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High Precision Emplacement Sensing Subsystem and Weed Removing Rover Using Arduino

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Abstract- In this project, weeds are removed in a semi-structured cultivated field using Arduino microcontroller. The main objective is to cut the weeds precisely which is grown near to the cultivable plant and collect it separately. A static camera is mounted for taking the images of a segment of the field. Coordinates of the weeds present in that segment is detected by IR sensors. The IR sensor uses electromagnetic radiation and thermal radiation. It consists of IR photodiode and IT LED (Light Emitting Diode). The coordinates of the weeds obtained from camera are communicated to the robot finally for cutting the weeds. This rover uses line follower technology for navigation as it is an autonomous system. It is used as a substitute for human workers to perform the weed removal process. It uses line follower technology for moving in a particular order in the crop field. This system will be monitored by smartphone through Wi-Fi module.

Keywords:- Line follower, IR sensors, IR detection system, Wi-Fi module, navigation.

I. INTRODUCTION

Every one depends on the agricultural foods in all over the world. The farmers are looking for new technologies to overcome the difficulties such as less availability of labor and high labor cost while using man power. In these days, the farmers are expected to produce high quality yields at low expenses with less dependent on labor forces. Weeds will degrade the crop, if it is not removed within the short span of time hence the routine process of hoeing weeds will produce the high yield.

Weed picking by manual method is a tedious and repetitive task. The main crops will be affected while using weedicide or herbicide for removing weeds from field. They reduce crop yield by competing for water, light, soil, nutrients and space. It also reduces crop quality by contaminating the commodity.

To overcome these problems, we have designed a robot using Arduino to detect and remove weeds aimed at less consumption of manual labor.

II. PROPOSED SYSTEM

In the proposed system we have designed the automated agro rover for removing the weeds from the crop field. That is this rover will automatically detect the weed and remove it from the crop field. It uses line follower technology for navigation around the crop field. This helps in reducing the weeds which acts as the barriers for the growth of the main crop.

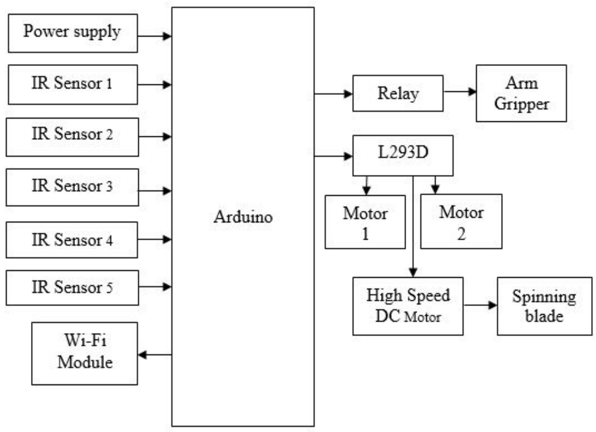

Fig 1. Block Diagram.

Fig 2. Flow Chart.

While using this agro rover the chemicals such as weedicide and herbicides, which affects the health of the main crops too, are not used here. Hence, the main crop will be in good quality and it will be healthy for people.

The rover is first placed in the crop field and gets started to move by the line follower technology and it finds the weed by using sensors. The line follower technology is a technology which follows a certain path and which is controlled by a feedback mechanism.

The weeds are identified and located by the sensors. Then the arm gripper will point the weed, moves towards to it and then plug it. As the arm gripper is able to rotate about 180°, it will plug the weed which is present in 180° area around it. Additionally a spinning blade is also attached under the base of the rover to cut the weed. That blade is connected to a high speed DC motor in which the height of the blade is adjustable for weed's height. The dimension of the crop field will be injected to the rover and so it will not move to the other fields as the rover is automated.

The camera is mounted on the rover. It is used to capture the video while the rover is working in the crop field to monitor that whether the rover will do the work properly by using mobile itself through Wi-Fi module. The block diagram of the rover is given below.

1. Arduino Uno:

The Arduino Uno is a microcontroller board based on the AT mega-328. It has 14 digital I/O pins (out of which 6 can be used as Pulse Width Modulation outputs), a power jack, 6 analog inputs, an USB connection, a ceramic resonator of 16 MHz, a reset button and an ICSP header.

It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

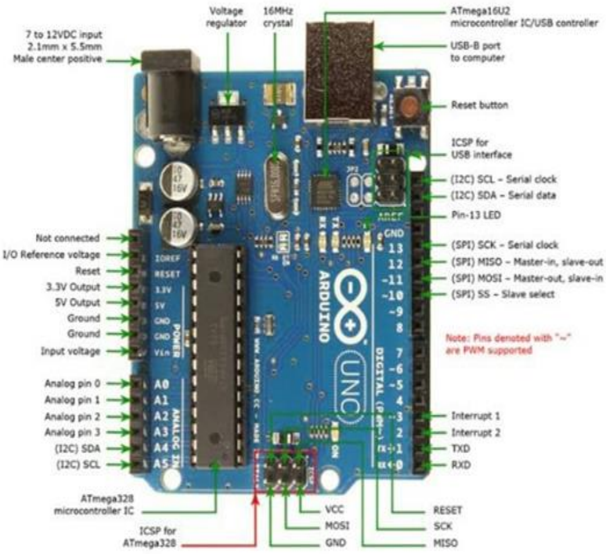

Fig 3. Arduino UNO.

2. Line Follower:

Follower robot is a mobile machine that can follow a path. The path can be a visible black line on a white surface (reverse), in order to lead a robot Trackback. Used the PIC18F458 from Microchip (40 pins). The robot uses 4 IR LEDs (Tx) and 4 IR sensors (Rx) with distance between the two sensors is 25 mm.

The first Rx receives an analog signal that depends on the intensity of light reflected by the black line of emitted beam by the TX. These signals are sent to the MCP comparator which creates digital signals (0 or 1) that are sent to Microcontroller PIC.

The created signals by comparator are digital, with each set of formed digital signals by MCP, and activities of microcontroller robot knows how follow correct drawn line. The table 2 defines the codes for the directions of the rover on the black line and the table 3 defines the codes for the directions of the rover on the white line.

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Table 1. Features of Arduino Uno.

Microcontroller	AT mega-328
Operating Voltage	5 V
Recommended Input Voltage	7-12 V
Input Voltage limits	6-20 V
Digital I/O Pins	14 (out of which 6 pins provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 Ma
DC Current for 3.3 V Pin	50 Ma
Flash Memory	32 KB (out of which 0.5KB is used by boot loader)
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz

Table 2. Follow a black line.

Rx1.Rx2.Rx3.Rx4	Actions of robot
0000	Stop
0110 0100 0010	Go straight
1100 1000	Turn right
0011 0001	Turn left

Table 3. Follow a white line.

Rx1.Rx2.Rx3.Rx4	Actions of robot
0000	Stop
1001 1011 1101	Go straight
0011 0111	Turn right
1100 1110	Turn left

III. RESULTS AND DISCUSSIONS

The proposed weed control rover is evaluated on both the automated weeding rover and the selective sprayer in a real-world field with flat and rough terrain areas.

To evaluate the automated weed removal, real leaves are chosen as targets, and we manually count the successful stamping rate after execution as the performance metric. The stamping evaluation is performed in an outdoor environment better. For short-path tests, we use 5 to 10 per m2targets and repeat such test for 10 times for each test speed.

To evaluate selective spraying, we set up a webcam to monitor weeds after spraying. Due to this simple monitoring method, the evaluation of selective spraying can be done with a full-row operation by counting the successful execution rate manually afterward from the recorded video.

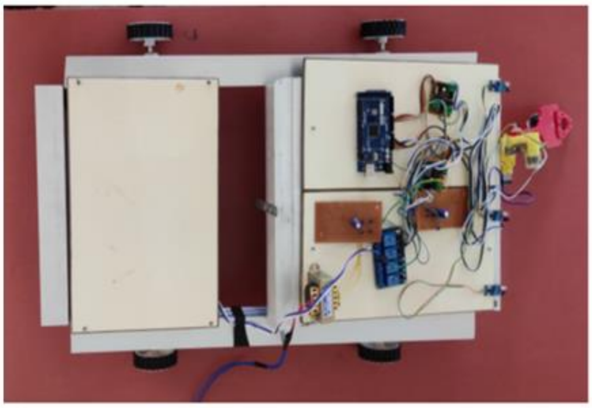

Fig 4. Hardware snapshot.

Table 4. Treatment rates for stamping.

Stamping			
Velocity (m/s) & Region	0.05	0.1	0.2
Flat	112/113	99/102	90/91
Rough	120/121	84/86	93/94

Table 5. Treatment rates for spraying.

Spraying			
Velocity (m/s) & Region	0.05	0.1	0.2
Flat	125/125	124/124	129/129
Region	120/121	111/112	118/119

Since we use labors for weed detection and removing method, the more labors should be hired for this purpose and it leads to high cost for rent which is given to labors we hire.

Sometimes they are not available too. Hence the main crop will be degraded as weeds acts as barriers for the growth of crop in the field. The following table will show the parameters of our proposed system and manual weed detection and hoeing system.

Table 6. Comparison of parameters between manual and automated rover method.

Parameters	Manual method	Proposed method
Time consumption	More	Less
Labors	More numbers of labors are needed	No need (Automated)
Accuracy	88%	94%
Cost	High cost (as pay for the labors we hire)	Low cost (need not to pay for labors as it does not need labors to hire)
Energy consumption	More	Less
Repetition process	Does not proceed after sometime as labors get tired	Proceeded in regular interval of time

Repetition process Does not proceed after sometime as labors get tired Proceeded in regular interval of time. Sometimes we use chemicals such as weedicide and herbicides for controlling the weeds. This will affect the health of the main crop and degrade the quality of the soil.

Table 7. Health parameters of soil and crop.

Parameters	Manual method	Proposed method
Usage of chemicals	More	No need to use
Health of the main crop	Good	Best
Health of the soil	Degraded slowly	Healthy

But by using our proposed agro rover, the main crop will grow healthy and it is healthy to the people. The crop will grow in less time as it removes the weeds periodically.

IV. CONCLUSION

This paper is an idea of Automated Agro Rover which is navigated through the cultivated field for weed detection and removal operation. The great advantage of this proposed system is that the farmers can enjoy weed-free and chemical-free farms. It focuses on reducing farming cost as well as increasing crop production in less time.

Instead of finding the weeds periodically by the farmers in the large field, the rover will locate each weed and remove it by using gripper mechanism. This is the main advantage of this automated rover system. This is helpful to save money, labor, physical efforts for economical cultivation and lots of time to the farmers, and they can focus on other agricultural requirements for the growth of crops.

V. FUTURE WORK

The proposed system can be modified for future application. In advancement of weed detection and removing process, some arrangements can be made to avoid mud stuck in between the teeth/blades, tires and wheels and made all weatherproof fittings for suitable to all weather conditions. There is need to be made to have inbuilt adjustability to change the width of working of the rover. Further development of the technology may make it possible for a robot with similar technology to weed any field in agriculture.

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