

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 8, August 2016

Design of an Agricultural Robot to Move between Rows

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ABSTRACT: The paper illustrates the implementation of a complete agricultural robot for farming. This is developed by integration of Arduino Mega 2560, a set of sensor for navigation of row, H-Bridge motor driver IC L298N. With the advancement of robotics technology and mechatronics principles, all operations are performed for different products at a time, e.g. Seed, fertilizer, weedicides and water, rate changes can be done by the user. Thus, algorithms are implemented for maximum output and speed control to guide the agricultural robot. The new technologies can serve efficiently for many problems by overcoming the limitation of the previous one. The system incorporates actuators and relevant sensors to measure and monitor the critical parameters that adversely control the motion of agricultural robot as well as the operations to perform. An ultrasonic sensor based row guidance with distance measuring, is to drive an agricultural robot through the row crops in the field. The new real time control to avoid collision and advancing towards the target at row end. Now a day's many industries are using robots for help to the human beings.

KEYWORDS: Arduino Mega 2560, ultrasonic sensors, Agriculture, AGRO-BOT, robot architecture, robots, motor driver IC L298N.

I. INTRODUCTION

The combination of two technologies can serve efficiently for many problems by overcoming the limitation of previous technologies. Robotics technologies alone serve very well for the various problems, but to develop the agriculture system with robotics which can be used in more complex dynamic. Farming keeps on changing with changing technologies such as with robotics and other technologies. The agricultural robot with sensors can collect data from its environment, to take the appropriate decisions based on data and control all the parts of robot till end point of the field.

II. PROBLEM DEFINITION

Agriculture is an occupation where about 56% of population is engaged. But technical advancement in agriculture is lesser as compared to other fields. With the automation during the farming operation is getting the elements of robotics [1] Population growth rate, increasing scarcity of food agriculture should see a boom, instead it has been observed that more and more people are leaving agriculture as an option for earning livelihood. Prominent reasons for this, are envisioned as below:

1. Land:

Land area to produce crops is depleting rapidly. The amount of land is inversely proportional to population.

2. Life Style

Change in human mind set and life style with more demand of comfort and to reduce man power needed in farming.

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3. Labour Shortage

Retaining quality agricultural production while coping up with rising labour shortage.

4. Women & Differently Abled people

Differently abled people and women found agriculture difficult despite of having agricultural land.

5. Resource Utilization

The increasing price of resources needed for farming like good quality seeds, weedicides, equipment.

Agricultural robot as a Solution

Agricultural robot provides an optimum and efficient solution for wide range of production of crops. It limits manual labour and provides a handy assistance to farmers, differently abled people, women and aspiring farmers. It utilizes resources in an optimum manner thus reducing the investment. Proper dispersal of seeds make most of the land area available.

With advancement of robotic technology and mechatronics principles total outlet performances are detected for different products at a time, e.g. seed, fertilizer, weedicides and water, rate changes are recorded. With the help of sensors with Arduino board will take the inputs and perform the task as programmed in it [2]

The smart and simple system is designed to drop the seeds on land [3]. Fig 1 shows all the component for navigation robot between rows.

The aim of the designed system is to check moisture, humidity of soil. The dispensing mechanism of water is to be controlled. The pump is used to control the rate of flow of water out from the container. Instead of using line follower, the sensors are used for row navigation that it can control the motion of robot [4-5].

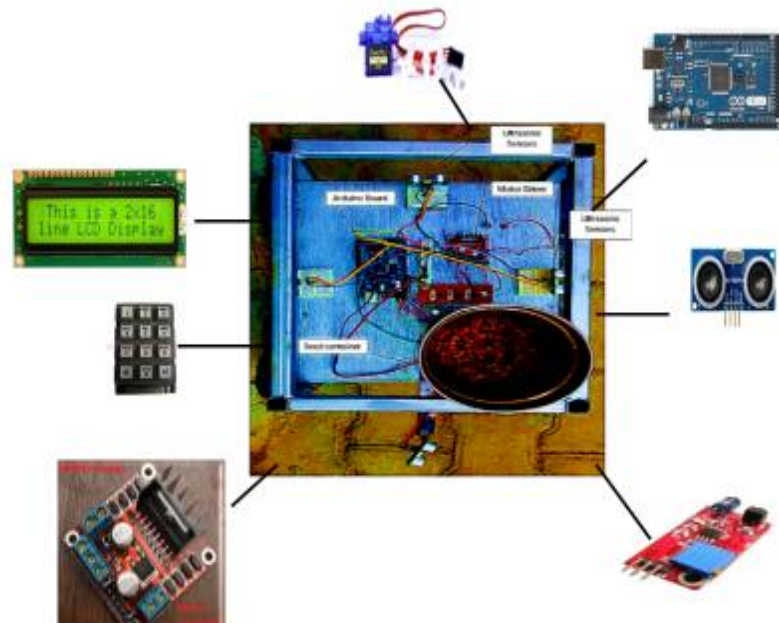


Fig. 1 Elementary Diagram of Agricultural Robot

To implement the agricultural robot the ultrasonic sensor, orientation sensor, soil moisture sensor, Arduino mega 2560, Driving motors, motor driver IC L298N, voltage divider, robot architecture are used. It can move in-between the straight rows, turn to the next row at the end of current distance.

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Jinlin, Xue, et al [6] have discussed that the hierarchical structure applied to the control system structure which can be readily used for vision based row guidance and row detection. A survey of the algorithms for seeking the guided row detection is proposed.

Gangurde et al [7] have discussed that the monitoring system using WSN which is reliable, adaptive and efficient and require to update and check the changes in real time.

Correll, et al [8] have proposed algorithm which is able to physically change the location of a plant and maximizes resources with maximum growth. These algorithms were implemented into gardening the robot and tested the object with camera.

Shrivastava et al [9] have discussed the proposed system with sensors used for increasing the efficiency and productivity with multitasking, and security. The robotic vehicle is used for multitasking feature as automatic and controlled seeding irrigation, manuring, Microcontroller is used with pumps, sensors, relays and motor drivers.

Bouton, et al [10] have proposed the algorithms for farming and surveillance to respond for motion and velocity control of robot on even at any terrain region. The developed approach can control the path tracking of robot in the field.

Sammonset et al [11] have implemented the system for spray control. This is achieved by the designing of autonomous mobile robot with pest control and disease prevention. This one estimate the process for controlling in the search for the navigation ability in commercial greenhouse.

Balaji, L, et al [12] have proposed the intelligent control technique using kiel software used in the movement of vehicle with Android, Bluetooth and different sensors like accelerometer, ultrasonic sensors etc.

III. HARDWARE IMPLEMENTATION

The real time data is taken through sensors as ultrasonic sensors, infrared sensors, and soil moisture sensor. The system with four ultrasonic sensors (HC-SR04) for four direction detection. The back sensor is mounted on a 9g micro-servo to be able to rotate 180° for aligning. Voltage divider is used to provide two voltage lines for 5V and 12V distinctive operations. The soil moisture sensor is used to measure soil moisture.

The outlet from the agricultural robot is to perform four operations as seeding, irrigation, manuring, weeding. A uniquely designed mechanism for seed and fertilizer dispensing is made. It consist of two rotating mounted for proper dispersal. The dispensing mechanism consist of pump. The pump controls the rate of flow of liquid out from the container.

The hardware and software used in the agricultural robot are described as following:

A. Chassis

The framework for chassis is made up of aluminum alloy square tubes. Aluminum is used to provide light weight and durability to chassis. It has sensors assembly on every side and all solid and liquid dispensing mechanism are mounted on the chassis. The electronic devices mounted on chassis controlled by microcontroller. Thread tread block tyres are used with 4.5" diameter for better gripping and push on land applications.

B. Overview Of Arduino Mega 2560 Board

Arduino is an open source electronics platform, family of microcontrollers (tiny computers) and a software creation environment (IDE) that makes easy to create sketches by which interaction with physical world is possible. In the agricultural robot, AVR microcontroller is based on the RISC technology of ARDUINO IDE which is used for projects based on Arduino boards.

C. Overview of IR Sensor

It is also called obstacle sensor. It is simple device, easy to build and calibrate and still, 8it provides a detection range of 10-30 centimeters. IR obstacle based divider is like an op-amp to accurately detect very small voltage changes. It has an adjustable range with POT, logical output generated is 1 or 0, and takes +5 volt DC supply.

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D. Overview of Ultrasonic Sensor

The ultrasonic sensor is used as a transducer to convert the ultrasound waves to the form of electrical signals and vice versa it senses and transmit the data. Its rated working current is 15 mA and measuring angle is 30 degree, power supply required is +5 volt, trigger input pulse width is 10us, working frequency is 40 Hz.

E. Overview of Servo Motor

Servomotors are used mainly for robotics and automated manufacturing. This is available in 360, 180, 60 degrees with various torque ratings for light and heavy applications. These motors are easy to implement to the robot. The used servo motor in agricultural robot is tiny and light weighted with high output torque. It rotates in 180 degree, 90 degree in each direction. It works for 0,90,-90 degrees for 1.5 ms, 2 ms to left and 2 ms to right respectively.

F. Mechanism. Overview of Complete Assembly of Dispensing

The actual prototype assembly of the dispensing mechanism. There is one containers for solid dispensing and one motor to run to perform the process of dropping the solid i.e. seeds, manure. There is other containers for liquid dispensing and one pump to perform the process of dropping the liquid i.e. water, weedicides etc. pump is driven by H-Bridge and by taking the action from the Arduino the dispensing process is performed and material is dropped.

IV. WORKING OF AGRICULTURAL ROBOT

Gear wheels are used for this purpose for high torques to turn the robot in other row. They help the robot to turn as regular tyres as well as row motion can be smooth.

By controlling the motors and data taken through sensors, the robot can be smoothly rotate.

The four sensors can give the data as f_1 , f_2 , f_3 , f_4 . Where the distance is calculated by sensors reading, compare all data to align the robot and move forward. The sensors process the data for reactive output as for ground detection, alignment, row motion, dispensing of materials. The most important driving skill is row motion control with orientation and turning in next row.

A. Initialization

The software initializes. It first setup and checks feasibility of other hardware. And then proceed to alignment for proper motion.

B. Alignment

The Agricultural robot deliberately 'aligns' itself at a strict parallel to the direction of motion with the help of four ultrasonic sensors (HY SRF-04/05). The sensor first detect the nearness to left or right sensor and the servo is commanded to turn back sensor. The reading are then calibrate it to properly align the robot with an error of ± 5 cm. after that initial data for different sensor is registered.

C. Row Motion

The motion of Agricultural robot on field is in recursive flood fill fashion as shown. Ultrasonic sensors also helps to avoid bumps with the boundary and navigate Agricultural robot to traverse into next row.

The motion of Agricultural robot in field is in recursive flood fill fashion as shown. Ultrasonic sensors also helps to avoid bumps with the boundary and navigate Agricultural robot to traverse the other row. The agricultural operations are performed while traversing of field.

The agricultural operations are performed while traversing of field. This based on the data fetched by sensors and calibrate regularly. The movement of robot on field is governed by row motion function. After alignment the actual traversal of field starts.

Main purpose is for navigation between rows to grow the crops in evenly distribution form. The decision is taken by robot to plan the route straightly. The robot has special mechanism for seeding, irrigation, manuring, weeding.

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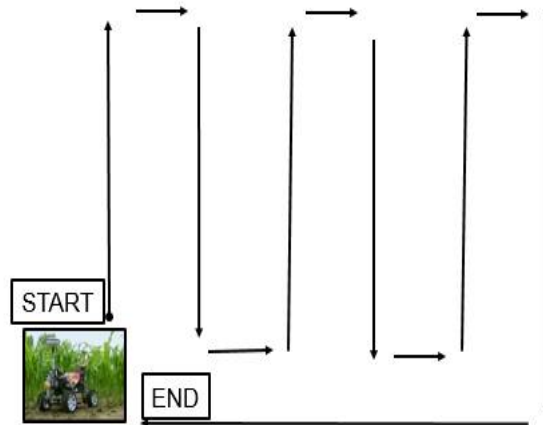


Fig 2. Demonstration of motion on field

V. RESULT

The agricultural robot moves in the crop row with the help of ultrasonic sensors. An Arduino mega and ultrasonic sensors are equipped on the robot.

The inter-row distance is measured to turn in next crop row. This test speed of robot is slow and length of each row is approximately 10m.

Table: Determination of Alignment Distance

Distance from Origin (Corner)	Error in Alignment Distance
20 cm 30 ⁰	3 cm 7 ⁰
20 cm 50 ⁰	5cm 10 ⁰
40 cm 30 ⁰	7 cm 5 ⁰
40 cm 50 ⁰	4cm 5 ⁰

The values derived from the measurement of sensors and real centre of rows. It is shown that the accurate results of seeds dispensed is up to +/-4 per 10 m. However, it can be indicated that agricultural robot is more accurate in navigation between rows.

VI. CONCLUSION AND FUTURE SCOPE

In the present work, agricultural operations has been performed using Arduino mega 2560 board in order to control the motion of agricultural robot for movement in the field and perform various operations i.e. seeding, irrigation, manuring, weeding. This paper present Agricultural robot robotic system for agriculture which can be modelled by various purposes using algorithm for comfort to farmers and can be interfaced by using Arduino board and various types of

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sensors. An agriculture robot can be experienced for several advancements. Implementation of agricultural robot has significant saving in terms of time, efficiency and saving the wastage of resources and reduced utilization of manpower should pay the cost once the system is activated.

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