International Journal of Robotics and Automation (IJRA)
Vol. 1, No. 2, June 2012, pp. 107~112
ISSN: 2089-4856

Advanced Agriculture System

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Article Info

Article history:

Received Apr 21, 2012
Revised Jun 3, 2012
Accepted Jun 10, 2012

Keyword:

Agriculture robot
DC Motor
Microcontroller
Seed & fertilizer cultivation
Steering mechanism

ABSTRACT

This article addresses the advanced system which improvesagriculture processes like cultivation on ploughed land, based on robotic platform. We have developed a robotic vehicle having four wheels and steered by DC motor. The advanced autonomous system architecture gives us the opportunity to develop a complete new range of agricultural equipment based on small smart machines. The machine will cultivate the farm by considering particular rows and specific column at fixed distance depending on crop. The obstacle detection problem will also be considered, sensed by infrared sensor. The whole algorithm, calculation, processing, monitoring are designed with motors & sensor interfaced with microcontroller. The result obtained through example activation unit is also presented. The dc motor simulation with feedforward and feedback technique shows precise output. With the help of two examples, a DC motor and a magnetic levitation system, the use of MATLAB and Simulink for modeling, analysis and control is designed.

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1. INTRODUCTION

In modern globalization, many technologists are trying to update a new development based on automation which works very rigidly, high effectively and within short time period. They have developed driverless tractors but they did not have ability to embrace the complexity of real world.

Now the approach of this project is to develop smart machine which do right thing in right place at right time with right amount in process of farming. The progressive invention in agriculture system is becoming an important task especially because of rising demand on quality of agriculture products and declining labour availability in rural farming areas. There are different processes in the farming system like ploughing, cultivating (seeding), weeding, harvesting etc. All these processes are advanced by modifying the mechanism in farming which works automatically without man power requirement. The small machine would be assembled from existing mass produced components without the need of specialized design and tooling. Because of small autonomous machine, its liability and insurance will be lot easier. Also the input energy require to this machine is less as compared with tractors or any agricultural instrument.

This paper presents unified framework that will facilitate the implementation of future autonomous agriculture system. The section I, introduction represents an overview of system and processing approach. In section II, it describes various processes in farming system like ploughing, seed mapping, seeding and reseeding [1]. The section III provides the system methodology [4]. This includes a description of an experimental platform and as well as hardware structure of controlling system [4]. The information of robotic system, designing part of robotic vehicle and path control mechanism is explained in section IV [2] [3]. The system algorithm is described in section V, which shows the actual working this autonomous farming robot. The experimental results with graphical analysis are clarified in section VI. The approaches of this system are

as self operating and controlling assembly, high speed machine, energy saving vehicle, highly accurate and economical robot is to be developed. Finally conclusions are drawn.

2. FARMING PROCESSES AND CULTIVATION SYSTEM

There are so many different processes in the farming system like ploughing, seeding, fertilizing, weeding, harvesting, spraying etc. which require large amount man power. So, to reduce this problem from rural area, the advanced implementation in farming should be necessary.

The various processes in farming are explained as below.

A. Seed bed preparation:
The process of preparing a bed for cultivating a seed in ground is called as "ploughing". It is primary farming process in which effectively mixing of top soil to prepare a seed bed is processed.

B. Seed mapping:
The process of recording the geospatial position of each seed passively as it goes in to ground is called as "seed mapping".

C. Seed placement:
The process of placing seed at a particular seed position is called as "seed placement". Rather than only record the position of each seed it would be better to be able to control the seed position.

D. Reseeding:
This is the concept of being able to identify where the seed was not placed and can automatically place another seed in same position.

3. METHODOLOGY

In this project, it is presenting that the farm cultivation process in advanced agriculture system which is controlled by microcontroller assembly. The technique of seed boringin ploughed land is based on row per column with fixed standard distance depending upon type of crop or type of cultivation. The other main part of this technique is sensor part. The sensor perform the well job of identifying obstacles as well as completion of farm and turn robotic vehicle to next row per column and follow remaining part of the farm.

The hardware structure to control the robotic seeding vehicle as advanced agriculture system is as shown in figure 1. The system includes two infrared 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.

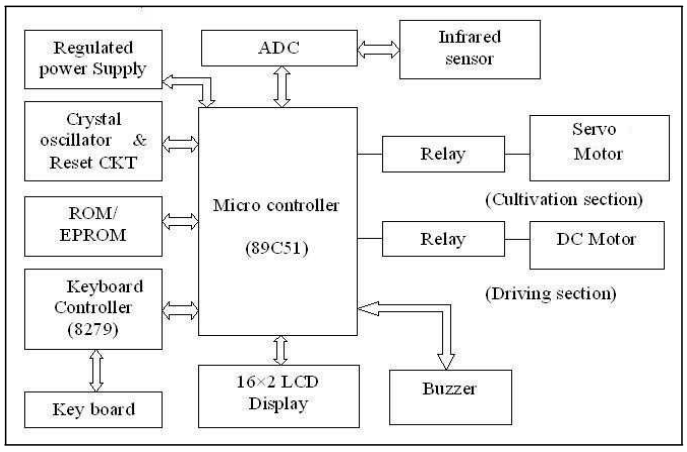

Figure 1. Hardware structure of Robotic system.

Depending upon the revolution per minute of DC motor axel, it drives vehicle at particular distance, the cultivation motor i.e. servo motor will be worked and controlled.

When DC motor would be started, vehicle moves along the particular columns of ploughed land for boring the seed. The infrared sensor is connected to the front edge of robot; other is at left side for controlling the movement of vehicle. The process of boring seed in a land is called pipe cultivation technique or pipe

boring process. The mechanism of that process consists of two or three pipe section which is separated at a particular distance according to the seed.

The seed drill or pipe is inserted vertically in the land at particular depth, corresponding IR sensor get interrupted and it sends signal to microcontroller through analog to digital converter. In case vertical rod is not inserted in land, microcontroller get understand that the land is not ready to cultivate or it is not ploughed or ploughed area of the land will be finished. There are two cases to sense the sensor as-

Case I: Obstacle is present:

If any obstacle is present like hard rock in the way of vehicle, the infrared sensor gets triggered automatically and fetches such instruction towards microcontroller to turn the vehicle in to 270˚ (as explained in section IV (B)) in forward direction and come back against same row per column and processed it further.

Case II: Completion of ploughed land:

If there is no any obstacle is present in the way of vehicle, it will moves up to last end of the column. At that position, it tries to move 270˚ but cannot succeed and microcontroller understand to move next columns and in reverse direction. Now it again check for case (I) and move away further. And it repeatedly follows these two cases.

When vehicle moves towards row per column, depending upon driver section of DC motor revolution, the servo motor terns shaft with +/- 900 regularly and seed gets boring through pipe mechanism which obeys the instruction of servo motor. The different distance is required for different seed cultivation, controlled by servo motor driver section.

4. MISSION PLANNING OPERATION

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. Design of robotic vehicle:

In this project, for developing the structure of robotic agriculture machine, simple technique is used. As shown on Figure 2, it shows the designing of vehicle.

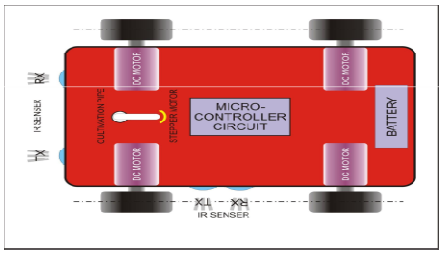

Figure 2. Designing of vehicle

It has four wheels which are individually driven and steered. These wheels drive respectively with two dc motor, provides direct drive without gearing. Also there are two sliding bearings, respectively connect to the front wheel and body, so that the front wheel can rotate between $+45^0$ or -45^0 around bearing. All dc motors are energized by dc supply through microcontroller circuit. Infrared sensor sets at the front edge of vehicle for sensing obstacle in the way of vehicle, provides instruction to microcontroller for controlling motion of wheels through dc motor. The cultivation pipe with funnel is fitted at front side of assembly, shown in figure 2. It is used to boring the seed, stored in funnel and controlled by servo motor. At cultivation section, a servo motor and an infrared sensor is used to boring seed in ground and check whether the seed is placed in ground or not by infrared sensor. If any error is detected in this process like seed box (funnel) is empty, land is not ploughed, battery backup problem etc., then it stars buzzer and shows the fault on display board.

B. Path controlling:

In agriculture environment heavy or loaded vehicle can't move easily on the bumpy road, so small vehicle is designed, operates on dc motor, in this project. For controlling path of vehicle, it should be predefined as shown in figure 3. Previously, the vehicle drives in straight line to first column and after end of ploughed land, the vehicle rotate 1800 and select second column and proceed further.

When obstacle is detected, the vehicle turns by 900 towards right side first and sense for another obstacle and turns by 900 towards left side or right side, depends upon condition as explained in section III. To determine instantaneous values of all motors, the analysis of rigid body velocity is used. During the translational motion the longitudinal direction of all front two wheels are oriented identically with respect to vehicle body and both wheels spin at same rate around their drive axes.

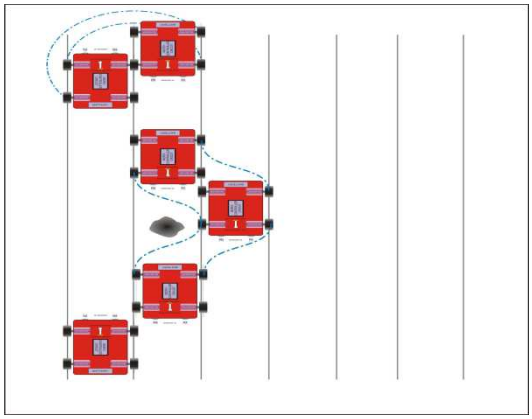

Figure 3. Path control mechanism

And during rotational motion longitudinal axis of each wheel is oriented at + 45^0 or -45^0 with respect to orientation of vehicle body. The dc motor simulates the open loop and closed loop performance with control system as below.

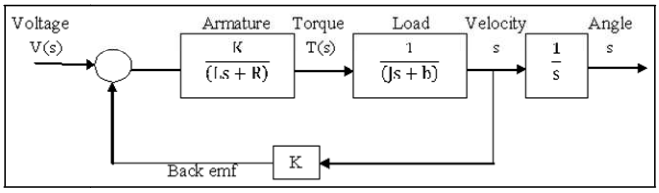

Figure 4. Block diagram of DC motor

The control inputs for the steering and driving motors are computed using feedback control system laws as

$$Gv(s) = \frac{w(s)}{V(s)} = \frac{K}{(R + Ls)(Js + b) + K^2}$$

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

5. ALGORITHM IMPLEMENTATION

The algorithm for operating the robotic agriculture vehicle and whole system is implemented as

1. Start the machine.
2. Select the distance between two columns according to seed type.
3. Display the distance on LCD display board.
4. Check the whether the seed box is empty or full.
5. If it is empty, buzzer will on and DC motor will off. If it is not empty, start the DC motor.
6. Vehicle starts to move in forward direction in straight line.

7. While processing it, if any obstacle is present in way of vehicle, sensed by infrared sensor. Microcontroller gives instruction to vehicle as rotated by 90^0 towards right and after some distance it will be rotated by 90^0 towards left and goes straight way.
8. After completion of ploughed line, the vehicle moves back by rotating 180^0 towards right side. Again it will go to step no. 8 up to end of ploughed land.

6. EXPERIMENTAL RESULTS

A series of automated robot guidance tests in jrowed ground nuts, jawar, wheat etc were conducted to validate the performance of the developed steering-based automated system. Ten rows of above crop were planted using a one-row planter in similar pattern. We tested following results as

1. Speed of vehicle depending upon moisture:

The speed of vehicle is only depends upon moisture level of soil. We have taken different results to the speed of vehicle as shown in figure 4. The red column shows the standard level of moisture for those seeds. The red column defines the good performance with characteristics as explained bellow.

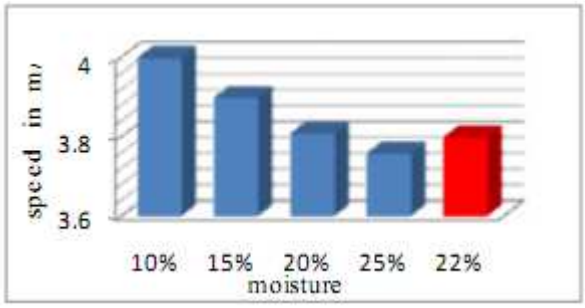

Figure 4. Graph shows speed depends on moisture

2. Speed torque characteristics of DC motor:

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

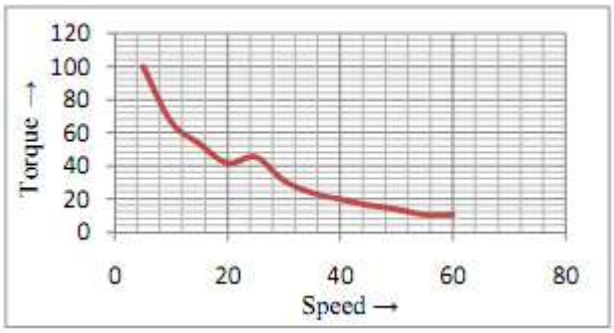

Figure 5. Graph of speed torque characteristics of dc motors

3. D.C. motor speed analysis with and without feedback :

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

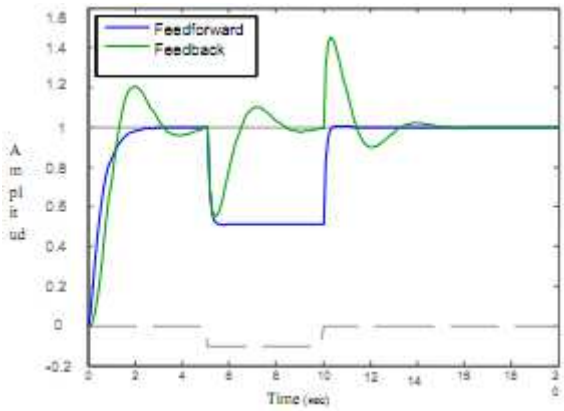

Figure 6. comparison between feedforward, feedback at Eb =0.085.

7. FUTURE IMPLEMENTATION

The system can be advanced for checking the moisture of farming land by moisture sensor and adjust the particular amount of water in soil (i.e. moisture of soil) according to seed and its requirement. It can automatically increase the moisture of soil in land, when providing water supply to this system. It can be also used fertilizer sawing instead of seed.

The system can further be modified to measuring various parameter in farming like crop growth, weed prevalence, its type etc. Also, one or many system can be monitored through GSM system.

8. CONCLUSION

The paper has presented that the requirements and progress made towards achieving a future precision autonomous farming system. The assembly is developed for cultivating ploughed land automatically i.e. no man power required. The project has consists of two different mechanism. The first mechanism contains making an assembly of vehicle and its motion, where as second mechanism is preparing a seed bed on ploughed land.

The microcontroller is used to control and monitoring the process of system motion of vehicle. It is controlled with help of DC motor and servo motor. This system also detect obstacle present in path of the vehicle by infrared sensor. It is also used for sensing turning position of vehicle at the end of land. Because of no man power requirement and high speed of operation, it has scope for further expansion.

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