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Sensing and Spraying Technique for Automated Sprayer Robot

Komal Singh[1], Pradnya Valanju[2]
[1, 2]*Electronics and Communication Engg, Maharashtra, India*

Abstract: ***Off-target loss due to manually spraying of pesti- cide over weeds results in destruction of the healthy crops, and it is considered as one of the major issue in agriculture. Sprayer automated weeder is an autonomous four-wheeler robot, with a unique sensing-spraying technique. Precision farming technique has been implemented. Robot will travel between the crop rows in straight path. An array of programmed sensors and sprayers are used to sense weeds and ,spray precise amount of pesticide . Robot is cost efficient when compared to the machines used in large scale agricultural sites.***
Index Terms: Off-target loss, precision farming, array of programmed sensors and sprayers.

I. INTRODUCTION

Weeds are the undesirable plants that grow wherever they want to. They grow in a place where they find proper warmth and moisture and compete with the crops for their moisture, nutrients and sunlight, and hence degrade the quality of healthy crops. Weed control is a significant issue in agricultural crop production. People in India use backpack type sprayer. Their pesticide tank has a maximum capacity of 15 litres and spray manually with a nozzle in one hand while pump on the other hand is used to spray the pesticide. Manually spraying of chemicals on weeds help in killing them however have a negative impact on the crops, as some chemicals may drip onto them, leading into degrading the quality of crops. Many surveys and experiments have revealed that excessive use of pesticides, fungicides, and herbicides results in emission of chemicals onto soil, crops and air and this results in adverse effect on human health and environment . Generally three main spraying patterns are currently used, those are broadcast, band, and target spraying. The traditional method of broadcast spraying is considered to be inefficient because an entire area is sprayed regardless of whether there are targets or not, present in that area. This approach has resulted in up to 60-70 percent of off-target losses. To reduce waste and environmental pollution stemming from off-target losses, band and target spraying methods were developed. In band spraying, only selected regions are treated. Experimental results in the field showed that band application and mechanical practice can reduce chemical use and impose minimal environmental effects. The target spraying system involves the detection of damaged or infected plots or plants in the field, and features real-time control of sprayer operation. Precision agriculture is a form of band spraying technique which is incorporated in many area outside India. Using precision farming only selected area is treated with chemicals which will reduce off-target losses and pesticide loss . To locate target, GPS and camera based techniques are used. Large machines and drones are used for spraying on large scale sites. GPS and camera based system is an expensive technique. So, sensor based target locating systems like ultrasonic sensors, IR sensors are used to detect the presence of the weed in the form of obstacle but will not precisely tell about how much weed is spread over a specific range of area. So color sensor based weed detection technique is implemented. Array of sensors is used so that if weed is of minute area, sensor can sense specifically that area. Automated array of sprayers are used which precisely spray on the dedicated area so as to reduce the disadvantages caused by conventional sprayers. This prototype can be used in small scale as well as large scale sites and is comparatively cheaper than the machines that use GPS and camera based tracking systems.

II. LITERATURE SURVEY

A cascade and programmable true color sensor is used for real time identification and of weed and crop plants. PR0126C sensor though expensive yet accurate is used. It has filters for any change in response of the reflected light. The sensor has 19-diode hexagon color IC.[1] Ultrasonic sensor was used to detect the presence of weed as an obstacle while moving along the field and an automated spraying mechanism is implemented with the help of relay driver to spray pesticides. Solar panel was mounted to power the machine[2]. An automatic robotic arm to monitor the growth of the plant in laboratories was developed where sensors used a compact color zoom camera and RGB color sensor to monitor the color change of leaves. These sensors were calibrated for better working. Color sensor give information about the health status of tissue by comparing sensor output with predetermined optimum values[3].

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Automatic Toward- target Sprayer was developed with two IR sensors on each side of the machine, to detect fruit trees. After the target is detected, its position is stored in the memory and then sprayer valve is triggered to spray on the target when the tractor reaches the location[4].

Automatic color sorting machine used TCS230 to detect the RGB color individually and with the help of motors, different color caps were sorted and kept on the respective container.

TCS230 uses frequency of different colors to detect them[5]. Variable rate sprayer was developed for precise spraying with the help of laser scanning technique. It controls nozzles flow rate individually based on the size of the target tree canopy in real time and array of sprayers spray differently.

Data processing algorithm was developed to use the data from the laser scanner to know the size of the canopy[6]. A laser scanning high speed sensor methodology was developed for data acquisition of the target tree canopy vertically, and variable-rate sprayer with automatic nozzle service and was manipulated by algorithms for flow control[7].

Precision farming technique holds a value in field through which we can reduce off- target losses and wastage of pesticides and protect crops from harmful effects. Color sensors can be used as an inexpensive method to detect weed unlike the modern methods like GPS and camera based technology.

III. PROPOSED SYSTEM

An autonomous four wheeler movable cart with unique sensing-spraying technique is designed. This robot will be used for weed killing purpose with precise pesticide spraying reducing off-target loss. Robot use array of color sensors which detect the green color of the weeds based on the frequencies received and segregate them as red, green and blue. Three different types of motors are used for achieving the target.

Four DC motors are used for four wheels to travel in a straight path. A servo motor is used, on which a plank is attached. At one end of the plank color sensors are attached and at the other end sprayers are attached. Servo is programmed to move in 180 degree motion back and forth. When sensor senses weed, servo rotates 180 degree clockwise and then spraying is done. And servo moves back to the original position. Entire servo system is mounted on a pulley based conveyor belt which moves the servo system in horizontal direction in steps.

A. Algorithm

1) Power ON the cart
2) DC motor triggers the wheel to move forward
3) Set Counter N=2
4) If weed is sensed YES: Servo rotates 180 degree clockwise If Sensor1 senses- Sprayer1 sprays If Sensor2 senses- Sprayer2 sprays If Sensor3 senses- Sprayer3 sprays If Sensor4 senses- Sprayer4 sprays If Sensor1 and 2 senses- Sprayer1 and 2 sprays If Sensor1 and 3 senses- Sprayer1 and 3 sprays If Sensor1 and 4 senses- Sprayer1 and 4 sprays If Sensor2 and 3 senses- Sprayer2 and 3 sprays If Sensor2 and 4 senses- Sprayer2 and 4 sprays If Sensor3 and 4 senses- Sprayer3 and 4 sprays NO Process is repeated from step 2
5) Servo rotates anti-clockwise
6) Stepper moves the pulley in horizontal direction(N=N-1)
7) If N=0
8) YES: Repeat process from step 3
9) NO: Repeat process from step 2

B. Sensing and Scanning

1) *Sensing Mechanism:* Texas based color sensor TCS3200 is used for weed detection purpose. Array of four color sensors aligned in 5cm*6cm fashion. This array of sensors will sense weeds individually and give pulse to the controller. TCS3200 is programmable color light-to-frequency converters that combine configurable silicon photo diodes and a current- to-frequency converter on a single monolithic CMOS integrated circuit[5]. In TCS3200, the light-to-frequency converter reads an 8 x 8 array of photo diodes. Sixteen photo diodes have blue filters, 16 photo diodes have green filters, 16 photo diodes have red filters, and 16 photo diodes are clear with no filters. Black and white balance sensor readings were taken at different intervals of time because the response of sensor changes due to changing ambience, so calibration needs to be done hence calibrated value was fed into the memory for red, green and blue color.

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Time	Color Balance	Red	Green	Blue
12.00pm	Black ,	447	463	303
	White	45	46	30
2.30pm	Black	241	290	202
	White	32	35	25
4.00pm	Black	150	132	126
	White	69	102	96
5.30pm	Black	176	205	171
	White	130	201	169

Table I. Tabulated Results Of Sensor Values

Average of table's value will be taken:

a) Red

White Balance: 253.5

Black Balance: 69

b) Green

White Balance: 272.5

Black Balance: 96

c) Blue

White Balance: 200.5

Black Balance: 80

According to the readings of Table I, the nearby sensor values are feed into the memory.

2) *Spraying Mechanism:* Programmable sprayers are used to spray upon the weed. Array of sprayer is used which is controlled by relay and controller. The alignment of sprayers is similar to the sensors. As these sprayers receives input from the controller only that sprayer nozzle will get open which has got a high input from its respective sensor.

IV. CONCLUSION

Robot was tested in different ambience and different crop conditions, and found that it worked efficiently in the farmland where weed are distributed in a straight path like in the chilly farm or corn farm. Machine learning can be included to make the robot more efficient in identification of difference between weed and crop.

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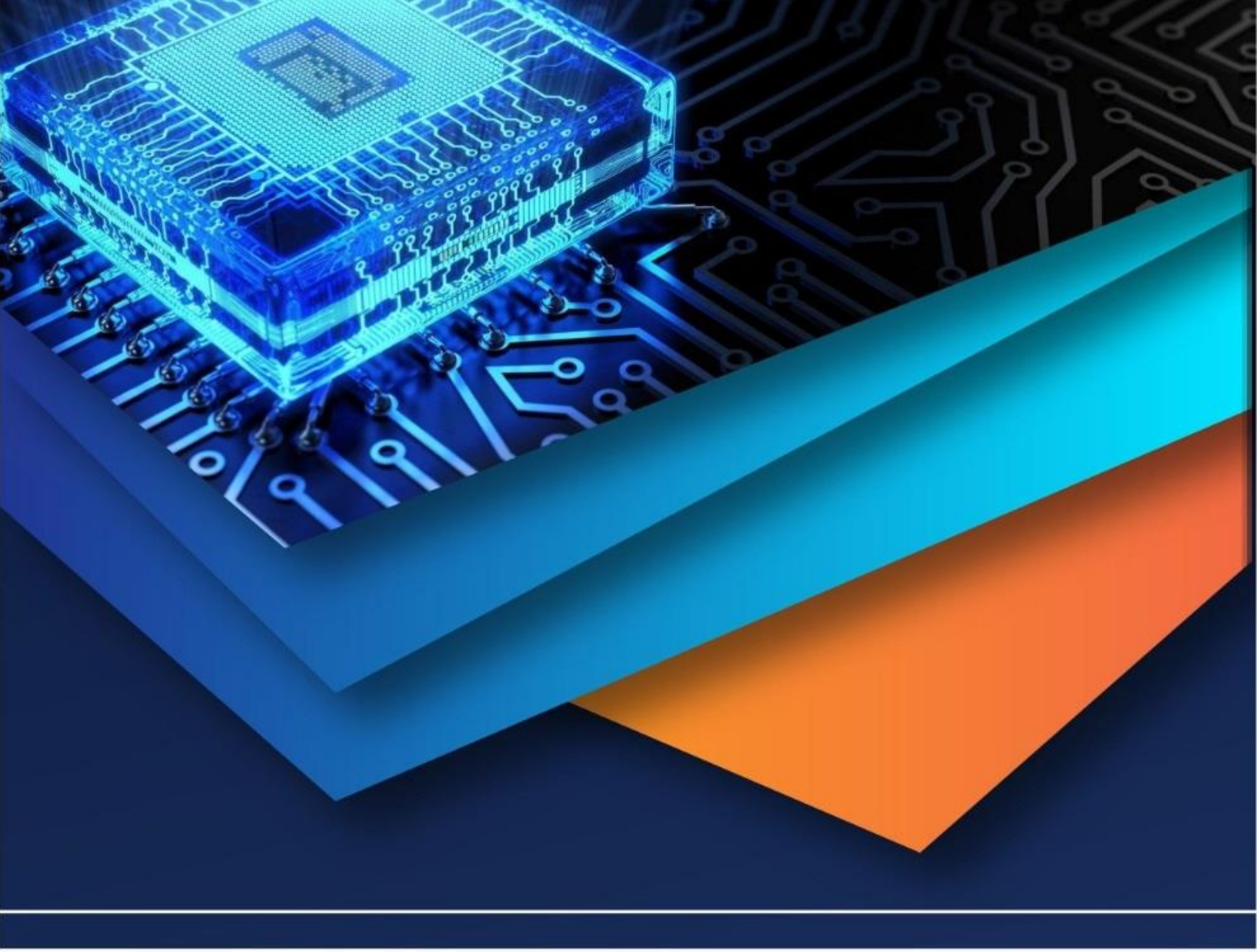

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