## ABSTRACT

Manual spraying of pesticides and herbicides to crops and weed inhibitors onto the field are quite laborious work to humans. Manual trimming of selected unwanted plants or harvested crops from the field is also difficult. Our project proposes a multipurpose solar powered, flexible, Remote Controlled, semi-automated spraying robot with 4 Degrees of Freedom (DoF) in spatial movement, with an additional plant mowing equipment. The robot is designed to spray pesticide/insecticide directly onto individual lesions minimizing wastage or excess chemical spraying, hence making the system cost effective and also environment friendly. It is designed to cut down undesired plants selectively by remotely controlling the start and stop of the mowing system. Alternatively, it also serves the purpose of maintaining lawns and sports field made of grass. The same system can be used for water spraying and mowing the grass to desired levels, leading to proper maintenance of the field. The robot is designed to move at 1.4m/s, with an effective spraying area of 0.98 sq. m. by the nozzle and an effective cutting area of 0.3 sq. m. by the mower, when stationary. The prototype has a battery back-up of 7.2hrs under minimum load conditions


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# I. INTRODUCTION

In India for rural population, agriculture is a vocation for their livelihood. Our aim is to incrementing the crop yield. Farmers conventionally use hand operated and fuel operated spray pump for spraying pesticides. There is a direct contact of pesticides with human which would be inimical. This incentivized us to design and fabricate a model that is predicated on moving mechanism. A pesticide is a substance utilized for controlling, obviating and ravaging pests. Solar powered pesticide sprayer rudiment ally a model which will be subsidiary in the agriculture field for the purport of spraying insecticides and pesticides on the crops. Thousands of non- target insects are supplement ally killed by this pesticide sprayer. A four wheeled pesticide sprayer along with spraying circuit will spray the insecticides and pesticides on the crops with a more expeditious rate and with minimum efforts. We introduce IOT concept in our project model. IOT has the faculty to transfer a data without requiring human-to-human or human-to computer interaction. Internet of Things is utilized to monitoring the information & it provides genuine time data which is updating through cloud technology. This model will surely avail the farmers in the spraying process and may prove vital for them in term of time efficiency.

## 1.2 Motivation

Use of chemical sprays is of major concern as it is hazardous to both human health and the environment. In general, most of the agriculturists use human operated knapsack sprayers that require more time to cover a given area. Motorized sprayers can cover much larger area in a stipulated time. During this process, though the farmers take lot of precautionary measures like wearing gloves, masks and outfits, sprayed chemicals will adversely affect their health. Therefore, use of autonomous robots provide a safe environment for farming, along with increase in efficient production of Agri-products due to increased level of monitoring and control of agricultural fields. Sports fields for professional sports need to be specifically maintained to allow convenient and non-obstructive game play.

## 1.3 Pesticide spraying

The pesticides have a vital influence of the agribusiness. Nearly 35% of crops have been safeguarded from the insects using pesticides. The pesticides are needed for agriculture field to increase the efficiency but they are also injurious to human and also to the environment. In the current methods, the farmers use the backpack sprayer which is manually operated by the human along the crop fields. They used to spray the pesticides in the targeted way manually. Here the sprayer is connected to the back of the tractor and this tractor was driven by the human. The pesticides were sprayed to the crops along the field. This method does not uses the selective spraying and the pesticides are spread to the field.

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## II. LITERATURE SURVEY

2.1 IOT Based Precision Agriculture Using Agribot: In this work IOT controlled robot, designated, Agribot has been designed, builted and demonstrated to carry out seeding and spraying pesticides in an agriculture field. The agribot will avail the farmers in incrementing crop yielded and bulwark them from inimical chemicals of pesticides.

2.2 Solar Powered Automatic Pesticides Sprayer: Solar-powered automated spraying machine uses solar energy as source. Solar energy is used to charge a storage battery which supplies the system. A four wheeled vehicle is moved automatically in a pre-fed path and sprays pesticides using a

DC pump and nozzle. Instruction is passed to the system using GSM/Cellular data which ensures no direct contact with human and thus safety of operator is ensured. Also it covers larger area in less time with uniform spraying.

2.3 Solar Operated Pesticide Sprayer For Agriculture Purpose:

Main objective of the project was to utilize inherently available solar energy in spraying operations thus achieving zero electricity.

Proposed model made it possible using simple and effective principle of storing sun energy in battery through constant supply of voltage from solar charge controller and then with the use of selected pump and nozzle, spraying operation can be carried out.

Fatigue and Stress that usually generates during working condition for the farmers has been reduced considerably after adopting ergonomic techniques during designing.

Hence analyzing the function v/s cost with the presently available equipment in market, solar sprayer equipment is more efficient with comparatively lesser cost.

2.4 Solar Automatic Pesticide Sprayer Using Zigbee: This project demonstrates the implementation of robotics and mechatronics in the field of agriculture. This being a test model the robustness of the vehicle is not very high. The performance is satisfactory under laboratory condition. The model gave a fairly good rate of area coverage and the cost of operation as calculated was also reasonably low. In addition the safety and long term health of the farmers is ensured by eliminating human labor completely from this process. It does not compromise the performance of a petrol based pesticide sprayer.

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# COMPONENTS

**HARDWARE COMPONENTS REQUIRED:**

1. **HC-05 Bluetooth module**
2. **Arduino Uno**
3. **L293D driver**
4. **Solar panel**
5. **DC motors**
6. **Linear Actuators**
7. **Mobile app**
8. **Battery**
9. **Manual Switch**
10. **Ply wood**
11. **Clamps**
12. **Nuts and Bolts**
13. **Wires**
14. **Wheels**
15. **Resister**
16. **Pump**
17. **Mower Blade**
18. **Storage tank**
19. **Pipes**
20. **Nozzles**
21. **Personal Computer**

**3.1 Components in detail**

3.1.1Bluetooth Module HC-05 And Arduino: HC05 module is pretty easy to use and Bluetooth Serial Port Protocol (SPP) module is fabricated for transparent wireless serial connection setup. The HC-05 Bluetooth module can be used to communicate between two microcontroller's like Arduino or communicate with any device with Bluetooth functionality like a Phone or Laptop and is shown in the Fig.4. To control the entire system, Bluetooth HC05 is connected to Arduino and to android smart phone wireless.pairing the HC- 05 module with microcontrollers is very easy because it works using the SPP.

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Figure 3.1: Arduino UNO board

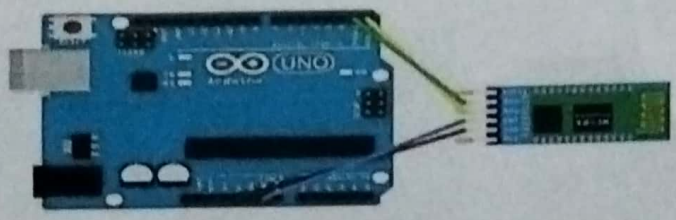


Figure 3.2: Arduino and Bluetooth connection

**New Features of the board are as follows**

**Microcontroller: ATmega328**

**Input Voltage: 5V**

**Recommended Voltage: 7-12V**

**Limits of Input Voltage: 6-20V**

**Digital I/O Pins: 14 of which 6 are for PWM output**

**Analog Input Pins: 6**

**DC Current on I/O Pins: 40mA**

**DC Current on 3.3V Pins: 50mA**

**Flash Memory: 32KB of which 0.5KB used by boot loader**

**SRAM: 2KB EEPROM: 1KB**

**Clock Speed: 16MHz**

**Schematic:** Arduino reference design uses Atmega 8, 168 or 328. Present models use ATmega328. The pin configuration is shown below. Maximum dimensions of Uno are 2.1x2.7 inches. USB and power jack connectors are extended outside the earlier 14 measurement. The board can be attached to base Four screw holes are provided. Gap between the pins 7 and 8 is 0.16".

**3.1.2 L293D Motor control Shield:** L293D shield is a driver board based on L293 IC, which can drive 4 DC motors and 2 stepper or Servo motors at the same time. Each channel of this module has the maximum current of 1.2A and doesn't work if the voltage is more than 25v or less than 4.5v.

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It can drive:

- 4 bi-directional DC motors with 8-bit speed selection(0-255)
- 2 stepper motors (unipolar or bipolar) with single coil, double coil, interleaved or micro-stepping.
- 2 servo motor.

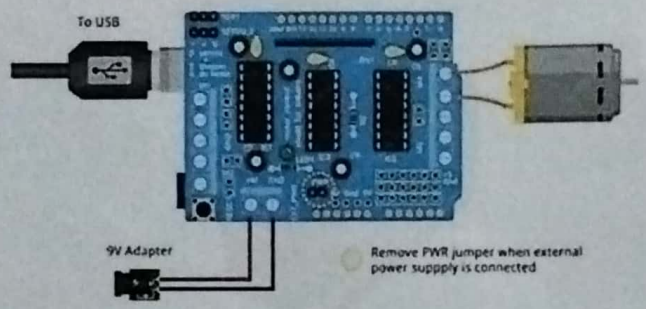


Figure 3.5: Wiring DC motor

Wiring DC Motor to L293D Motor Shield & Arduino: The following sketch will give you complete understanding on how to control speed and spinning direction of a DC motor with L293D motor driver shield and can serve as the basis for more practical experiments and projects.

**3.1.3 Solar panel:** A solar panel, or photo-voltaic (PV) module, is an assembly of photo-voltaic cells mounted in a framework for installation. Solar panels use sunlight as a source of energy and generate direct current electricity. A collection of PV modules is called a PV panel, and a system of panels is an array. Arrays of a photovoltaic system supply solar electricity to electrical equipment.

Fig 3.6. Solar panel

**3.1.5 Battery:** Battery are a collection of one or more cells whose chemical reactions create a flow of electrons in a circuit. All batteries are made up of three basic components: an anode (the '-' side), a cathode (the '+' side), and some kind of electrolyte (a substance that chemically reacts with the anode and cathode). When the anode and cathode of a battery is connected to a circuit, a chemical

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reaction takes place between the anode and the electrolyte. This reaction causes electrons to flow through the circuit and back into the cathode where another chemical reaction takes place. When the material in the cathode or anode is consumed or no longer able to be used in the reaction, the battery is unable to produce electricity. At that point, your battery is "dead." Batteries that must be thrown away after use are known as primary batteries. Batteries that can be recharged are called secondary batteries.

Fig 3.11: 12V Sealed lead acid battery(1.3Ah)

**4.13: Pump**: A 12V DC pump is to be used for pumping the pesticide from storage tank to the Nozzles.

Voltage rating 12 V DC

Max current rating 1000 mA

Flow rate 350-700 L/H

Inlet dia 0.354 in

Outlet dia 0.295 in

Specs of pump The pump is placed directly on the storage tank, the pump we have chosen has 3 suction cups which will stabilize the pump. The chosen pump is of centrifugal type as here the pesticide has to be pumped upwards (against gravity) at high speeds. The pump has to lift the pesticide to almost 30 inches.

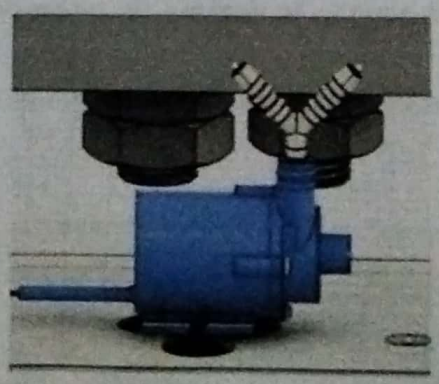

Fig 4.28: Placing Y joint at the outlet of pump

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## PROPOSED SYSTEM

This system is a robot designed for agricultural purpose.

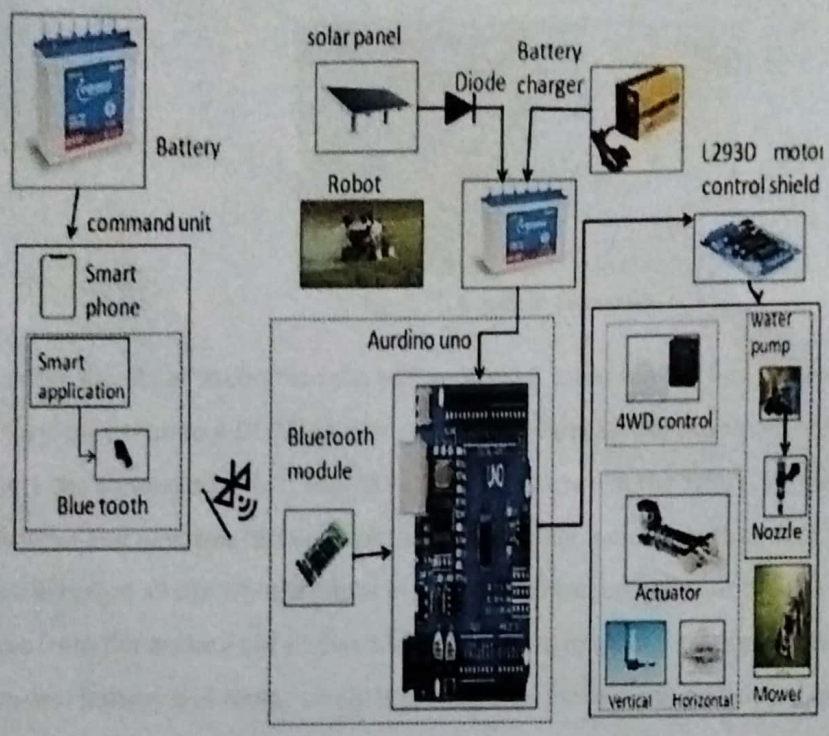


Fig 5.1. Block diagram of proposed system

This system is a robot designed for agricultural and sport fields maintenance purpose. Agro robot is developed with Arduino, L293D Motor control Shield, HC-05 Bluetooth Module, 4 Wheel drive with 4 DC Motors, Water pump, Nozzles, Mower setup, Battery and Solar Panel. This Agrobot with Manual Sun Tracking Solar Panel performs a number of concurrent operations. Today, the man power to do the farming is major concern, this machine removes the hurdles of agriculture laborers. Their efficiency and operating speed greatly affect the productivity. The different electrical components are connected to the combination of Arduino board and Motor Shield.

## 5.2 Circuit connections between all electrical components

The Bluetooth module Motor shield and the Arduino board are connected as shown in the figure.

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After giving the above connections, give power supply to Motor shield and check if all the lights in Arduino, Motor shield and Bluetooth module are glowing. To check the working of Bluetooth module.

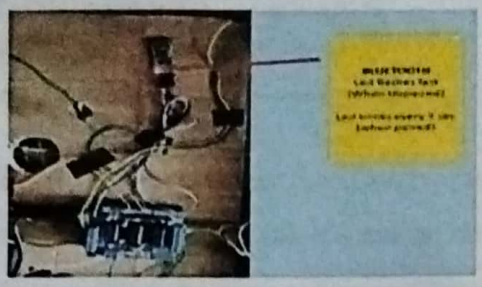

Fig 5.21: Circuit 2: (Bluetooth)

A typical motor shield can accommodate 4 DC motors, 2 servo motors and 2 stepper motors. For our application we only require 4 DC Motors to move in tandem, so the terminals of 4-wheel drive with DC motors are connected in M1, M2, M3 and M4 as shown in the figure. While connecting the wires to the positive and negative terminals of the motor shield make sure that they are connected in such a way that all the wheels rotate in the same direction either anti-clock wise or clockwise. The wires from the battery are screwed in the slots provided in the Motor Shield. A manual switch between Battery and Motor shield is provided so that we can switch ON and OFF the robot at our will. Otherwise, the circuit will always be in ON position which will waste a lot of power.

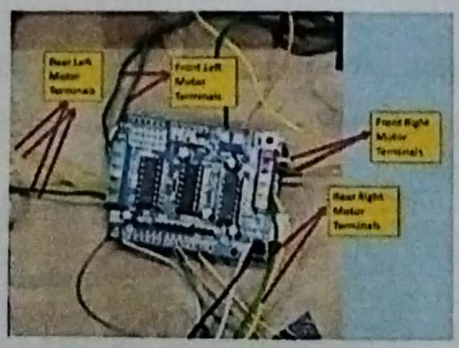


Fig 5.22: Circuit 3: ( Drive motor connections)

Now the pump and the mower have to be operated independently but on command. This can be achieved by connecting positive terminals of Pump and Motor to any two of the D series (i.e. D9, D10, D11....so on) which are present on the Arduino Board, and the negative terminals of the pump and the Mower are to be connected to the ground of the Arduino board.

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Fig 5.23: Circuit 4: (Mower and Pump connections)

For the chosen battery charging and discharging are from the same two terminals, so a diode is provided for the recharging of Battery through solar panel. It is placed on top of the positive terminal of the battery. This diode also makes sure that the battery does not overcharge. Now the power supply connections have to be made to Arduino and Motor shield so that they can distribute the power to all the electrical components and they run according to the input commands. A switch is provided to ON/OFF the circuit whenever needed.

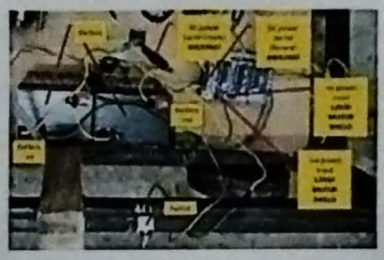

Fig 5.24: Circuit 5: (Power supply connections)

From the above circuit we can see that only Arduino power supply is connected, so a dim light glows in the Motor shield. Motor shield power supply is cut off by the switch (OFF Position).

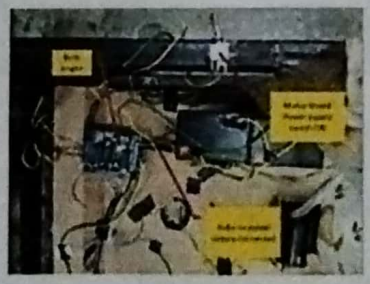

Fig 5.26: Circuit 26: (Both Motor shield and Arduino ON)

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From the above circuit we can see that both Arduino and Motor power supplyare connected, so a bright light glows in the Motor shield. Now the switch in in ON position.

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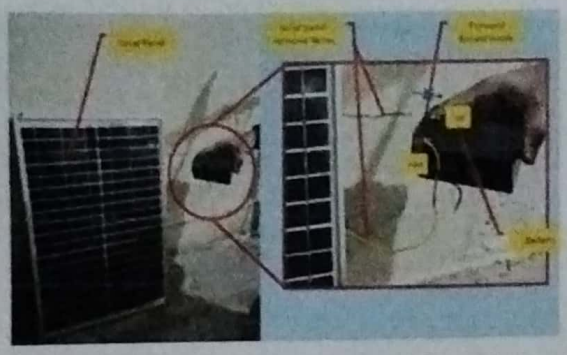

Fig 5.27: Circuit 8: (Solar Panel and Battery)

From the above diagram, we can see the connection of solar panel to the battery. A diode is provided in forward biased from solar panel to battery to prevent the back flow of current from battery to solar panel.

## 5.3 Program for the robot:

Before giving any connections to the Arduino and Motor shield, first compile a code in a PC in an app called ARDUINO IDE. Compile a code for the required application without any errors. Then plug in the Arduino board with the PC and upload the code

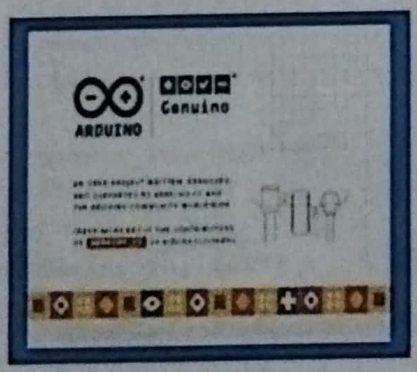


Fig 5.28: Arduino IDE Software

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Agrobot_sprayer_mower

```
#include <AFMotor.h>
#define mower_FR 9 //Mower Digital pin 9
#define pump_RE 10 //Pump Digital pin 10
boolean mower = false;
boolean pump = false;
//initial motors pin
AF_DCMotor motor1(1, MOTOR12_1KHZ);
AF_DCMotor motor2(2, MOTOR12_1KHZ);
AF_DCMotor motor3(3, MOTOR34_1KHZ);
AF_DCMotor motor4(4, MOTOR34_1KHZ);
char command;
void setup()
{
  pinMode(mower_FR, OUTPUT);
  pinMode(pump_RE, OUTPUT);
  Serial.begin(9600); //Set the baud rate to your Bluetooth
}
void loop()
{
  if (Serial.available() > 0) {
  command = Serial.read();
  Stop(); //initialize with motors stoped
  if (mower) {
  digitalWrite(mower_FR, HIGH);
  }
  if (!mower) {
  digitalWrite(mower_FR, LOW);
  }
  if (pump) {
  digitalWrite(pump_RE, HIGH);
  }
  if (!pump) {
  digitalWrite(pump_RE, LOW);
  }
```

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Wheels 4

Long PVC Pipe (Dia 1 inch) 1

Long PVC pipe (Dia 1.05 inch) 1

Spray Nozzles 2

Tubing (3m long) 1

Y joint with straws 1 12V

DC Pump 1

Container (1 Litre capacity) 1

Cutting blade 1

Arduino Board 1

L293D Motor Control Shield 1

HC-05 Bluetooth Module 1

Electrical Wires (5m long) 1

Rubber washers (Internal dia 0.99 in) 3

Screws (M08) 3

Nuts (8mm) 5

Switch 1

Solar Panel 1

Forward Biased Diode 1

6V Sealed Lead-Acid Battery (4.5Ah) 2

Custom Made Stoppers (PVC) 2

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## VI. RESULTS

From that we have get the result, the solar powered pesticide sprayer using IOT is the automotive system technology which is the best for the farm. Hence it consume the time, man power and no need to more than one person to handle the system.

### CONCLUSION AND FUTURE SCOPE

## CONCLUSION

- The prototype gave a fairly good rate of area coverage with a reasonably low operating cost. The system addresses the issue of dearth of agricultural labour and ensures safe agricultural practices by completely eliminating, handling of harmful chemicals, cutting crops and extensive labour by the farmer as it can be operated remotely.

- The proposed spraying & mower robot is suitable for small and medium scale farmers. Large scale production of the spraying unit will reduce the cost significantly giving partial thrust to Indian agriculture practices.

- The unit can be scaled up based on the requirement. The developed system can not only be used for spraying fertilizer, pesticides, fungicides, lawn watering and crop cutting , weeding and lawn mowing but also for maintenance of sports fields like cricket ground.

- With the proposed design of the robot in this project, the above mentioned gaps can be eliminated completely. This project integrates two of the major activities in agriculture which are Pesticide spraying and Crop Cutting (or Weed Removal).

- Workload on the farmers is decreased and health problems also. Successful in constructing robot which can be travelled on rough, uneven surfaces also and weighing enough load of pump and other equipment. Successful in developing a robot whose construction is enough to withstand the challenges of the field.

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## FUTURE SCOPE

Mechatronics is playing an enormous role in agricultural production and management. There is a desire for autonomous and timesaving technology in agriculture to possess efficient farm management. The researchers are now aiming towards different types of farming parameters to style autonomous multipurpose agricultural robots because traditional farm machineries and topological dependent. Till date the multipurpose agricultural robots have been researched and developed mainly for harvesting, fertilizer spraying, picking fruits, sowing, solar energy and monitoring of crops. Robots like these are brilliant replacements for manpower to a better extent as they deploy unmanned sensors and machinery systems. The agricultural benefits of development of these autonomous and intelligent robots are to improve repetitive precision, efficiency, reliability and minimization of soil compaction and chemical utilization. The robots have the potential of multitasking, sensory measures, idle operation as well working in odd operating conditions. The study on multipurpose agricultural robot system had been done using model structure design along with various precision farming machineries. With fully automated farms in the future, robots can perform all the tasks like ploughing, seed sowing, pesticides spraying, monitoring of pests and diseases, harvesting, etc.

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