. Most aspects of farming are exceptionally labor-intensive, with much of that labor comprised of repetitive and standardized tasks—an ideal niche for robotics and automation. We're already seeing agricultural robots—or AgBots—beginning to appear on farms and performing tasks ranging from planting and watering, to harvesting and sorting. Eventually, this new wave of smart equipment will make it possible to produce more and higher quality food with less manpower. Sowing seeds was once a laborious manual process. Modern agriculture improved on that with seeding machines, which can cover more ground much faster than a human. However, these often use a scatter method that can be inaccurate and wasteful when seeds fall outside of the optimal location. Effective seeding requires control over two variables: planting seeds at the correct depth, and spacing plants at the appropriate distance apart to allow for optimal growth. Precision seeding equipment is designed to maximize these variables every time. Combining geo mapping and sensor data detailing soil quality, density, moisture and nutrient levels takes a lot of the guess workout of these eding process. Seeds have the best chance to sprout and grow and the overall crop will have a greater harvest. As farming moves into the future, existing precision seeders will come together with autonomous tractors and IoT-enabled systems that feed information back to the farmer. An entire field could be planted this way, with only a single human monitoring the process over a video feed or digital control dashboard on a computer or tablet, while multiple machines roll across the field. Subsurface Drip Irrigation (SDI) is already a prevalent irrigation method that allows farmers to control when and how much water theircropsreceive.BypairingtheseSDIsystemswithincreasinglysophisticatedIoT-enabledsensorstocontinuouslymonitormoisturelevelsandplanthealth,farmers will be able to intervene only when necessary, otherwise allowing the system to operate autonomously.

II. LITERATURE REVIEW

Zhao andZhao[1] discussed the Eye-in-hand camera was used to precisely determine spray position of each crop. Based on the center and area of 2D minimum-enclosing-circle (MEC) of crop canopy, a method to calculate spray position and spray time was determined. In addition, locating algorithm for the MEC center in nozzle reference frame and the hand-eye calibration matrix were studied. The processing of a mechanical arm guiding nozzle to spray was divided into three stages: reset, alignment, and hovering spray, and servo method of each stage was investigated. For preliminary verification of the theoretical studies on the approach, a simplified experimental prototype containing one spray mechanical arm was built. The results showed that the prototype could achieve the effect of “spraying while moving and accurately spraying on target.”

Castellano and ManzanoAgugliaro[2]elaborated the Review on proposed the use of vehicles to control pests and crop diseases is needed to maintain agricultural production. This paper describes how to design and implement a low cost intelligent telecontrol system applied for agricultural machinery that are designed for use in places where human presence is not adequate, such as pesticide spraying tasks in farming environments as green houses. The intelligent telecontrol system acts as a security system to protect against outsiders, and loss of communications due to fading or others interference. Related to the classic remote control, our system protects from potential over sights of the operator. In addition, in the proposed system, the vehicle state is shown in the console, due the bidirectional communications. The originality of this system is based onthefactthatitis10 times cheaper than autonomous systems; those systems need electronic systems, GPS, a complex sensorial system, and a beforehand mapping performedonthenewworkenvironment.The system was successfully applied in prototype vehicle used for spraying tasks, and the result shows that the system operated stably and has confirmed the effectiveness of this intelligent telecontrol system. The proposed technology will help providing solutions for humans and robots working together in agricultural environments considered to be harmful to human.

Oberti et al. [3]discussed due to their recognized role in causing environmental pressures, the need to reduce production costs and public concerns over the healthfulness of fresh products and food, reducing pesticide use in agriculture is a major objective. In current farming practice, pesticides are typically applied uniformly across fields, despite many pests and diseases exhibiting uneven spatial distributions and evolving around discrete foci. This is the fundamental rationale for implementing the selective targeting agricultural robot developed within the EU- project crops. The crops manipulator was configured to six degrees of freedom and equipped with of pesticideapplicationssuchthatpesticidesaredepositedonlywhereandwhen they are needed and at the correct dose. This approach is explored using the example of powdery mildew on grape vines controlled by means of a modularanewprecision-sprayingend-effectorwithanintegrateddisease-sensingsystembasedonR-G-NIRmultispectralimaging.Theroboticsystem.

Berenstein and Ben-Shahar[4] discussed explained Image registration is the process of aligning two or more images of the same scene taken at different times; from different viewpoints; and/or by different sensors. This research focuses on developing a practical method for automatic image registration for agricultural systems that use multimodal sensory systems and operate in natural environments. While not limited to any modalities; here we focus on systems with visual and thermal sensory inputs. Our approach is based on pre- calibrating a distance-dependent transformation matrix (DDTM) between the sensors; and representing it in a compact way by regressing the distance- dependent coefficients as distance-dependent functions. The DDTM is measured by calculating a projective transformation matrix for varying distances between the sensors and possible targets. To do so we designed a unique experimental setup including unique Artificial Control Points (ACPs) and their detection algorithms for the two sensors. We demonstrate the utility of our approach using different experiments and evaluation criteria.

LiuandLi [5]described Variable rate spray, which has extensive developing prospects, has become an important part of precision agriculture. Thispaperreviewstheresearchandapplicationofvariablespraytechnologyin weed control. According to weed information source, it can be divided into two types: map based and real- time sensor based, machine vision and image processing used as a weed detection means is developing faster and faster.Therearemainlythreedifferentwaysofvariablespray:changingthesystempressure,direct injection, and PWM (Pulse Width Modulation),but there have been variable nozzles in recent years. Weed detection means and ways of variable spray vary from each other, but all for the purpose of refinement of weed management and herbicide savings.

Zhang andLiu[6]achieved accurate mechanical inter-rows weeding, an agricultural implement guidance system based on machine vision was designed. The guidance system consists of a color video camera, an industrial panel PC, a lateral displacement controller, a GPS receiver, a hydraulic system, and an agricultural implement. To improve the accuracy and reliability of the guidance system, the choice of color space, the method of guidance line detection, and the method of controlling the implement were investigated. First, considering the adverse effect of illumination variation on image processing, the HIS(hue, saturation, intensity)color model was used to process images, and a threshold algorithm based on the H component was used to produce gray scale images. Second, according to the characteristics of the crop row sin the image, a method of crop line identification based on linear scanning was proposed. To approximate the trend of a crop row in the image to a line, pixels at the bottom and top edges of the image were selected as two endpoints of the line. Candidate lines were created by moving the position of these endpoints. The line with the most target points was regarded as the crop line. Finally, fuzzy control was used to control the agricultural implement. This algorithm can effectively control the agricultural implement tracking the guidance line. Path tracing experiments were conducted at three different speedsof0.6, 1.0and1.4 m/s in the cornfield on a sunny day. The maximum lateral errors were 4.5 cm, 5.5 cm and 6.8 cm at the three speeds. The average lateral errors were less than 2.7 cm for all speeds. The experimental results demonstrated that the guidance system successfully adapted to changes in natural light and had good dynamic performance at all speeds.

Millot andSaiz-Rubio[7] implemented the technology in European vineyards is occurring at a slower pace than in newer production zones such as Australia, Chile, South Africa, or the USA, where vast production fields favor the incorporation of automated systems. The Vine Robot project emerges with the purpose of enhancing the management of vineyards through the combination of robotics, precision farming, and information technology. The project is sponsored by the European Commission, and aims at designing, developing, and deploying a novel use-case agricultural robot endowed with non-invasive biosensors to map vegetative growth in vines and red grape maturity. This paper explains the navigation strategies devised forthe robot in its autonomous motion along the rows and provides the first-year results on automatic steering using a stereoscopic vision camera as primary sensor for surroundingawarenessandtrajectorysearch[7].Thevisionmodelconfinesthe robot universe into a set of situations occurring inside a look-ahead space 5-m wideand8-mlongattheheightoccupiedbythevinecanopy.Fieldexperiments conducted in 2015 in a commercial vineyard showed stable behavior for low speed and revealed important sources of errors at higher speeds due to significant differences between vision- calculated angles and measured wheel angles. In addition to the effect of mechanical components in the navigation results, row perception was occasionally challenged by adjacent rows when canopy gaps appeared along the way. The Vine Robot project emerges with the purpose of enhancing the management of vineyards through the combination of robotics, precision farming,andinformationtechnology.TheprojectissponsoredbytheEuropean Commission, and aims at designing, developing, and deploying a novel use- case agricultural. Implemented the technology in European vineyards is occurring at a slower pace than in newer production zones such as Australia, Chile, South Africa, or the USA, where vast production fields favor the incorporation of automated systems. The Vine Robot project emerges with the purpose of enhancing the management of vineyards through the combination of robotics, precision farming, and information technology. The project is sponsored by the European Commission, and aims at designing, developing, and deploying a novel use-case agricultural robot endowed with non-invasive biosensors to map vegetative growth in vines and red grape maturity. This paper explains the navigation strategies devised for the robot in its autonomous motion along the rows and provides the first-year results on automatic steering using a stereoscopic vision camera as primary sensor for surroundingawarenessandtrajectorysearch.Thevisionmodelconfinesthe robot universe into a set of situations occurring inside a look-ahead space 5-m wideand8-mlongattheheightoccupiedbythevinecanopy.Fieldexperiments conducted in 2015 in a commercial vineyard showed stable behavior for low speed and revealed important sources of errors at higher speeds due to significant differences between vision- calculated angles and measured wheel angles. The Vine Robot project emerges with the purpose of enhancing the management of vineyards through the combination of robotics, precision farming,andinformationtechnology.TheprojectissponsoredbytheEuropean Commission, and aims at designing, developing, and deploying a novel use- case agricultural spray: changing the system pressure, direct injection, and PWM (Pulse Width Modulation), but there have been variable nozzles in recent years.

III. EXISTING SYSTEM

This project is part of a non-going research aimed to replace the traditional spraying methods with an agricultural robotic sprayer. The robot navigates autonomously along the vineyard rows and performs specific spraying toward detected targets. For site-specific spraying the target must first be detected and then sprayed. This research focuses on the spraying process to completely cover the target while minimizing the amount of material sprayed. On-going research focused on the target detection and on the development of a fully operational agricultural spraying robot. The diameter of the sprayer is set according to the shape and size of the targetliketherecentlyproposedpatentthatsuggestsachangeablenozzle aperture. However, in existing approach was designed, built, and implemented in real-world conditions and included experimental procedures and experiments for evaluation and validation of the spraying device for agricultural amorphous shapes and variable-sized targets.

IV. PROPOSED SYSTEM

The spraying device (SD) was designed and built as an experimental tool to implement the One Target–One Shoot (OTOS) spraying method. The device is mounted on a mobile robotic sprayer and supplies pressurized pesticide. A pesticidesprayingmechanismwiththehelpofcurrentroboticstechnology is the main purpose of this project which would

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help the farmer in his day-to-day spraying activity. This project is basically a robot with an attached spraying mechanism and is divided into two parts. First, we started by designing the chassis for our robot. Our main challengewastodesignanadjustablechassiswhichcouldcarryaloadof1Kg, so for it we used iron as the metal for chassis. But the chassis itself weighed 1Kgs, so in order to avoid excessive weight of the device, iron has not been used as the only metal in the chassis of the device.

4.1TRANSMITTER MODULE

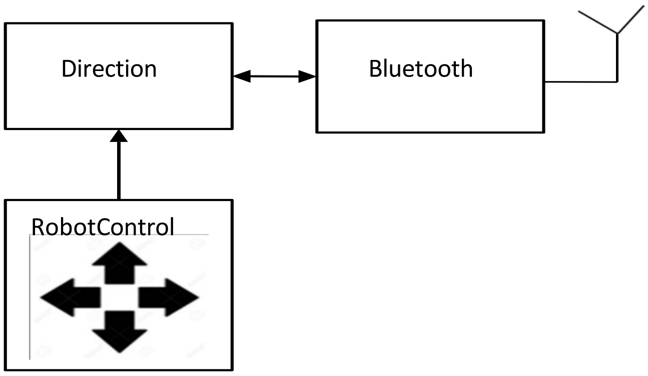

Figure1.TransmitterModule

1.2 RECEIVERMODULE

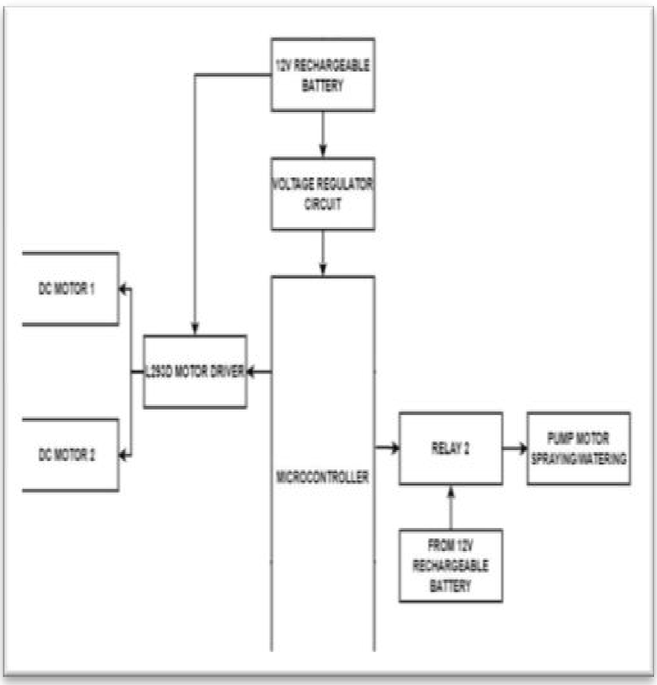

Figure2.ReceiverModule

4.3 ARDUINO NANO

Figure3. Arduino Nano

Arduino Nano controls the other componentsRaspberry Pi, motors, motor driver module, ultrasonic sensor.

4.4. L298N DRIVER MODULE

Figure4. L298n Driver Module

Useful in robotics application, bidirectional DC motor controller and stepper motor driver.

4.5 DC GEAR MOTOR

Figure5. DC Gear Motor

The DC Grear Motor was moved to the rover forward, backward, left, and right.

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V. RESULTS ANDDISCUSSION

The proposed work of simulation results by using Proteus software.

5.1 SIMULATION RESULTS

The key outcome of the project is the achievement of accurate fertilizer dropping. The robot's servo motor-controlled fertilizer dispenser mechanism ensures precise placement and optimal contact, ultimately leading to improved germination rates and crop yield. Moreover, the integration of a sensor allows the robot to monitor thecontent in the soil effectively.

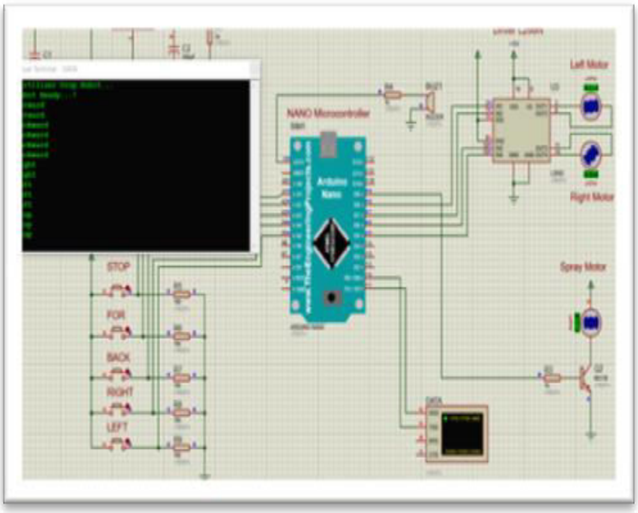

Figure 6.Simulation Result of ReceiverModule

The robot's ability to follow predefined paths accurately is critical for efficient seed sowing operations. The integration of a Bluetooth module facilitates wireless communication between the ag-robot and external devices such as smartphones or computers. This wireless control and monitoring capability allows users to remotely control the robot, send commands, and receive real-time data and feedback regarding the robot's operation and status. This feature provides convenience and flexibility for farmers and agricultural practitioners. The robot's servo motor-controlled fertilizer dispenser mechanism ensures precise placement and optimal contact, ultimately leading to improved germination rates and crop yield. Moreover, the integration of a sensor allows the robot to monitor the content in the soil effectively.The key outcome of the project is the achievement of accurate fertilizer dropping. The robot's servo motor-controlled fertilizer dispenser mechanism ensures precise placement and optimal contact, ultimately leading to improved germination rates and crop yield. Moreover, the integration of a sensor allows the robot to monitor the content in the soil effectively. The robot's ability to follow predefined paths accurately is critical for efficient seed sowing operations. The integration of a Bluetooth module facilitates wireless communication between the ag-robot and external devices such as smartphones or computers. This wireless control and monitoring capability allows users to remotely control the robot, send commands, and receive real-time data and feedback regarding the robot's operation and status. This feature provides convenience and flexibility for farmers and agricultural practitioners.

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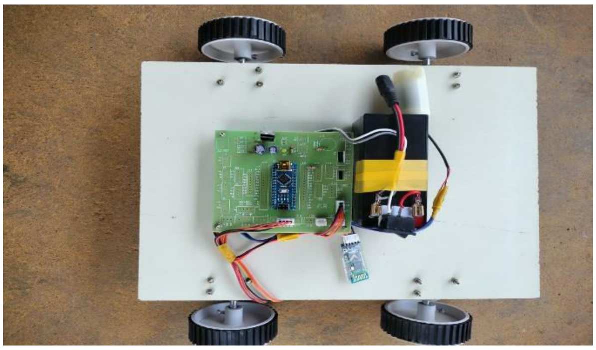
5.2 HARDWARE RESULTS



The implementation of the proposed IoT-based fertilizer spray robot Control System yielded significant outcomes in enhancing precision agriculture practices. By seamlessly integrating advanced technologies into the control mechanism of Fertilizer Spray Robots, the system enabled real-time monitoring and responsive control. The key components, including sensor nodes, communication modules, and an intelligent control algorithm, collectively contributed to the success of the system.Equipping the Fertilizer Spray Robot with sensors such as soil moisture sensors and GPS units proved instrumental in collecting crucial data from the agricultural environment. The continuous monitoring of soil moisture levels by IoT-enabled sensors and the transmission of this data to a centralized control system exemplified the system's effectiveness.The control system, driven by an intelligent algorithm, demonstrated proficient decision-making capabilities regarding the activation and deactivation of the fertilizer spray mechanism on the robot. This strategic approach ensured that the application of fertilizer occurred precisely when and where needed, leading to optimal resource utilization.The integration of GPS technology played a crucial role in achieving accurate positioning, thereby facilitating precise control over the application of fertilizers in specific areas of the field. These results collectively signify the system's effectiveness in advancing precision agriculture through innovative hardware solutions.

5.3 ADVANTAGES

- Wireless operation will eliminate the health issues and would even save them from tedious work.
- Itwillhavelessuseofmanpower.
- Efficientandhealth-consciousoperationduetoremotesensing.
- Withthehelpoflivefeedofsprayingthefarmerisexpectedto control the robot wirelessly from a distant place.
- Spraying robot can benefit agriculture in many ways, including increased precision, effectiveness.

VI. CONCLUSION

The proposed work an easy code implementation not only for the simulation, but also into the embedded ECU. An intelligent robot system spraying pesticides, to control the robot through a wireless alternative to manual completion of plant spray test, reducing direct exposure to pesticides andthehumanbody,reducepesticideharmto people,andimproveproduction efficiency.Bygood,canbedifferentterrain,differentheightscropsbyspraying operation tests show that a certain protective, practical, mobile robot, better spray effect at the right working environment, such Its low cost, ease of handling and easy maintenance and other characteristics of individuals with a broadmarketinagriculturalproduction.TheintegrationofaBluetoothmodule facilitates wireless communication between the ag-robot and external devices such as smartphones or computers. This wireless control and monitoring capability allows users to remotely control the robot, send commands, and receive real-time data and feedback regardingthe robot's operationand status. This feature provides convenience and flexibility for farmers and agricultural practitioners. An intelligent robot system spraying pesticides, to control the robot through a wireless alternative to manual completion of plant spray test, reducing direct exposure to pesticides and the human body, reduce pesticide harm to people, and improve production efficiency.

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