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Automatic Weed Removal System

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***Abstract*: This paper addresses a new system which can be implemented in agriculture processes. An electronic system improves different agriculture processes like weed control, cultivation, harvesting, spraying by using autonomous vehicle which increases speed, accuracy and life. We have developed a robotic vehicle having four wheels and steered by dc motor and IR sensor arrangement. This vehicle will control the weeds in the farm by considering particular rows per column at fixed distance depending on the crop and also detects the obstacles present in the path of vehicle. The whole algorithm, calculation, processing, monitoring are designed with motors and sensors interfaced with microcontroller.**

***Keywords*: Researching, designing, and new robots**

1. Introduction

Today, robotics is a quickly growing field, as technological advances continue; researching, designing, and producing new robots serve numerous practical grounds, whether domestically, commercially, or militarily. Applying automation to agriculture has assist create numerous improvements to the industry while helping farmers save money and time. Agricultural Robots or agribot is a robot employed for agricultural purposes. The main area of application of robots in agriculture is at the harvesting stage. These have many benefits for the agricultural industry, including a higher quality of frozen produce, low production cost, and a smaller need for manual labor. The main purpose of this paper is to design automatic detection and weed removal system using the machine vision to achieve guidance along the field, identification of crops from the captured image by camera and removal of weeds in the agriculture field. Controlling the weeds in the agriculture field is a big deal in agriculture crop production. Maximum 90% of weeds are controlled by using herbicides (chemical weed killer). Reducing herbicide options, fear of ground water contamination, and customer pressure to ignore herbicide use, are all pushing the farmers to away from reliance on herbicides. Hand weeding is also not effective and not suitable for wide range. To overcome these problems in weeding, automatic detection and weed control system detects the weeds in the field and remove it mechanically. This system uses two machine vision systems: one to guide the agriculture robot along the field and another is to identify the crops and weeds by its color and shape parameters. Weed removal is achieved with mechanical hoe. Weeds in the inter row and within row also removed by this hoe and rotating disc. This system is highly useful to replace the usage of herbicide and the shortage of labors.

2. Experimental farming process elements of the robotic weeding system

The following descriptions are organized as work packages within the robotic weeding project. Different cooperation partners are responsible for achieving the specific package aims.

A. Seed geo-referencing

A map of geo-referenced seeds can be created by integrating a highly accurate positioning system with seed detection sensors on each seeding unit of the machine. During the seeding operation, the positions of seeds dropped into the furrow are logged and stored in a computer memory.

B. Plant recognition

The identification of the central positions of the plant (ideally the position in which the stems penetrate the ground) and the identification of the positions of the leaves of the plant is an important prerequisite for the operations of robotic compensation. To physically remove or treat weeds with minimal crop damage, it will be necessary to obtain accurate information on the location of crops and weeds. System integration includes definitions of weed control parameters and specifications of the technical framework. The target areas of attention for the weeding system will be the areas within the row and close to the crop. Through the use of controlled automatic platforms to perform weeding activities, we can include the well-known and well developed row hoe to get a complete system to indicate the three areas i) between the rows, ii) between the rows and iii) area close to the culture. The requirements of the platform for weeding applications in terms of weeding within a row or near weeds are different. Operations such as seeding, row processing and movement require higher weight tools, speed and energy requirements, while individual plant treatments such as harvesting and micro-spraying will be performed at lower speeds and with lighter and smaller tools . Modules include sensor interfaces, low and high level controllers and more. , it was possible to develop a real-time control system and a suitable vehicle was developed for research in field conditions. The vehicle has 4-WD, which allows you to test different driving strategies. The vehicle is specially designed to drive in a row; this was achieved with the use of wheel motors. The vehicle can drive in row crops during the development of mechanics, electronics and software that we focused on to make the vehicle flexible. The choice of technology for the various functions has a great impact on

functionality, flexibility and performance. During the development process, we had security in the back of our minds and made an effort to eliminate or reduce the risks related to an autonomous vehicle.

- The robot can be divided into following four main modules:
- A vehicle as a transport platform, for example. Tools for weeding for row weeding. The vehicle may be equipped with the control modules described below.
- A control unit, with the Vision input, other necessary sensors provides the vehicle and the instruments with the necessary control signals.
- A vision system that detects the position of the crop in relation to the position of the vehicle.
- The development of vision system is not a primary goal. Therefore, we want to simplify the vision system and we should be able to recognize points on the ground with a good contrast to the terrain. It should be able to replace this simple module with more advanced modules for crop recognition in the field

3. Methodology

In this project, it is presented that the farm weeds control process for advanced agriculture system which is controlled by microcontroller assembly. The technique of weed control system which is based on row per column with fixed standard distance depending upon type of crop or type of cultivation in the field. The other main part of this technique is sensor part. The sensor perform the well job of identifying weed present in between to crop lines as well as completion of farm and also turn robotic vehicle to the next row per column of the field and follow remaining part of the farm. The hardware structure which is used to control the robotic weed control vehicle as advanced agriculture robotic system is as shown in figure 1. The system includes one color sensors, two DC motor, two servo motor and whole parts are controlled by microcontroller assembly as designed in hardware. The operation of DC motor is based on simple electromagnetism, used to give energy to the wheels of vehicle depending upon the number of turns the servo motor and the weed removing tool works accordingly

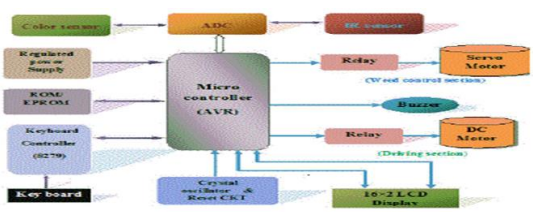

Fig. 1. Hardware structure of robotic weed removing vehicle

Depending upon the revolution per minute of the DC [direct current] motor axel, it drives vehicle at particular distance, the weed cutting tool motor i.e. servo motor will be worked and controlled. When DC motor would be started, vehicle moves along the particular columns between the two crop lines. The color sensor is connected to the front edge of robot; other is at left side for controlling the movement of vehicle. The process of weed control starts from sensing the color of the weed which is in front of robotic vehicle once the color is sensed by color sensor then the controller work as per the information given from color sensor and given instruction to the weed control tool which is present behind and that robotic vehicle, tool moves to down position. if color sensor do not senses the color of the weed then that weed control tool is in up position and save the energy, means if there is weed present in between that two lines of crop then color sensors senses the color and then only weed cutting tool is in down position otherwise weed cutting tool is in up position. The mechanism of that process which is done consists of one weed cutting tool.

A. Case I: weed is present

If there is a brush, the color sensor automatically turns on and gets that instruction on the microcontroller so that it turns the weed control down (as explained in section IV (B) if there is no brush between the cropping lines and then again) the color sensor obtains this instruction from the microcontroller so that the pest control tool rotates upwards and processes it further.

B. Case II: completion of the cultivation firm

If there is no signal from both side sensors, the controller can understand that the clipping has been completed, it will move to the last end of the column. In that position, try moving at 270º?? But it cannot succeed and the microcontroller understands to move the following columns and in the opposite direction. Now go back to reviewing the case (I) and run away more. And he repeatedly follows these two cases. When the vehicle moves towards the row per column, depending on the section of the DC motor's turn conductor, the servomotor drives the shaft with an up and down position mechanism that obeys the servomotor instructions. The different distance is required for different weed cutting processes, controlled by the servomotor controller section.

C. Case III: presence of obstacles

If there are any obstacles such as hard rock in the vehicle path, the infrared sensor automatically activates and obtains these instructions to the microcontroller and stop the robotic vehicle and the person carrying out the inspection removes the obstacle in the robotic vehicle restarts.

4. Robotic system

A robot is a mechanical and artificial agent. It is usually an electromechanical system, conveys a sense that it has agency of its own. It is a device that automatically complicated task, because of software programming.

A. Designing the weed removing robot

It has four wheels that are driven and directed individually. These wheels are driven by two DC motors, respectively, providing direct transmission without gears. There are also two

sliding bearings, respectively that connect to the front wheel and the body, so that the front wheel can rotate between 450 or 450 around the bearing. All DC motors are powered by the DC power supply through the microcontroller circuit. The series of color sensors at the front edge of the vehicle to detect the color of the algae in the shape of the vehicle, provide instructions to the microcontroller to control the movement of the cutting tool through a servomotor. The weed control tool is mounted on the rear side of the assembly, shown in Figure 2. It is used to cut weeds between two crop columns controlled by a servo motor. In the weed cutting section, a servomotor and an infrared sensor are used to place the weed control tool on the ground and check whether the instrument is on the ground or not by the infrared sensor. If an error is detected in this process, because the weed cutter does not fall to the ground, the backup battery problem, etc., activates the buzzer and shows the fault on the screen.

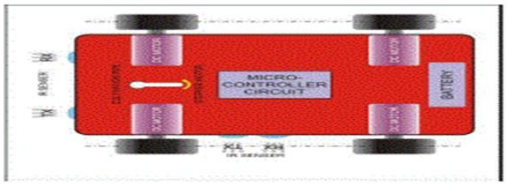

Fig. 2. Designing of vehicle

B. *Path controlling*

In the agricultural environment, not heavy or loaded vehicles can be easily moved on the road with potholes, so the small vehicle is designed, works with a DC motor in this project. To check the vehicle path, it must be preset as shown in Figure 3. Previously, the vehicle straight to the first column and after the end of the ploughed terrain of the vehicle turns 1800 selects the second column and continues. To maintain the position of the robotic vehicle between two rows, there are two sensors that detect the distance between the crop line and the edge of the robot. If the distance from one side decreases, the distance from the other side increases. The vehicle moves slightly at a distance, increasing the high side to keep the same distance to the side and then the robot moves forward. To determine the instantaneous values of all the motors, the analysis of the speed of the rigid body is used. During translation, the longitudinal direction of all the two front wheels are oriented identically to the vehicle body and the wheels turn and during the rotation movement, the longitudinal axis of each wheel is oriented +450 or -450 compared to the orientation of the vehicle body.

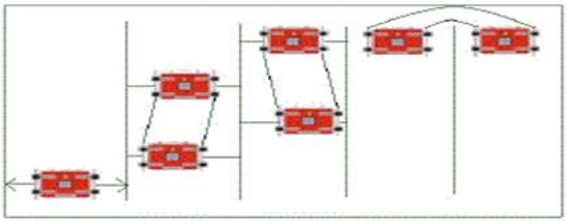

Fig. 3. Path control mechanism

The MATLAB is used for controlling, modeling and analysis of DC motor with the help of two conditions as feed forward and feedback system. The equation of transfer function for controlling of DC motor is obtained by using block diagram representation as shown in figure 4. The control inputs for the steering and driving motors are computed using feedback control system laws as image

Where,
Gv (s) -closed loop gain
w (s) - angular velocity
V (s) - input voltage

C. *Algorithm of operation*

The algorithm to operate the robotic agricultural vehicle and the whole system is implemented as

- Start the machine.
- Select the vertical distance in meters.
- Displays the distance between two cutting lines and the robot on the LCD screen.
- Check if the color sensor is activated or deactivated.
- If it is off, the buzzer will be activated and the DC motor will switch off. If it is on, turn on the DC motor.
- The vehicle begins to move forward based on the distance between the trim lines.
- During processing, if the distance of one of the sides decreases with respect to the other side, move the robot slightly on the other side and keep the distance between the cutting line and the robot on both sides of the robot. The microcontroller gives instructions to the vehicle, it goes directly.
- If the color sensor detects the color of the algae between the crop lines after completing the plowing line, the vehicle turns back by rotating 1800 on the right side. Again you will go to the point no. 8 at the end of the plowed land.

5. Experimental result

A. *Speed of the vehicle*

The speed of vehicle is only depends upon moisture level present in the soil. We have taken different results of speed of vehicle in different moisture content as shown in figure 5. The red column shows the standard level of moisture for those seeds in field. The red column defines the good performance of the robotic weed machine with characteristics as explained below.

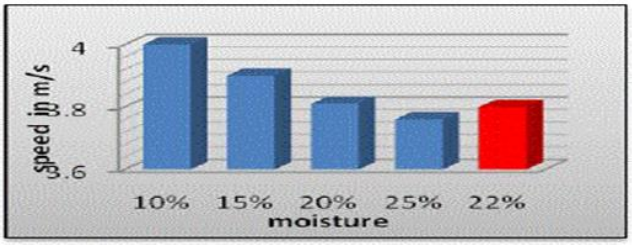

Fig. 4. Result of speed in different moisture conditions

B. *Speed torque characteristics of DC motor*

The D.C. motor is operated on 12V with a speed of 60 rpm. The graph shows the torque speed characteristics of D.C. motor with respect to full load. It is obtained by increasing armature voltage from 1V upto 12V linearly. The following result is plotted in Fig. 5.

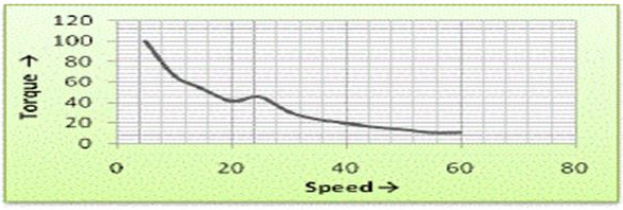

Fig. 5. Torque speed characteristics

C. *Dc motor speed analysis*

The graph shows two techniques for reducing the sensitivity of the angular velocity (ω) to load variation i.e. change in torque opposed by the motor load. The plot compares between the closed loop bode diagram with its simulation when back e.m.f. constant (E_b=0.085). The simulation of feed forward and the feedback of the robot is represented as shown in Fig. 6.

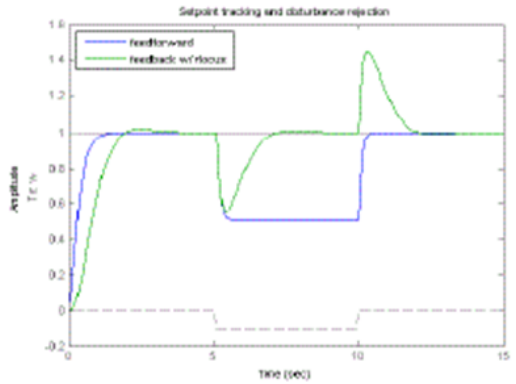

Fig. 6. Comparison between feed forward and feedback

D. *Green color intensity sensor*

The output of green color sensor is obtained by considering different shades and its amount of intensity as shown in figure 8, which shows as percentage of green color which increases out of the sensor is also varying accordingly.

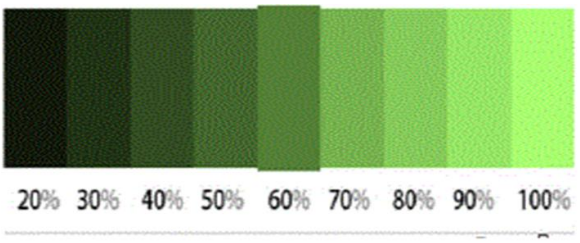

Fig. 7. Green color shades

Table 1
Results of color sensor

Sr. no	Color shade in percent	Output on LCD display
1	20	8-10
2	30	13-15
3	40	22-24
4	50	30-33
5	60	38-42
6	70	48-52
7	80	57-61
8	90	65-68
9	100	73-77

E. *Current and battery discharge time*

Table 2 shows Current consumed by the DC motor and Microcontroller, servo motor, color sensor, IR sensor and from that we can calculate the discharging time for battery with load and without load. Formula to calculate to time for no load is

Table 2
Current and battery discharge time with load and no load

No Of Battery (12V)	Current (mA) No load	Current (mA) With load	Microcontroller current(mA)	Battery discharge time with no load (Hr)	Battery discharge Time with load (Hr)
1	930	1250	100	1.29	0.96
2	930	1250	100	2.58	1.92
3	930	1250	100	3.87	2.88
4	930	1250	100	5.16	3.84

6. Future implementation

This system can be further implemented with moisture sensor which can be helpful to find out the moisture of the soil and determines the water needed for the plant seeds and its requirements. It can also be used to increase the moisture of the soil by connecting it with a water supply. It can be further modified in order to measure the growth rate of plant, weed prevalence etc. Also one or more systems can be monitored through GSM.

7. Conclusion

The document presented that the requirements and progress made to achieve a future autonomous precision farming system. The assembly is developed for the weed control system in automatically plowed land, that is to say, no human energy is required. The project consists of two different mechanisms. The first mechanism consists of making an assembly of the vehicle and its movement, while the second mechanism is to cut weeds between the cutting lines. The microcontroller is used to control and monitor the movement process of the vehicle system. It is controlled with the help of the DC motor and the servomotor. This system also detects obstacles in the vehicle path by means of an infrared sensor. It is also used to detect the turning position of the vehicle on the ground. Since there is no need for energy and high operational speed, it has room for further expansion

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