

Wireless Multipurpose Agricultural Robot Based on Solar

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Abstract

This paper deals with the exposition of how robotics can be applied in the fields of agriculture. About 60% rural population of India is depends on agriculture to earn their livelihoods. Aimed at designing multipurpose autonomous agricultural robotic vehicle is to increase the productivity and reduce the labour involved, the robot is designed to increase the productivity and reducing the basic functions required to be carried out in farms. These robots are used to reduce human intervention, efficient utilization of resources.

Keywords - Agribot, Ploughing, Autonomous, Agricultural

I. INTRODUCTION

The main motive for developing Agricultural Automation Technology is decreasing labour force, a phenomenon common in the developed world. The reasons are the need for improved food quality. Robotics and artificial intelligence achievements offer solutions in precision agriculture to processes related to seeding, harvesting, weed control, grove supervision, chemical applications, etc. to improve productivity and efficiency[1]. Precision autonomous farming is the operation, guidance and control of autonomous machines to carry out agricultural tasks. It motivates agricultural robotics. The goal of agricultural robotics is more than just the application of robotics technologies to agriculture. The multipurpose agricultural robots are designed to perform the basic functions required to be carried out in farms[2]. These robots are used for agricultural operations perform autonomously such as ploughing, seed sowing, mud closing and water spraying.

II. ROBOTICS IN AGRICULTURE

The robotics fields are gradually increasing its productivity in agriculture field. Some of the major problems in the Indian agricultural are rising of input costs, accessibility of skilled labours, lack of water resources and crop monitoring. To overcome these problems, the automation technologies with robots were used in agriculture. The automation in the agriculture could help farmers to reduce their efforts.

Motivation for the research is to decrease harvesting cost and increase the productivity. Conventional harvesting method is highly labour intensive and inefficient in terms of both economy and time. Machine harvesting systems by robot are a partial solution to overcome these issues efficiently. Thus reduce the harvesting cost to about 35-45% of total production cost. An Agribot is designed to reduce harvesting cost.

A. Design Methodology

The proposed system focused on the design, development and the fabrication of the multipurpose agricultural robot with ploughing and seeding[1]. The multipurpose agricultural Robot is used to control the four functions like ploughing the soil, seed sowing, grass cutting and water spraying with least changes in accessories through transmitter and receiver without affecting cost. The block diagram of the proposed model is shown in figure.

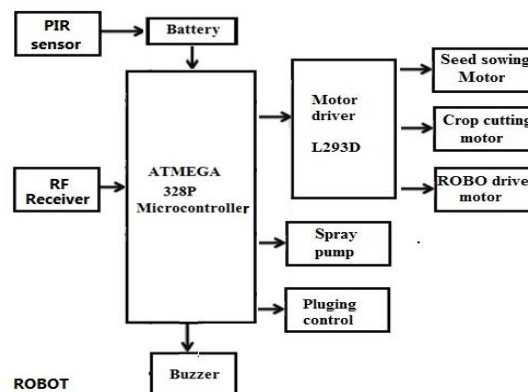


Fig. 1 Block diagram of proposed model

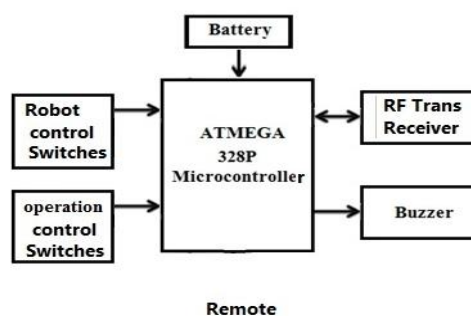


Fig. 2 Block diagram of remote

III. HARDWARE MODEL

The whole system of the robot works with the battery. The robot requires 12V battery to operate the system. The base frame consists of 4 wheels connected to four arms and wheels are driven by dc motor. One end of the frame, cutter is driven by dc motor which is made to cut the grass. The seeds are spreaded through drilled hole on the shaft by the linked mechanism with dug soil processing[1]. A leveller is made to close the seeds and water pump sprayer is used for spraying the water. Transmitter and receiver is used to control the entire operation of robot for ploughing, seeding and irrigation systems. The Heart of the proposed system is Microcontroller. Transmitter receiver module, DC motors are interfaced to the Microcontroller to provide various operations like Ploughing, seeding, levelling and water spraying. The entire mechanism of the system is controlled by transmitter receiver. The wireless communication enables the robot to move in four directions as front, back, right and left.

Various commands used to move robot into forward, reverse, stop, left and right. The microcontroller in the proposed model enables various functions in the field according to the commands received.

IV. SOFTWARE MODEL

Once the connection is established then the application will show connected status as shown in figure below. The nine commands are stored using set keys option for as F (forward), B (backward), L (levelling), P(ploughing), S(Seeding), W (watering),1(to stop all the functions of the robot). According to the applied commands and program loaded to microcontroller the robot will move and performs above functions. AT89S52 microcontroller is used to control various operations of proposed system. Port2 and port1 of AT89S52 microcontroller are used to control ploughing, seeding, levelling and water spraying through motor drivers of robot. Ploughing motors are connected to output pins (3 &6), Levelling motors are connected to output pins (11 &14) of motor driver L293D. L293 D is the motor driver for controlling DC motor operations for ploughing and levelling. DC Motor used for wheels is connected to another L293D driver for proper movement of wheels. Similarly for seeding and water spraying functions, other L293D motor drivers are used. The flow chart for the proposed model is shown in figure. The C program is developed for microcontroller to control the above operations.

V. MOTOR PARAMETERS

A. Analysis of the parameters for ploughing, seeding, leveling and water spraying is shown in tables1 and 2

Table 1: WHEELING FUNCTION

Sr. No.	Parameter	Value obtained by proposed model
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1.	Torque of motor	0.24 N-m
2.	Speed of motor	200 RPM

Table 2: SEED SAWING AND CUTTING FUNCTION

Sr. No.	Parameter	Value obtained by proposed model
1.	Torque of motor	0.098 N-m
2.	Speed of motor	60 RPM

VI. COMPONENTS

A. Sprinkler Motors

The sprinkler motors are used for spraying pesticides. A motor of high speed is used to spray pesticides at proper velocity and pressure. The farmer uses the joystick to turn on the sprinkler motor. Pre-mixing of pesticides is done to achieve faster and efficient field results. So the amount of pesticides sprayed can be efficiently controlled. Specific spraying of pesticides at needed location is possible as the control of the motor is in the farmer's hands. Various new technologies can be used to improve the efficiency and control of spraying rates.

B. ATMEGA328p

The Arduino Uno is a microcontroller board based on the ATmega328p (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as USB-to-serial converter.

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. Dual H-bridge Motor Driver integrated circuit (IC)[3].

C. Driver Circuit

Gear motor cannot be connected to the microcontroller directly because of its low current output. A motor driver is a little current amplifier; the function of motor drivers is to take a low-current control signal and then turn it into a higher-current signal that can drive a motor. An external driver is used which increases the current output and drives the motor. The motor driving circuit using IC L293D is implemented with the help of 4 resistors of value 4.7 K ohms and 3.3 K ohms on each side.

It works on the concept of H-bridge. H-bridge is a circuit which allows the voltage to be flown in either direction. As you know voltage need to change its direction for being able to rotate the motor in

clockwise or anticlockwise direction, hence H-bridge IC are ideal for driving a DC motor. In a single L293D chip there two H Bridge circuit inside the IC which can rotate two dc motor independently. Due its size it is very much used in robotic application for controlling DC motors. Given below is the pin diagram of a L293D motor controller. There are two Enable pins on L293d. Pin 1 and pin 9, for being able to drive the motor, the pin 1 and 9 need to be high. For driving the motor with left H-bridge you need to enable pin 1 to high. And for right H-Bridge you need to make the pin 9 to high. If anyone of the either pin 1 or pin 9 goes low then the motor in the corresponding section will suspend working. It's like a switch.

D. Solar Panel

Solar panel refers to a panel designed to absorb the sun's rays as a source of energy for generating electricity or heating. A photovoltaic (in short PV) module is a packaged, connected assembly of typically 6×10 solar cells. Solar Photovoltaic panels constitute the solar array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions, and typically ranges from 100 to 365 watts. The efficiency of a module determines the area of a module given the same rated output – an 8% efficient 230 watt module will have twice the area of a 16% efficient 230 watt module. There are a few solar panels available that are exceeding 19% efficiency. A single solar module can produce only a limited amount of power; most installations contain multiple modules. Electrical connections are made in series to achieve a desired output voltage and/or in parallel to provide a desired current capability. The conducting wires that take the current off the modules may contain silver, copper or other non-magnetic conductive [transition metals]. The cells must be connected electrically to one another and to the rest of the system. Externally, popular terrestrial usage photovoltaic modules use MC3 (older) or MC4 connectors to facilitate easy weatherproof connections to the rest of the system. Bypass diodes may be incorporated or used externally, in case of partial module shading, to maximize the output of module sections still illuminated. Anodized aluminium alloy frame with high mechanical strength[4]. Operating temperature is 40 to 80 °C

1. Ploughing function

The primary purpose of ploughing is to turn over the upper layer of the soil, bringing fresh nutrients to the surface, while burying weeds and the remains of previous crops and allowing them to break down. In the prototype model shown above, Servo Motor is used for ploughing the farm. As the screw rod rotates, the nut welded to the cultivator slides between the screws of the rod. Then the cultivator is lowered down and the soil is dug up to 1.5 inches. On

field work we can implement pneumatic and hydraulic system to get the required high torque.

2. Seed sowing function

Seeding is planting seeds in a place or on an object. In the prototype model shown above, a box is used for Seed storage and is arranged to sow the seeds when wheels are rotated. The movement of wheels of the robot causes the shaft to throw the seeds to the field.

3. Grass cutting

Grass cutting operation is performed by cutter provided at front side of the model. The height of cutter can be maintained according to the requirement.

4. Irrigation function

Irrigation is the method in which a controlled amount of water is supplied to plants at regular intervals for agriculture. In the prototype model shown above, drivers are used for water pump to spray the water in the field.

E. Calculations

For Motor Selection

$$\begin{aligned} \text{Radius of wheel shaft- } & 1\text{cm} \\ \text{Total torque } & T = F * r \\ & = m * g * r \\ & = 10 * 9.81 * 10^{-2} \\ & = 0.981 \text{ Nm} \end{aligned}$$

For one motor

$$\begin{aligned} T & = \frac{T}{4} = 0.981/4 = 0.24 \text{ Nm} \\ 1\text{Nm} & = 10.197 \text{ kg-cm} \end{aligned}$$

Hence,

$$\begin{aligned} T & = 0.24 * 10.197 \\ T & = 2.447 \text{ Kg-cm} \end{aligned}$$

For 200rpm

$$\begin{aligned} & = (200 * 2\pi * 7 * 10^{-2}) / 60 \\ & = 1.466 \text{ m/s} \end{aligned}$$

Speed test-

$$\begin{aligned} \text{Length} & = 16 * 59.2 = 947 \text{ cm in 30 sec} \\ W & = 14\text{cm} \\ a & = 1.328 \text{ m}^2 \end{aligned}$$

1 R = 33ft² in 38.14 minutes

Total power requirement = 24Watt

$$\begin{aligned} \text{Energy consumed} & = \frac{24 * 38.14}{1000 * 60} \\ & = 0.01525 \text{ KWh} \end{aligned}$$

VII. CONCLUSIONS

Multipurpose autonomous agricultural robot has successfully implemented and tested for various functions like ploughing, seeding, cutting and water spraying. It was developed by integrating agricultural robot with C programming. Various parameters like soil condition, area covered by the robot and weight of the material for levelling are analyzed for different motors. The advantages of multipurpose agricultural robots are reducing human intervention, ensuring proper irrigation and efficient utilization of resources.

These robots are mainly useful in automated weed control; usage of fertilizers based on soil condition, soil sensors for drip irrigation in rain feed areas. The proposed system is mainly used for crop establishment, plant care and selective harvesting. In future, it can be extended by using ultrasonic sensors and cameras for performing the same operations without human operator for measuring the various parameters like soil condition, area covered by the robot and weight of the material for levelling.

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