DESIGN AND FABRICATION OF MULTIPURPOSE AGRICULTURAL ROBOT

A Thesis

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SONARGAON UNIVERSITY (SU), DHAKA

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A thesis report submitted to the department of mechanical engineering for the partial fulfillment of the degree of Bachelor of Science in Mechanical Engineering.

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APPROVAL

This is to certify that the project on "DESIGN AND FABRICATION OF MULTIPURPOSE AGRICULTURAL ROBOT" By MD SAKIBUL ISLAM (ID No: ME 2101023013), MD. GAZZALI HOSSEN (ID No: ME 2103025426), MD. AKRAM HOSSAIN (ID No: BME 1503007299), MD SHAHIN ALAM (ID No: BME 1903019425), MAHADI HASNAT (ID No: BME 2001020112) have been carried out under our supervision. The project has been carried out in partial fulfillment of the requirements of the degree of Bachelor of Science (B.Sc.) in Mechanical Engineering of years of 2025 and has been approved as to it's style and contents.

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DECLARATION

We, hereby, declare that the work presented in this project is the outcome of the investigation and research work performed by us under the supervision of *Ibrahim Khalil Apurba, Lecturer*, Department of Mechanical Engineering, Sonargaon University (SU). We also declare that no part of this project and thesis has been or is being submitted elsewhere for the award of any degree.

Abstract

Mechanization has significantly transformed agriculture in Bangladesh by enhancing productivity, reducing labor costs, and saving time through the use of machines in various farming stages. This project presents a cost-effective, multipurpose agricultural robot designed to automate key tasks such as plowing, seed sowing, water spraying, and pesticide application. The system is powered by an Arduino Uno microcontroller, enabling precise operation and coordination. The robot is controlled via a smartphone Bluetooth application and is developed using computer software for both design and simulation, the prototype integrates electronic, sensor, and mechanical systems to offer an efficient and sustainable solution for modern farming, especially in developing countries.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

Farming is vital to Bangladesh's economy, relying heavily on traditional methods like plowing and sowing. However, these methods often lead to productivity challenges and high labor costs. Mechanization offers a solution, bridging the gap between manual labor and modern technology. Agribusinesses increasingly turn to automation, focusing on automating key farming tasks like seeding, weeding, and spraying. Designing robots for these tasks requires consideration of both the agricultural environment and precision levels compared to conventional methods. Environmental factors such as bumpy terrain and varying soil moisture levels must be accounted for in sensor selection. Despite advancements, challenges like limited energy and water access persist, urging the need for technological advancement in farming [1]. Research is ongoing in areas like remote sensor usage for data collection to improve agricultural efficiency. However, full automation in farming remains elusive due to various obstacles, hindering widespread adoption by farmers. This paper proposes smart agriculture solutions using automation technology to address these challenges and benefit farmers. The integration of IoT technology in agriculture facilitates automation, enabling real-time data collection on soil conditions and crop growth for informed decision-making. Solar-powered robots offer sustainability benefits by reducing reliance on fossil fuels and lowering carbon emissions. By optimizing crop yields and enabling remote monitoring, IoT-based robots have the potential to transform agriculture, making it more efficient, sustainable, and profitable. An agricultural robot (AG bot) provides an overview of its significance, functionality, and applications in modern farming practices. Agricultural robots, also known as robots or robots, are innovative machines designed to assist and automate various tasks in agriculture, ranging from planting and harvesting to irrigation and pest control.

1.2 Literature Review

Here are summaries of papers on multipurpose agricultural robots, including details of the year, authors, title, and a brief introduction to their work:

D A Mada In 2013, made a research paper and mentioned the importance of smart agricultural systems by giving examples [2]. The conclusion from the paper was the need for a multipurpose machine that will be used before harvesting the crops. We considered this for our research and further production of our multipurpose agricultural machine.

Jin et al, present the design and experimental results of a multipurpose agricultural robot in 2021 [3]. The robot is equipped with various modules for tasks such as plowing, seeding, spraying, and harvesting. It utilizes advanced control algorithms and sensor systems to navigate and perform tasks autonomously in different agricultural environments.

Wang [4] and colleagues developed a versatile agricultural robot system capable of performing multiple tasks in 2020. Their work focuses on the design and implementation of the robot's mechanical structure, control system, and task specific modules. The robot system aims to improve efficiency and reduce labor costs in agricultural operations.

Liu et al. present the development of a multipurpose agricultural robot tailored for small-scale farms in 2021. The robot is designed to be affordable and adaptable to various farm sizes and crop types. Their research addresses the specific challenges faced by small-scale farmers, offering a practical solution to improve productivity and sustainability [5].

In 2021, Chen and co-authors explore the integration of IoT technology into a multipurpose agricultural robot. Their work focuses on enhancing the robot's capabilities through real-time data collection and analysis. By leveraging IoT, the robot can optimize resource usage, monitor crop health, and adapt to changing environmental conditions for improved agricultural performance [6].

Kim et al. propose an autonomous navigation system tailored for a multipurpose agricultural robot in 2022. Their research emphasizes the development of robust localization and mapping algorithms to enable accurate and efficient navigation in complex farm environments. The system aims to enhance the robot's autonomy and reliability during task execution [7].

Gupta and collaborators introduce a vision-based control system designed for a multipurpose agricultural robot in 2022 [8]. Their work focuses on integrating computer vision techniques to enable object detection, localization, and manipulation tasks. By harnessing visual information, the robot can perform precise and adaptive actions, enhancing its effectiveness in various agricultural tasks.

In 2022 Patel et al. [9] explore a swarm robotics approach for multipurpose agricultural tasks. Their research investigates the coordination and cooperation of multiple robotic agents to accomplish complex farming.

In 2023 Yang et al. propose an energy-efficient design for a solar-powered multipurpose agricultural robot. Their work focuses on optimizing the robot's power management system to maximize energy harvesting and utilization. By harnessing solar energy, the robot can operate autonomously for extended periods, reducing reliance on conventional power sources and minimizing environmental impact [10].

1.3 Objectives

The design of multipurpose agro equipment machines will help Bangladesh farmers in the rural side and small farms It will reduce the cost of seed feeding, pesticide sprinkling, and crop cutting in the field and will help to increase the economic standard of a Bangladesh farmer.

1. To design and fabricate multipurpose agriculture machines.
2. To minimize the cost so that it should be affordable for everyone.
3. To reduce the amount of time for operation.

1.4 Methodology

Our methodology for the project:

• Creating an idea for a multipurpose agricultural robot system and drawing a list of components/materials to determine which components/materials are needed to construct it.

• Collecting all the components/materials to construct the system.

• Finally, we constructed this system & checked that it is working very well.

1.5 Structure of the Project

This project book consists of five chapters. The first chapter contains the statement of the introduction, our background study for the project, Literature Review, objectives of the study in the project, Methodology, and the project organization. Chapter two contains System design and simulation. Here we describe the design of this project, block diagram and circuit diagram, working principle, background, real project, details of components, and instrument details of the whole project. Chapter three contains the Hardware implementation.Chapter four deals with the experimental results, calculations, advantages, and application of this project. In the final chapter, we discuss about future scope and conclusion of our project.

CHAPTER 2

SYSTEM DESIGN AND SIMULATION

2.1 Introduction

In this chapter we describe our project block diagram, circuit diagram, project working principle and final project view.

2.2 Block Diagram

In our project, we have set up an Agricultural Robot. In this system, we are using an Android app-based Bluetooth controller. Here we also use a DC 12A Storage battery, HC-05 Bluetooth module, L298 DC motor driver module, MOSFET, DC Geared Motor, ETC.

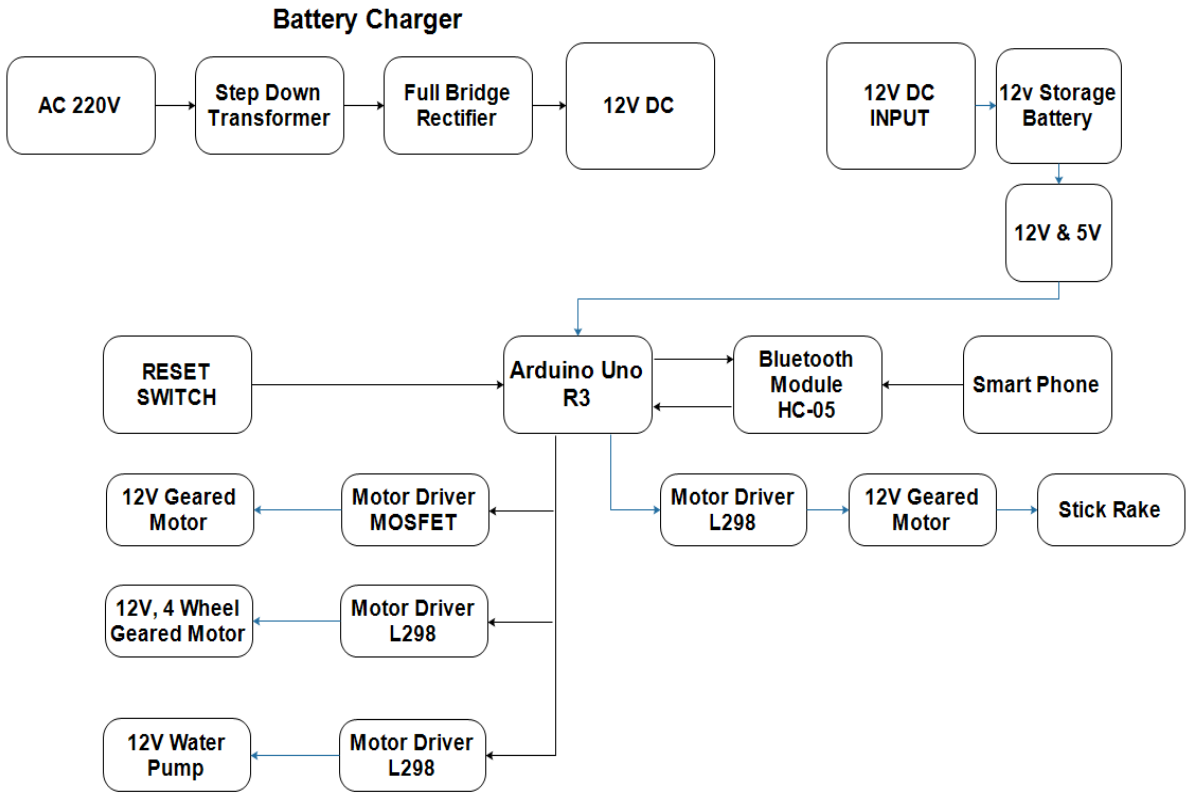


Figure 2.2: Block Diagram of Multipurpose Agricultural Robot System.

2.3 Working Principle

The robot is powered by four DC geared motors, which are also responsible for turning. The motors are powered by a 12V battery. The power for the motor is regulated by the L298 Motor driver module. The direction of motor rotation can be controlled by a Bluetooth-controlled smartphone app controller for steering the vehicle in either a left or right direction. Main Control Unit an Arduino microcontroller board is visible inside the middle compartment of car. Receives control commands wirelessly from smart phone. Controls motor drivers and actuators based on the program logic. Robotic Arm with Gripper Mechanism at the front, a metallic claw (excavator-like) is used to dig soil, pull weeds. DC Gear Motor Powers the vertical motion of the arm, seen mounted at the back of the arm support. The transparent hopper box at the top is used for Seed storage for sowing automation. Fertilizer dispenser. A controlled mechanism could allow dispensing at intervals.

2.4 Basic 2D Drawing of System

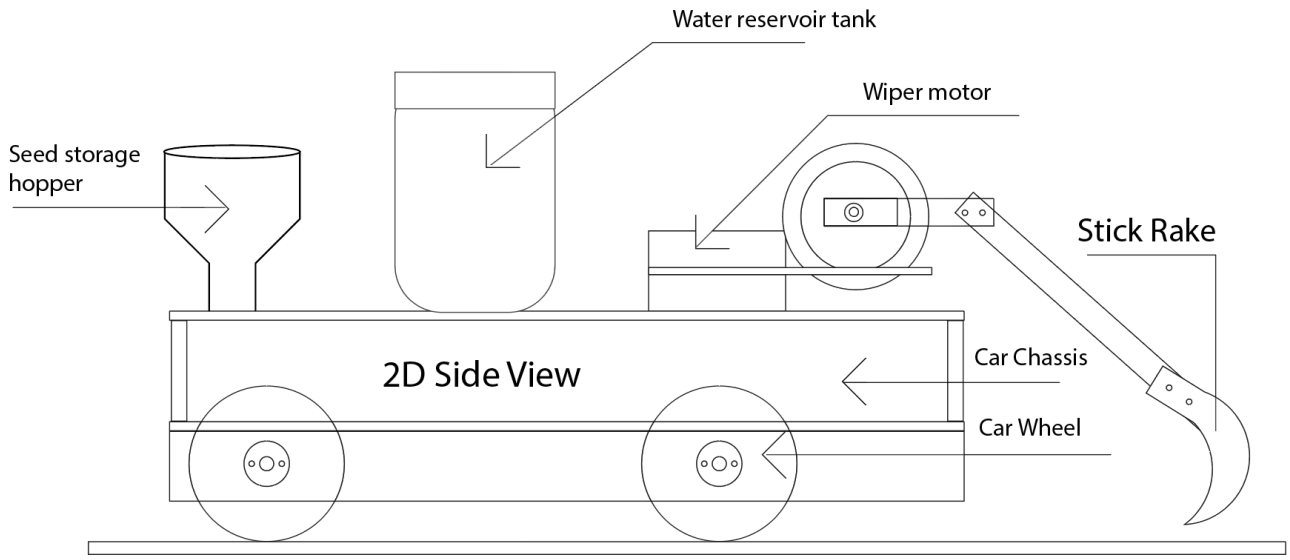


Figure 2.4: Basic Drawing of this System

This 2D side view drawing illustrates a multi-functional agricultural robot, which appears to be designed for tasks like sowing seeds, watering, and possibly clearing debris using a stick rake. Here is a breakdown of its key components:

Parts and Their Functions

- **Seed Storage Hopper:**

A funnel-shaped container used to store seeds.

Seeds are likely dispensed in a controlled manner for sowing as the robot moves.

- **Water Reservoir Tank:**

Holds water for irrigation.

It may be connected to a system that allows controlled water delivery to the soil.

- **Wiper Motor:**

Typically used in car wipers, but here it is repurposed to drive a mechanical action—possibly the stick rake.

Converts electrical energy into mechanical motion.

- **Stick Rake:**

Mounted on a pivot and driven by the wiper motor.

Could be used to clear sticks, leaves, or debris from the soil surface before sowing or watering.

- **Car Chassis:**

The base frame that supports all components of the robot.

Provides structural integrity and houses mechanical/electronic parts.

- **Car Wheels:**

Allow the robot to move across the field.

Movement can be manual or motor-driven.

This agricultural robot is likely autonomous or remotely operated, designed to:

- Clear the field using the stick rake.
- Sow seeds via the hopper.
- Water plants using the water tank.

Its modular design allows for simultaneous or sequential task execution, improving efficiency in agricultural operations, especially for small-scale farms or precision agriculture.

2.5 Power Supply

In this project we use one 5 volt regulated power supply to convert the 220 volt ac in to 5 volt dc with the help of the 5 volt regulator circuit. First OF all we step down the 220volt ac into 6 volt ac with the help of step down transformer.

Step down transformer step down the voltage from 220 volt ac to 12 volt ac. This ac is further

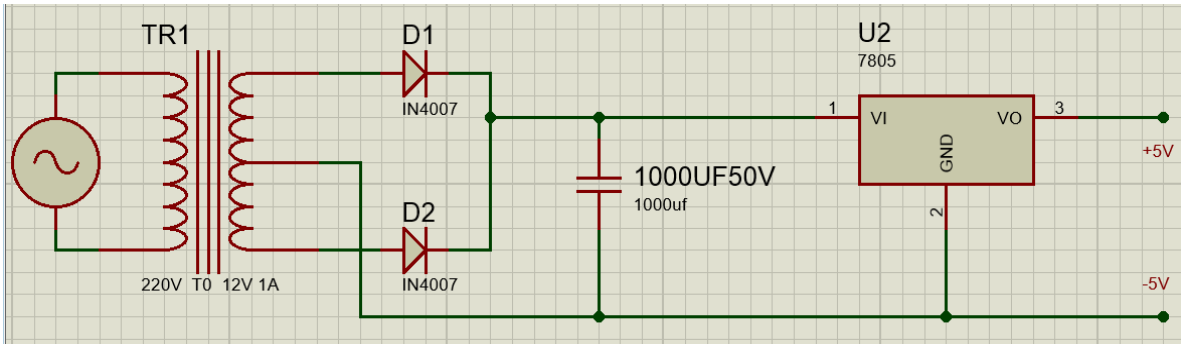


Fig -2.6: Power Supply

converted into the dc voltage with the help of the full wave rectifier circuit. Output of the diode is pulsating dc. So to convert the pulsating dc into smooth dc we use electrolytic capacitor. Electrolytic capacitor converts the pulsating dc into smooth dc. This Dc is further regulated by the IC 7805 Regulator. IC 7805 regulator provide a regulated 5Volt dc to the microcontroller circuit and LCD circuit. Pin no 11, 32 of the controller is connected to the positive supply. Pin no 12, 31 is connected to the ground. Pin no 1 is connected to external resistor capacitor to provide an automatic reset option when power is on.

As discussed in the previous section all the components required will be assembled right now to design and implement our project. A Solder, soldering wire and solder holder will be required to assemble these components according to the circuit diagram listed below.

2.6 Circuit Diagram

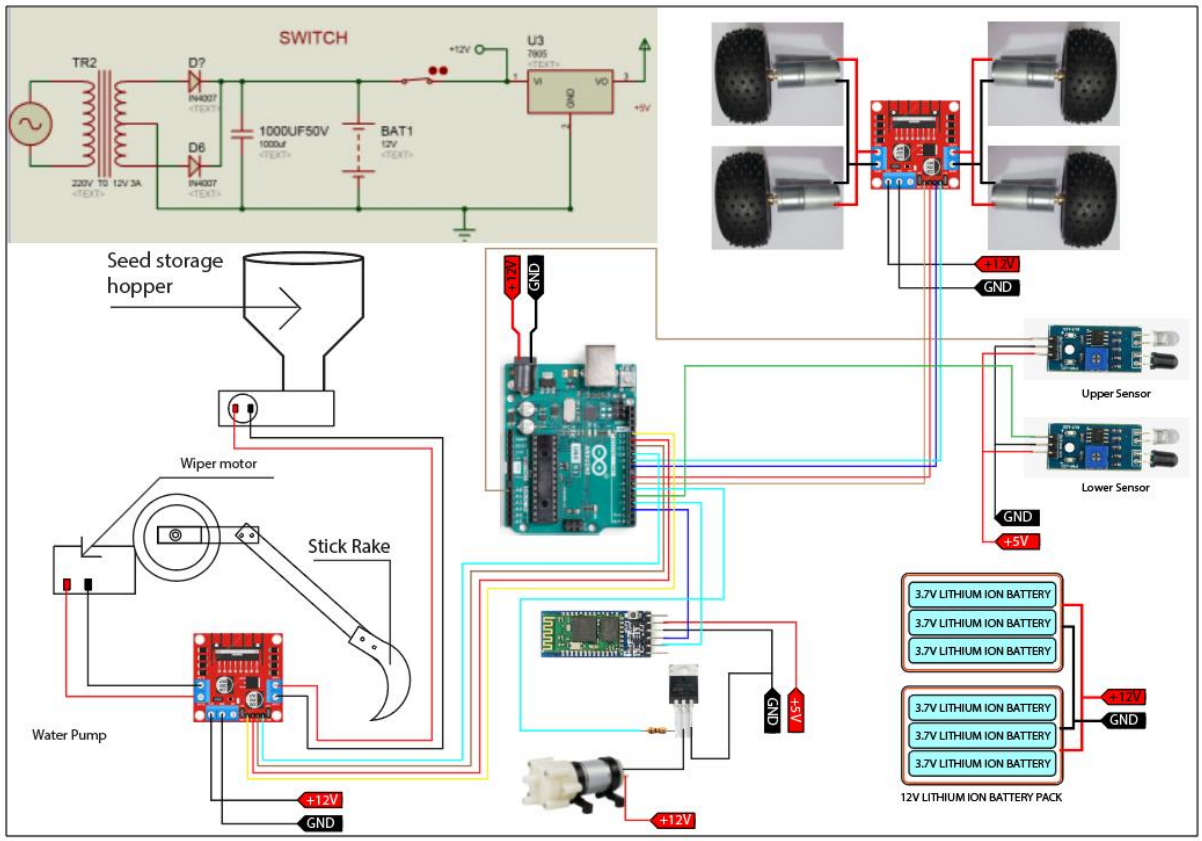


Fig -2.6: Circuit Diagram

This circuit diagram represents a *multipurpose agricultural robot* that integrates soil preparation, seed sowing, and watering functionalities, all wirelessly controlled via a smartphone using Bluetooth communication. At the heart of the system is an *Arduino Uno* microcontroller that manages the robot's operations. The Arduino is powered by a 12V lithium-ion battery pack composed of six 3.7V cells connected in a configuration to provide stable 12V output. A *7805 voltage regulator* is used to convert 12V to 5V for components that require lower voltage, such as sensors and the Bluetooth module. The *mobility of the robot* is enabled by four DC geared motors attached to wheels, which are driven by a dual H-bridge motor driver module (L298N). The motor driver receives power from the 12V supply and signal inputs from the Arduino. This allows the robot to move in all directions, guided by commands sent from a smartphone via a Bluetooth module (HC-05). The Bluetooth module communicates wirelessly with the Arduino and is powered by a 5V source.

The robot includes a *stick rake mechanism, driven by a wiper motor. This is used to till or grab the soil before planting seeds. The motor receives its control signals from another L298N motor driver, connected to the Arduino. Beside the rake, a **hopper mechanism* controlled by a geared DC motor is used to drop seeds. The Arduino controls this motor too, ensuring seeds are dispensed in the prepared soil in a timely manner. The *watering system* consists of a small water pump, also powered by 12V. A transistor (likely an NPN type) acts as a switch, allowing the Arduino to control the pump's operation. A base resistor ensures correct biasing of the transistor, while the pump gets its power directly from the 12V supply line. Two *infrared sensors* (upper and lower) are used, most likely to detect obstacles or for soil surface alignment. They are powered by 5V and send their output back to the Arduino. These sensors help the robot align itself properly or detect planting rows or the ground level to adjust the stick rake or seed hopper mechanisms accordingly. The entire power system starts from a 220V AC supply, stepped down to 12V AC by a transformer (TR2), then rectified by diodes (D6 and D7) and filtered by a 1000uF capacitor. This forms an optional charging or stationary supply input rather than a part of the mobile robot, which runs on the lithium-ion battery pack. In summary, this agricultural robot integrates multiple functions soil raking, seed sowing, and irrigation controlled intelligently by an Arduino. It receives commands from a smartphone via Bluetooth and uses multiple motors and sensors to perform agricultural operations autonomously or semi-autonomously in a small-scale farming environment.

2.7 Real View of Project

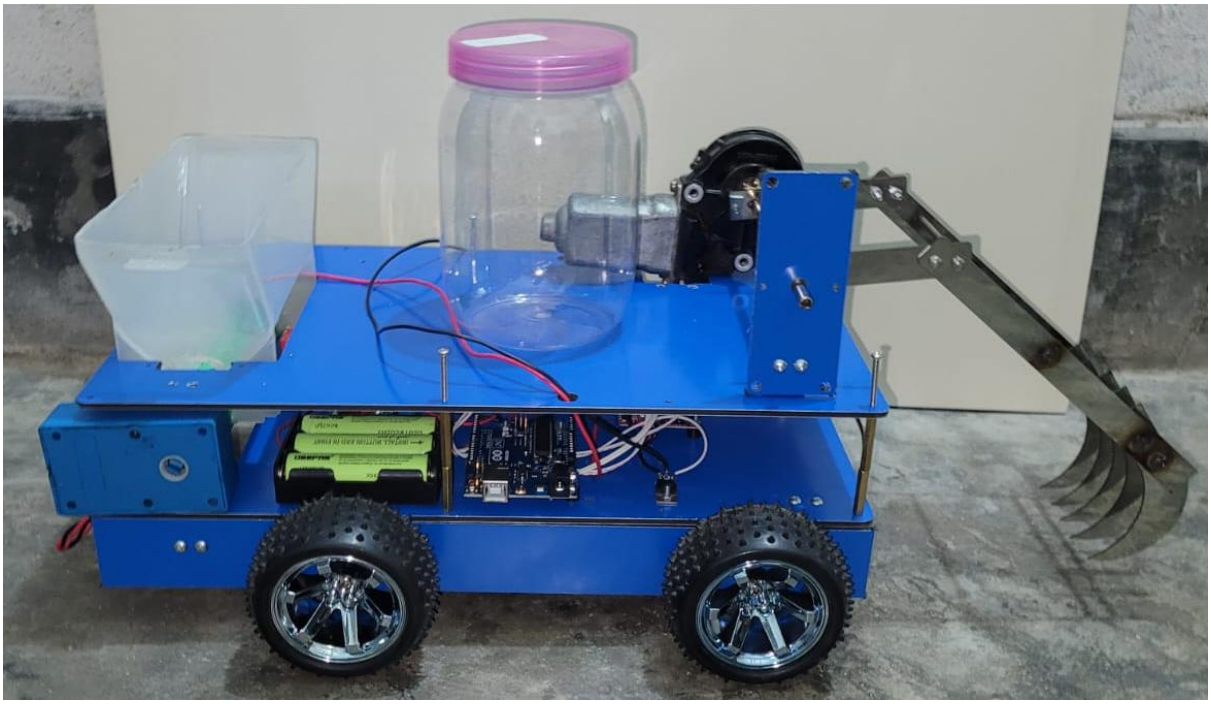


Figure 2.7: Our Project Prototype (Side View)

2.8 Robot control app:

The **Bluetooth RC Controller App** is a mobile application designed to wirelessly control robots, cars, or other Bluetooth-enabled devices using a smartphone. It communicates with devices like Arduino or any microcontroller equipped with a Bluetooth module HC-05.

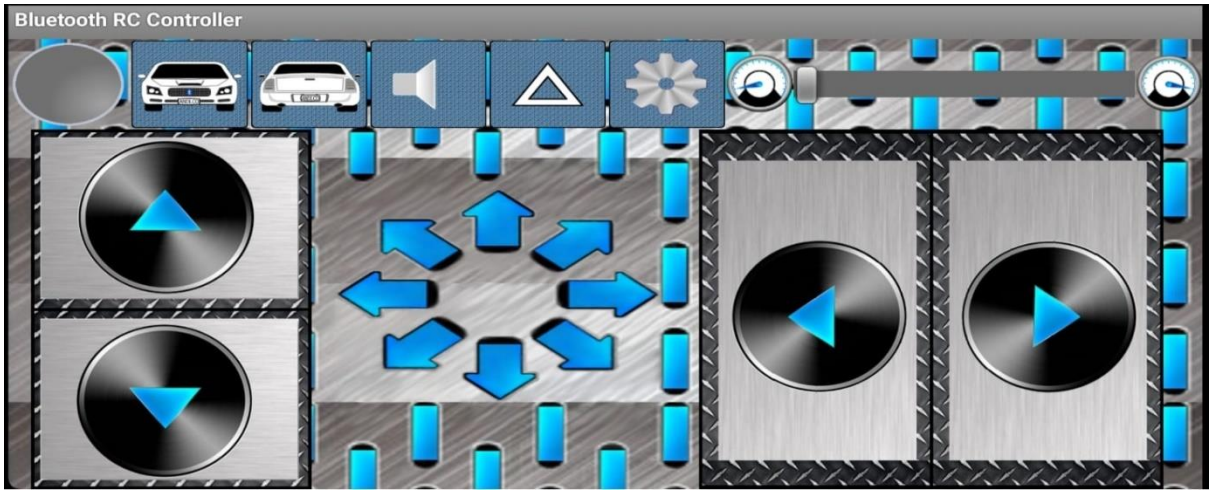


Figure 2.8: Our Project Prototype (Side View)

Key Features

- **Directional Control Buttons**: The app includes virtual buttons for movements—forward, backward, left, right, and stop.
- **Custom Commands**: Some versions allow setting your own custom characters or strings to match your robot's command protocol.
- **Simple Pairing**: Easily pairs with Bluetooth modules like HC-05 by selecting from a list of available Bluetooth devices.
- **Real-Time Control**: Sends commands instantly, allowing responsive real-time operation of your robot.

CHAPTER 3

HARDWARE IMPLEMENTATION

3.1 Introduction

This Project has worked on the Hardware section. Hardware is the most visible part of any information system. Here, our main hardware is 12V DC Power supply, four wheel geared motor, Arduino Uno R3, Bluetooth Module HC-05, Motor Driver L298, Motor Driver MOSFET, 12V Geared Motor, Stick Rake, Wire, Cable Tie, Switch, Chamber Material, etc. This equipment will be attached and made properly.

3.2 Components List and Costing:

No	Components Name	Quantity	Unit Price	Total Price
01	Stick Rake	1	600	600
02	Seeding Geared motor	1	500	500
03	Car wheel geared motor	4	250	1000
04	Car wheel	4	120	480
05	Car wheel geared motor driver	2	400	800
06	Arduino microcontroller board	1	550	550
07	IR limit sensor	2	100	200
08	Water pump	1	180	180
09	Water reserve tank	1	60	60
10	Seed delivery hopper	1	300	300
11	12V battery	1	250	250
12	Car chassis	1	500	500
13	Connecting wire	30	5	150
14	220V Power supply	1	200	200
15	MOSFET	1	50	50
16	Wiper motor	1	280	280
Total=				**6,100**

3.3 Arduino Uno R3

The Arduino Uno R3 is a microcontroller board based on the ATmega328.It has 14(Fourteen) digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, 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.

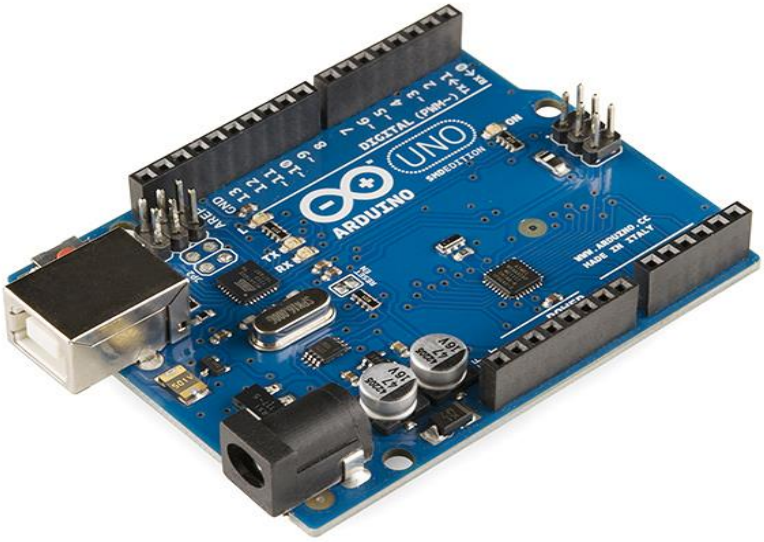


Fig: 3.1: Arduino Uno R3

For the sake of simplicity, we will make groups of pins with similar functionalities.

Power Pins there are four power pins viz. one VIN pin & three 3.3V pins. The VIN pin can be used to directly supply the Arduino Uno R3 and its peripherals, if you have a regulated 5V voltage source. The 3.3V pins are the output of an on-board voltage regulator. These pins can be used to supply power to external components.

GND is a ground pin of Arduino Uno R3 development board.

I2C Pins are used to hook up all sorts of I2C sensors and peripherals in your project. Both I2C Master and I2C Slave are supported. I2C interface functionality can be realized programmatically, and the clock frequency is 100 kHz at a maximum. It should be noted that I2C clock frequency should be higher than the slowest clock frequency of the slave device.

GPIO Pins Arduino Uno R3 has 17 GPIO pins which can be assigned to various functions such as I2C, I2S, UART, PWM, IR Remote Control, LED Light and Button programmatically. Each digital enabled GPIO can be configured to internal pull-up or pull-down, or set to high impedance. When configured as an input, it can also be set to edge-trigger or level-trigger to generate CPU interrupts.

ADC Channel The NodeMCU is embedded with a 10-bit precision SAR ADC. The two functions can be implemented using ADC viz. Testing power supply voltage of VDD3P3 pin and testing input voltage of TOUT pin. However, they cannot be implemented at the same time.

UART Pins Arduino Uno R3 has 2 UART interfaces, i.e. UART0 and UART1, which provide asynchronous communication (RS232 and RS485), and can communicate at up to 4.5 Mbps. UART0 (TXD0, RXD0, RST0 & CTS0 pins) can be used for communication. It supports fluid control. However, UART1 (TXD1 pin) features only data transmit signal so, it is usually used for printing log.

SPI Pins Arduino Uno R3 features two SPIs (SPI and HSPI) in slave and master modes. These SPIs also support the following general-purpose SPI features:

- 4 timing modes of the SPI format transfer
- Up to 80 MHz and the divided clocks of 80 MHz
- Up to 64-Byte FIFO

SDIO Pins Arduino Uno R3 features Secure Digital Input/output Interface (SDIO) which is used to directly interface SD cards. 4-bit 25 MHz SDIO v1.1 and 4-bit 50 MHz SDIO v2.0 are supported.

PWM Pins The board has 4 channels of Pulse Width Modulation (PWM). The PWM output can be implemented programmatically and used for driving digital motors and LEDs. PWM frequency range is adjustable from 1000 μs to 10000 μs, i.e., between 100 Hz and 1 kHz.

Control Pins are used to control Arduino Uno R3. These pins include Chip Enable pin (EN), Reset pin (RST) and WAKE pin.

- EN pin – The Arduino Uno R3 chip is enabled when EN pin is pulled HIGH. When pulled LOW the chip works at minimum power.
- RST pin – RST pin is used to reset the Arduino Uno R3 chip.
- WAKE pin – Wake pin is used to wake the chip from deep-sleep.

Technical specifications:

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (Atmega328P) of which 0.5 KB used by boot loader
SRAM	2 KB (Atmega328P)
EEPROM	1 KB (Atmega328P)
Clock Speed	16 MHz

The Atmega328 is a single chip micro-controller created by Atmel and belongs to the mega AVR series. Today the Atmega328 is commonly used in many projects and autonomous systems where a simple, low-powered, low-cost micro-controller is needed. Perhaps the most common implementation of this chip is on the popular Arduino development platform, namely the Arduino Uno and Arduino Nano models.

Key features of this device is as below.

- 28-pin AVR Microcontroller
- Flash Program Memory: 32 k bytes
- EEPROM Data Memory: 1 k bytes
- SRAM Data Memory: 2 k bytes
- I/O Pins: 23
- Timers: Two 8-bit / One 16-bit
- A/D Converter: 10-bit Six Channel
- PWM: Six Channels
- RTC: Yes with Separate Oscillator
- MSSP: SPI and I²C Master and Slave Support
- USART: Yes
- External Oscillator: up to 20MHz

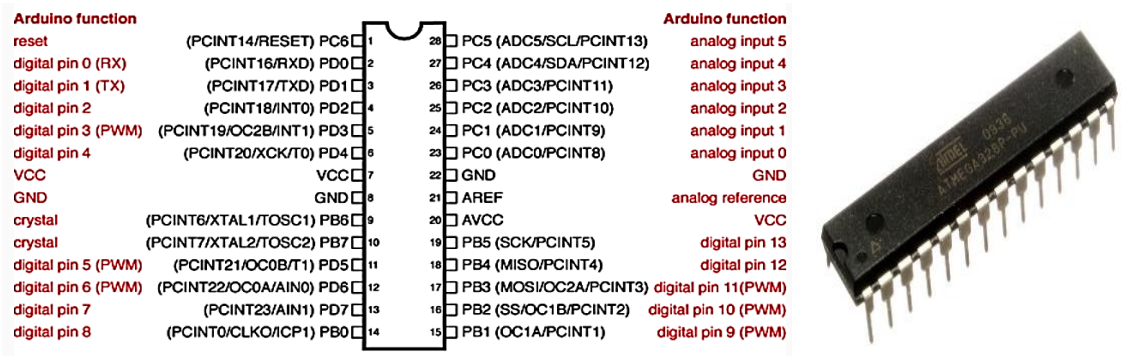


Fig: 3.2: ATMEGA328P-PU chip to Arduino Pin Mapping

3.4 Power Supply

A bridge rectifier circuit is a common part of the electronic power supplies. Many electronic circuits require rectified DC power supply for powering the various electronic basic components from available AC mains supply. We can find this rectifier in a wide variety of electronic AC power devices like home appliances, motor controllers, modulation process, welding applications, etc.

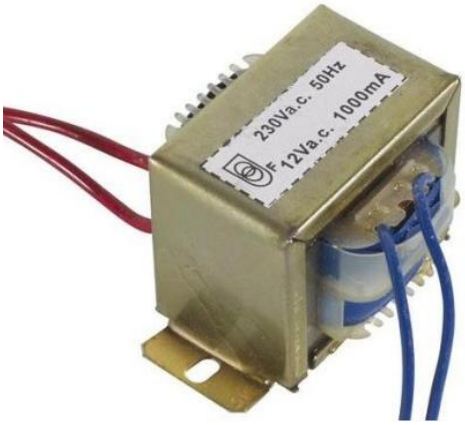


Fig: 3.3 220/12V Transformer

The bridge rectifier circuit diagram consists of various stages of devices like transformer, Diode Bridge, filtering and regulators. The first stage of the circuit is a transformer which is a step-down type that changes the amplitude of the input voltage. Most of the electronic projects uses 230/12V transformer to step-down the AC mains 230V to 12V AC supply. Next stage is a diode-bridge rectifier which uses four or more diodes depending on the type of

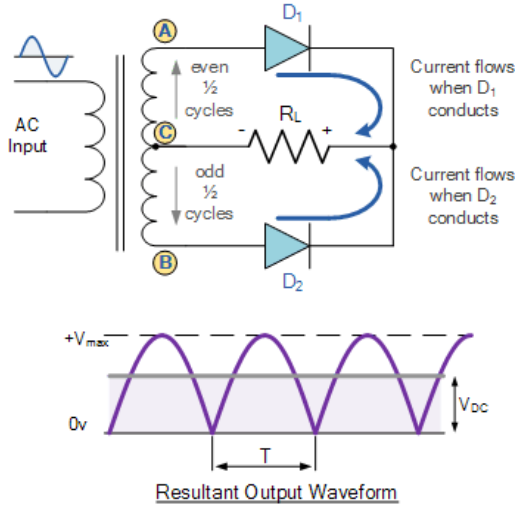


Fig: 3.4 Output Waveforms of 220V/12V rectifier

bridge rectifier. Choosing a particular diode or any other switching device for a corresponding rectifier needs some considerations of the device like Peak Inverse Voltage (PIV), forward current If, voltage ratings, etc. It is responsible for producing unidirectional or DC current at the load by conducting a set of diodes for every half cycle of the input signal.

Since the output after the diode bridge rectifiers is of pulsating nature, and for producing it as a pure DC, filtering is necessary. Filtering is normally performed with one or more capacitors attached across the load, as you can observe in the below figure wherein smoothing of wave is performed. This capacitor rating also depends on the output voltage.

3.5 Voltage Regulator IC 7805

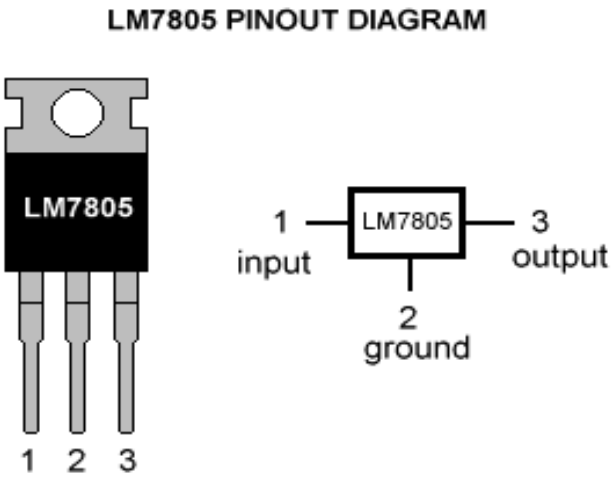


Fig: 3.5 LM7805 pin out diagram

As we require a 5V we need LM7805 Voltage Regulator IC.

7805 IC Rating:

Input voltage range 7V- 35V

Current rating I_c = 1A

Output voltage range $V_{Max=5.2V}$,$V_{Min=4.8V}$

3.6 Vero board

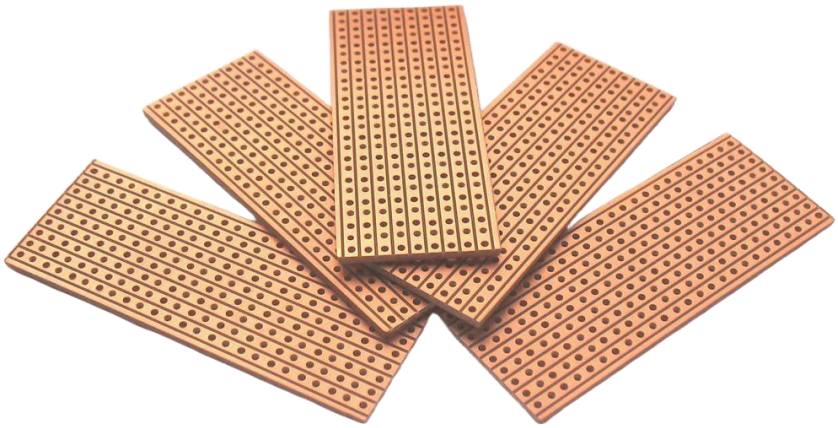


Fig: 3.6 Vero board

Vero board is a brand of strip board, a pre-formed circuit board material of copper strips on an insulating bonded paper board which was originated and developed in the early 1960s by the Electronics Department of Vero Precision Engineering Ltd (VPE). It was introduced as a general-purpose material for use in constructing electronic circuits - differing from purpose-designed printed circuit boards (PCBs) in that a variety of electronic circuits may be constructed using a standard wiring board.

3.7 Automatic Seed Sowing System



Fig: 3.7 Automatic Seed Sowing System

This is a motorized hopper-based seed sowing system designed for automated planting. The main component is a 12V DC gear motor connected to a rotating roller mechanism placed at the bottom of a plastic hopper. The hopper holds the seeds, and when voltage is applied to the motor, the roller starts rotating. The roller contains several holes or slots that pick up seeds from the hopper and drop them into the soil as it turns. This system ensures uniform seed distribution and reduces manual labor. It can be used in small-scale automated agricultural robots.

Specification:

- Motor Operation Voltage:12V
- Speed: 55 Rpm
- No load current: 2A
- Stall current: 10A
- Stall Torque: 45 kg-cm
- Motor Power: 120W
- Shaft diameter: 10mm
- Shaft dimension: 29mm
- Weight:1280gr

3.8 Automatic Soil Digging Stick Rake

This is a stick rake system powered by a 12V wiper gear motor and constructed using stainless steel (SS). The rake is designed for digging soil efficiently and is controlled automatically using two IR

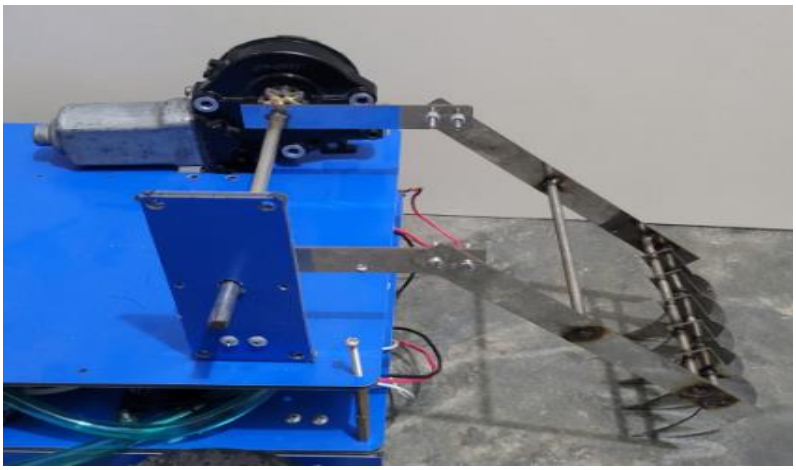


Fig: 3.8 Automatic Soil Digging Stick Rake

sensors. The IR sensors detect the position of the rake, determining how far it should move up down. These signals are processed by a microcontroller, which controls the motor accordingly. When the IR sensors detect that the rake has reached the desired position, the microcontroller stops or reverses the motor direction. This setup allows automatic depth control agricultural robots.

Specifications:

- Voltage: 12V DC
- Current Draw: 3A to 6A (varies with load)
- Speed:

  Low speed: ~45 RPM

  High speed: ~60 RPM

  (Some motors may have variable or intermittent modes)

- Torque: 4 Nm to 10 Nm (depends on motor type)
- Shaft Type: Splined or D-shaft (varies by model)
- Mounting: Bolt-on or bracket-mounted
- Gear Type: Worm gear (for self-locking feature)
- Protection Rating: IP54 (splash-resistant)

Common Applications:

- Automotive windshield wipers
- Marine wiper systems
- Industrial cleaning equipment

Optional Features:

- Parking Switch: Auto-reset when turned off
- Intermittent Wiper Control: Adjustable delay
- Thermal Protection: Overload cut-off

3.9 12V Battery & 18650 3.7V 3 battery case

A lithium battery is a type of rechargeable (or sometimes non-rechargeable) battery that uses lithium ions (Li-ion) or lithium metal as a key component of its electrochemistry. These batteries are widely used due to their high energy density, lightweight, and long cycle life.



Fig: 3.9 Battery & 18650 3.7V 3 battery case

Basic Specifications:

- **Model:** 18650 (18mm diameter × 65mm length)
- **Chemistry:** Li-ion (Lithium-Ion) or Li-ion Hybrid
- **Nominal Voltage:** 3.7V
- **Capacity:** 4800mAh (milliampere-hours)
- **Energy:** ~17.76Wh (Watt-hours)
- **Charging Voltage:** 4.2V (standard for Li-ion)
- **Discharge Cut-off Voltage:** 2.5V–3.0V (varies by manufacturer)

Performance & Ratings:

- **Continuous Discharge Current:** 5A–10A (depends on brand)

- **Peak Discharge Current:** 10A–15A (short bursts)
- **Cycle Life:** 500–1000 cycles (to ~80% capacity)

- **Operating Temperature:**
    - **Charging:** 0°C to 45°C
    - **Discharging:** -20°C to 60°C

- **Safety & Protection:**

- **Protection Circuit:** Some include PCB (overcharge, over-discharge, short-circuit protection)
- **Certifications:** UL, CE, RoHS (if from a reputable brand)
- **Venting Mechanism:** PTC (pressure relief in case of overheating)

Physical Characteristics:

- **Weight:** ~45g–50g
- **Terminals:** Flat top or button top (check compatibility)
- **Case Material:** Steel (usually)

- **Charging Recommendations:**

- **Standard Charge:** 0.5C (2.4A for 4800mAh)
- **Fast Charge:** Up to 1C (4.8A, if supported)
- **Charging Time:** ~3–4 hours (standard rate)

Common Applications:

- Flashlights, power banks
- Laptops, electric tools
- E-bikes, portable devices

3.10 IR Sensor Module



Fig: 3.10 IR Sensor Module

Arduino 5V IR Sensor Module Specifications

Feature	**PIR Motion (HC-SR501)**	**IR Proximity (TCRT5000)**	**IR Receiver (TSOP38238)**	**IR Beam Break (KY-008)**
Operating Voltage	5V-12V (5V optimal)	3-5V (5V compatible)	2.5-5.5V (5V ideal)	5V only
Current Draw	65µA (idle), 8mA active	20mA (LED) + 5mA output	0.5mA (standby)	30mA (LED)
Output Type	Digital (TTL)	Digital (TTL)/Analog	Digital (demodulated)	Digital (TTL)
Detection Range	3-7m (adjustable)	1-25mm	10-15m (remote)	10-30cm
Response Time	0.3-5s (adjustable)	<10ms	<100µs	Instant
Interface	Single digital pin	Analog/Digital pin	Digital pin	Digital pin
Modulation	N/A	N/A	38kHz carrier	N/A
LED Indicator	Yes (red)	Yes (red/green)	No	Yes (IR emitter)
Dimensions	32×24×18mm	15×10×5mm	17×10×7mm	18×15×10mm
Special Features	Sensitivity & delay pots	Ambient light compensation	NEC protocol support	Requires reflector

Arduino Connection Guide:

IR Proximity Sensor:

VCC → 5V

OUT → Arduino Pin

GND → GND

3.11 25GA 100 RPM geared motor

A gear motor (or geared motor) is a small electric motor (AC induction, permanent magnet DC, or brushless DC) designed with an integral (non-separable) gear reducer (gearhead) attached. The end shield on the drive end of the motor (light blue, below) is designed to provide a dual function. The side facing the motor provides the armature/rotor bearing support and a sealing provision through which the integral rotor



Fig: 3.11 25GA 100 RPM geared motor

or armature shaft pinion passes. The other side of the motor end shield provides multiple bearing supports for the gearing itself, and a sealing and fastening provision for the gear housing (orange, below). This construction offers many benefits for a user and eliminates the guesswork of sizing a motor and gear reducer on your own.

Parameter	Specification
Motor Type	Permanent Magnet DC Geared Motor
Gearbox Type	Spur/Planetary (typically metal gears)
Output RPM	100 RPM (±10%) at rated voltage
Rated Voltage	6V or 12V DC (verify model-specific)
No-Load Current	60-100 mA
Stall Current	500-800 mA (varies by model)
Rated Torque	2-3 kg·cm (0.2-0.3 Nm)
Stall Torque	5-8 kg·cm (0.5-0.8 Nm)
Gear Ratio	~1:120 to 1:150 (varies by model)
Shaft Type	D-shaped or round (6mm diameter)
Shaft Length	10-15 mm

Electrical Characteristics

Parameter	Value
Operating Voltage Range	3V (min) - 12V (max)
Rated Power	1.5W - 3W
Encoder Option	Some models include quadrature encoder
Rotation Direction	Reversible (flip polarity to reverse)

Mechanical Specifications

Parameter	Value
Body Diameter	25mm (standard "GA" size)
Length (without shaft)	~40mm
Weight	150-200 grams
Gear Material	Metal (brass/steel) or nylon
Bearing Type	Sleeve or ball bearing

Mounting Holes	M2 or M3 threaded holes (front flange)

Performance Characteristics

Parameter	Value
Efficiency	~60-70%
Start Voltage	1.5V (minimum)
Noise Level	<45 dB (at rated load)
Lifespan	500-1000 hours (continuous operation)

Thermal Specifications

Parameter	Value
Operating Temperature	-10°C to +60°C
Max Winding Temp	+85°C (before damage occurs)

Connection Details

Wire Gauge	22-24 AWG
Connector Type	JST, bare wires, or terminal blocks
Standard Wire Length	15-20 cm

Typical Applications

Robotics (wheel drives, robotic arms)

Automation (conveyor belts, feeders)

DIY Projects (camera sliders, automatic doors)

Educational Kits (Arduino/RPi motor projects)

3.12 Cars Wheel



Fig: 3.12 Cars Tire 85mm*38mm Wheel

Specification:

- Diameter: 85mm
- Width: 38mm
- Color: Blue and Black
- .Internal tire material: Sponge
- Car hub is reinforced nylon, very sturdy

Features:

- Tire with sponge liner for more strength
- With upgraded tire tread for greater friction
- New design wheel for better combination with the motor
- Diameter: 85 mm
- Width : 38 mm
- The material of Wheel: High-strength plastic
- The material of Tyre: Rubber

CHAPTER 4

Results and Discussion

4.1 Results: The Agribot is purely non-conventional and reduces human effort. It saves time for farmers and water for irrigation. The result shows accuracy in seed sowing and watering the crop. The estimated time for basic activities is observed to be less than traditional farming. The prototype of the project is shown in Figures 4.1. The setup contains a seed drum for seeding, plowing rods for plowing the soil, and a tank to supply water to the field. A prototype of a multipurpose agriculture robot has been implemented successfully, which is capable of sowing seeds and watering crops accordingly. The greatest part of this robot is that it is mostly self-governing, so that farmers can spend more time on other agricultural activities. In automated mode, it performs all functions automatically upon receiving power. This mode allows users to activate specific functions individually by pressing the corresponding buttons. For instance, if plowing is required, only the plowing function is activated when its switch is turned on. Additionally, the robot can be controlled via mobile devices using a Bluetooth system, operating within a range of 10 meters. Testing of the robot was conducted on a small farmland, where it successfully performed tasks, such as plowing, seeding, and watering.

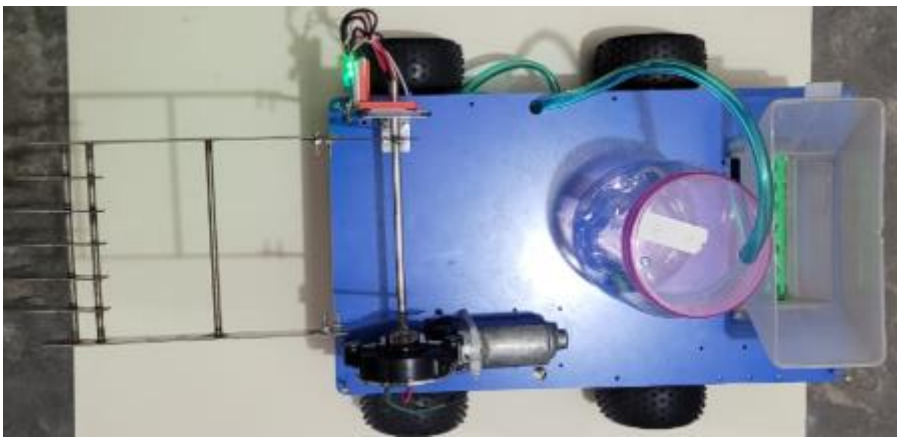


Fig: 4.1 Multipurpose Agriculture Robot

4.2 Experimental Data:

1. Testing Environment

Field Type: Small agricultural test bed

Control Method: Bluetooth (Smartphone-Controlled)

Mode: Automated

2. Task Performed

Plowing

Seed Sowing

Water Spraying

3. Plowing

Area Covered: 2 sq. meters

Time Taken: 5 minutes

4. Seed Sowing

Speed: 55 RPM

Row Length: 70mm

Opening: 06

Seeds Name: Mustard

Diameter: 1-2 mm

Time Taken: 15 Seeds/sec

5. Water Spraying

Tank Capacity: 1000 ml

Area Covered: 1 sq. meters

Time Taken- 20 sec

6. Power Consumption

Battery: 12V DC

Full Charge Duration: 45 minutes operation

Charging Time: 1.5 hours

Comparative Analysis of Seeding and Water Spraying Mechanisms

This section presents a comparative analysis between the developed project and the multipurpose agricultural machine described in the research article titled "Design and Fabrication of Multipurpose Agricultural Machine" (JETIR, 2021). The focus of the comparison is on the operational design and performance of the seeding and water spraying mechanisms.

1. Seeding Mechanism

Feature	**Design and Fabrication of Multipurpose Agricultural robot**	**JETIR Project Description**
Operation Type	Wireless remote-operated	Manual operation
Seeding Drive	Motor-driven shaft	Chain drive connected to front wheel
Seed Dropping Rate	900 seeds per minute(based on 55 RPM, 6 openings)	75 seeds per minute (based on 30 RPM, 5 openings)
Seed Delivery Control	Controlled via wireless system	Mechanical via drum seeder
Adjustability	Expected adjustable rate and distance (confirm if implemented)	Fixed by mechanical design (regular interval via chain drive)

2. Water Spraying System

Feature	**Design and Fabrication of Multipurpose Agricultural robot**	**JETIR Project Description**
Operation Type	Wireless-controlled, electric pump driven	Gravity-based through PVC pipe with holes
Spray Mechanism	Pump system	Manual tap opening, no pressure pump
Flow Rate	100ml/s	62.5 ml/s
Tank Capacity	1 liter (20sec of spray time)	20–30 liters (approx. 6–8 mins of spray time)
Automation Level	Higher (remote control, possible sensor integration)	Basic (manual tap, constant flow)

Summary of Key Differences

- Our project emphasizes automation and precision through remote operation, likely providing better control and flexibility.
- JETIR project uses manual power and mechanical systems, which are simpler but less adaptable.
- In seeding, Our motor-driven shaft could allow better accuracy and programmable intervals.
- In spraying, Our pump system could offer higher pressure, uniform distribution, and integration with timers or sensors for efficiency.

Stick rake 45 degree up resting position:

The stick rake is raised at an angle of 45° from the horizontal. This position raised position of the arm. The angle is measured between the lower segment of the arm and a horizontal reference line extended from the base or joint of the motor. This could represent an intermediate or "ready" position for grasping or lifting.

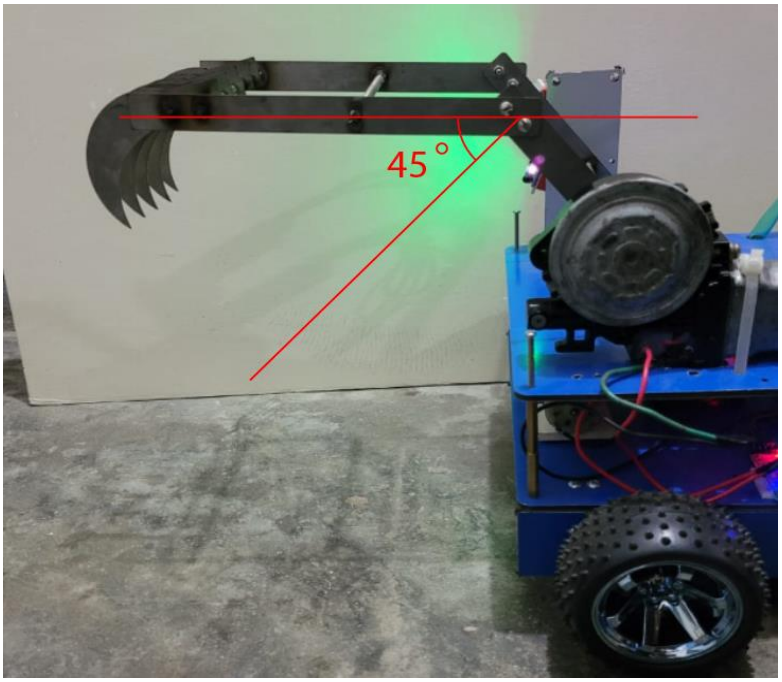


Fig: 4.2: Stick rake 45 degree up resting position.

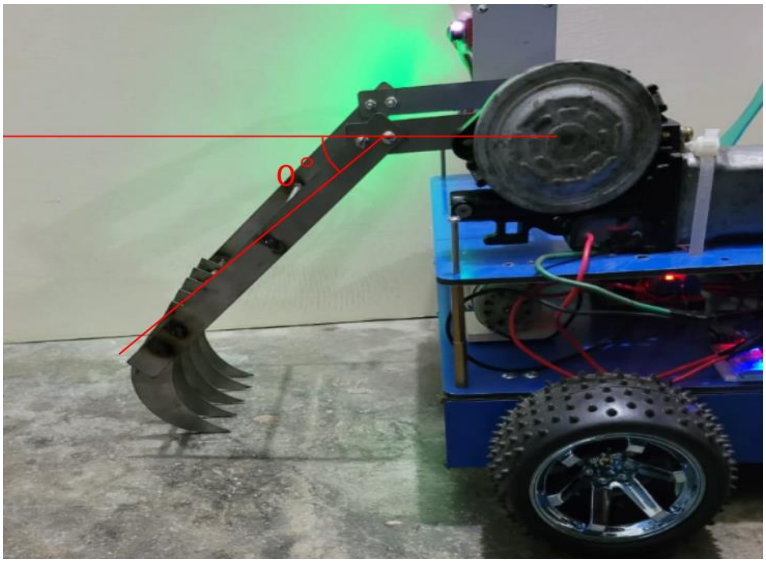


Fig: 4.3: Stick rake 45 degree down resting position.

The stick rake is fully lowered, forming an angle of 0° with the horizontal. This likely represents the grasping position, where the stick rake is closer to the ground it's ready to work. The red horizontal line again acts as the reference, showing that the arm is now aligned with it.

4.3 Advantages of the Multipurpose Agricultural Robot:

1. **Labor Reduction**
    - Reduces dependency on human labor for repetitive tasks like seeding, watering, and soil raking.
2. **Wireless Control**
    - The Bluetooth module allows farmers to control the robot via smartphone, improving ease of use and remote accessibility.
3. **Multifunctionality**
    - Combines multiple agricultural tasks (soil preparation, seeding, watering) into a single machine, saving time and cost.
4. **Precision Farming**
    - Ensures accurate seeding and watering at designated spots, improving crop yield and reducing wastage.
5. **Environmentally Friendly**
    - Operates on electric power (rechargeable batteries), reducing fuel usage and emissions compared to traditional machinery.
6. **Cost-Effective for Small Farmers**
    - An affordable automation solution, especially useful for small-scale farmers who can't afford large tractors or machines.
7. **Modular Design**
    - The structure appears modular, meaning components like the seeder, water pump, or rake can be upgraded or repaired individually.
8. **Educational Value**
    - Excellent for educational and research purposes in agricultural robotics and embedded systems.
9. **Adaptable Terrain Navigation**
    - The four-wheel design provides good stability and mobility in rough or uneven soil surfaces.

4.4 Disadvantages of the Multipurpose Agricultural Robot

1. **Limited Battery Life**
    - Operates on rechargeable batteries, which may not last long enough for extended fieldwork without frequent recharging.
2. **Low Load Capacity**
    - May not handle large-scale farming tasks or heavy loads due to its compact and lightweight design.
3. **Weather Dependency**
    - Not weatherproof; exposure to rain, mud, or harsh sun could damage electronics or mechanical components.

4.5 Discussion: The Multipurpose Agricultural Robot is an innovative and cost-effective solution designed to assist farmers in performing essential agricultural tasks such as soil preparation, seed sowing, and watering. The robot operates on a four-wheel mobile platform and is wirelessly controlled via Bluetooth using a smartphone. It includes a stick rake mechanism to loosen the soil, a water pump to irrigate targeted areas, and a hopper-based gear motor for systematic seed distribution. The design emphasizes ease of use, reduced labor, and precision in small-scale farming applications.

This project successfully integrates mechanical systems with embedded electronics to automate repetitive farming operations, offering significant time and resource savings. While it provides multiple advantages such as portability, multifunctionality, and eco-friendly operation, it also has limitations, including short battery life, limited field coverage, and the need for manual control and supervision. Despite these drawbacks, the robot demonstrates great potential in educational environments and small farms, and it lays the groundwork for further enhancements like autonomous navigation and sensor integration. Overall, this project showcases how robotics can contribute meaningfully to modern, efficient, and sustainable

CHAPTER 5

Conclusion and Future Recommendation

5.1 Conclusion

In conclusion, the Multipurpose Agricultural Robot represents a practical and innovative step toward the modernization of traditional farming practices. By integrating basic agricultural functions such as soil raking, watering, and seeding into a single, mobile, Bluetooth-controlled unit, the robot offers a smart solution that reduces manual labor and increases operational efficiency. Though currently limited by factors like battery capacity, terrain adaptability, and manual control requirements, the project highlights the potential of low-cost automation in agriculture. With further development, including the addition of sensors and autonomous navigation features, this robot could become a valuable tool for small and medium-scale farmers, contributing to more sustainable and efficient farming methods.

5.2 Future Recommendation

future recommendations for improving the Multipurpose Agricultural Robot:

- **Integrate soil moisture and environmental sensors** to enable data-driven decisions for watering and seeding.
- **Upgrade from Bluetooth to Wi-Fi, GSM, or LoRa** for extended wireless control range and better connectivity in large fields.
- **Implement GPS-based navigation and autonomous control algorithms** to eliminate the need for constant manual operation.
- **Increase precision of the seeding and raking mechanisms** through better motor control and calibration.
- **Add obstacle detection sensors** (e.g., ultrasonic or infrared) for safe and efficient navigation.
- **Develop a mobile or web-based app** with a graphical interface for easier remote control and monitoring.
- **Incorporate machine learning techniques** to allow the robot to adapt its behavior based on field conditions over time.

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Appendix

```
#include <SoftwareSerial.h>

// Lemit Switch

#define Sensor_Up A0  // Sensor_Up

#define Sensor_Downe 4  // Sensor_Downe


// Define software serial pins for HC-05

#define BT_RX 2  // Connect to TX of HC-05

#define BT_TX 3  // Connect to RX of HC-05


// Define motor driver pins for 4-wheel car

//#define ENA 5   // Speed control for Motor A

#define IN1 6   // Direction control for Motor A

#define IN2 7   // Direction control for Motor A

//#define ENB 8   // Speed control for Motor B

#define IN3 8   // Direction control for Motor B

#define IN4 9   // Direction control for Motor B


#define SEED_MOTOR1 12   // Seed Motor

#define SEED_MOTOR2 13   // Seed Motor
```

```
#define Tiller_MOTOR1 10   // Tiller Motor
#define Tiller_MOTOR2 11   // Tiller Motor

#define Water_Pump 5

//int speedValue = 150; // Default speed (0-255)

SoftwareSerial BTSerial(BT_RX, BT_TX);

int REF_Up_SEN=0;
int REF_Downe_SEN=0;

void setup() {
   Serial.begin(9600);   // Start serial communication with PC
   BTSerial.begin(9600); // Start serial communication with HC-05
   Serial.println("HC-05 Bluetooth Module Ready");

   // Initialize motor driver pins
   //pinMode(ENA, OUTPUT);
   pinMode(Sensor_Up, INPUT);
   pinMode(Sensor_Downe, INPUT);
```

```
  pinMode(IN1, OUTPUT);
  pinMode(IN2, OUTPUT);
  //pinMode(ENB, OUTPUT);
  pinMode(IN3, OUTPUT);
  pinMode(IN4, OUTPUT);

  pinMode(Tiller_MOTOR1, OUTPUT);
  pinMode(Tiller_MOTOR2, OUTPUT);
  digitalWrite(Tiller_MOTOR1, LOW);
  digitalWrite(Tiller_MOTOR2, LOW);

  pinMode(SEED_MOTOR1, OUTPUT);
  pinMode(SEED_MOTOR2, OUTPUT);
  digitalWrite(SEED_MOTOR1, LOW);
  digitalWrite(SEED_MOTOR2, LOW);

  pinMode(Water_Pump, OUTPUT);
  digitalWrite(Water_Pump, LOW);

}

void loop() {
```

```
// If data is received from Bluetooth, send it to Serial Monitor
if (BTSerial.available()) {
    char data = BTSerial.read();
    //Serial.print("Received: ");
    //Serial.println(data);
    controlMotor(data);
}

if(digitalRead(Sensor_Up)==LOW && REF_Up_SEN==1)
  {
   REF_Up_SEN=0;
   digitalWrite(Tiller_MOTOR1, LOW);
   digitalWrite(Tiller_MOTOR2, LOW);
   Serial.println("UP ------------------------------------ SENSOR/n");
   }
if(digitalRead(Sensor_Downe)==LOW && REF_Downe_SEN==1)
   {
    REF_Downe_SEN=0;
    digitalWrite(Tiller_MOTOR1, LOW);
    digitalWrite(Tiller_MOTOR2, LOW);
    Serial.println("DOWNE ------------------------------------ SENSOR/n");
   }
```

```
    // If data is received from Serial Monitor, send it to Bluetooth
    if (Serial.available()) {
        char data = Serial.read();
        BTSerial.write(data);
        Serial.print("Sent: ");
        Serial.println(data);
    }
     //analogWrite(ENA, speedValue);
     //analogWrite(ENB, speedValue);
}

void controlMotor(char command) {
    switch (command) {
        case 'F': // Move Forward
            digitalWrite(IN1, HIGH);
            digitalWrite(IN2, LOW);
            digitalWrite(IN3, HIGH);
            digitalWrite(IN4, LOW);
            //analogWrite(ENA, speedValue);
            //analogWrite(ENB, speedValue);
            Serial.println("Car Moving Forward");
```

```
    break;
  case 'B': // Move Backward
    digitalWrite(IN1, LOW);
    digitalWrite(IN2, HIGH);
    digitalWrite(IN3, LOW);
    digitalWrite(IN4, HIGH);
    //analogWrite(ENA, speedValue);
    //analogWrite(ENB, speedValue);
    Serial.println("Car Moving Backward");
    break;
  case 'L': // Turn Left
    digitalWrite(IN1, LOW);
    digitalWrite(IN2, HIGH);
    digitalWrite(IN3, HIGH);
    digitalWrite(IN4, LOW);
    //analogWrite(ENA, speedValue);
    //analogWrite(ENB, speedValue);
    Serial.println("Car Turning Left");
    break;
  case 'R': // Turn Right
    digitalWrite(IN1, HIGH);
    digitalWrite(IN2, LOW);
```

```
    digitalWrite(IN3, LOW);
    digitalWrite(IN4, HIGH);
    //analogWrite(ENA, speedValue);
    //analogWrite(ENB, speedValue);
    Serial.println("Car Turning Right");
    break;
 case 'S': // Stop Car
    digitalWrite(IN1, LOW);
    digitalWrite(IN2, LOW);
    digitalWrite(IN3, LOW);
    digitalWrite(IN4, LOW);
    //analogWrite(ENA, 0);
    //analogWrite(ENB, 0);
    //Serial.println("Car Stopped");
    break;

case 'X': // Seed Motor ON
    digitalWrite(SEED_MOTOR1, HIGH);
    digitalWrite(SEED_MOTOR2, LOW);
    Serial.println("Speed: 1");
    break;
 case 'x': // Seed Motor OFF
```

```
    digitalWrite(SEED_MOTOR1, LOW);
    digitalWrite(SEED_MOTOR2, LOW);
    Serial.println("Speed: 2");
    break;
  case 'W': // Tiller_MOTOR ON (Forwared)
    Serial.println("UP ------------------------------------ MOTOR/n");
    //REF_Downe_SEN=0;
    if(REF_Up_SEN==0){
      REF_Up_SEN=1;
    digitalWrite(Tiller_MOTOR1, HIGH);
    digitalWrite(Tiller_MOTOR2, LOW);
    }
    break;
/*
  case 'U': // Tiller_MOTOR OFF (STOP)
    REF_Downe_SEN=0;
    REF_Up_SEN=0;
    digitalWrite(Tiller_MOTOR1, LOW);
    digitalWrite(Tiller_MOTOR2, HIGH);
    break;
*/
  case 'V': // Tiller_MOTOR ON (Revearse)
```

```
      Serial.println("DWNE ------------------------------------ MOTOR/n");
         //REF_Up_SEN=0;
         if(REF_Downe_SEN==0){
           REF_Downe_SEN=1;
         digitalWrite(Tiller_MOTOR1, LOW);
         digitalWrite(Tiller_MOTOR2, HIGH);
         }
         break;

      case '0': // Water Pump ON
         digitalWrite(Water_Pump, LOW);
         Serial.println("PUMP OFF");
         break;
      case 'q': // Water Pump OFF
         digitalWrite(Water_Pump, HIGH);
         Serial.println("PUMP ON");
         break; }
}
```