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Tree Planting Robot for Reforestation

A. H. Ansari[1], Belkar Akanksha Ishwar [2], Jondhale Tai Bhausaheb[3], Shelke Puja Ravindra[4]

[1,2,3,4] Department of Electronic and Telecommunication Engineering, Pravara Rural Engineering Collage, Loni, Maharashtra, India
[1]ahameeda@rediffmail.com,[2]kanshabelkar@gmail.com, [3]jondhaletai2018@gmail.com, [4]pujaravishelke@gmail.com

ABSTRACT

The fundamental need for our project is that an autonomous tree planting robot be dependable and efficient, fit for any type of tree plantation job. Our project's primary goal is to decrease the amount of labor required to plant trees. People are too preoccupied with their jobs these days to plant trees, which means that in the near future, there will be a significant decline in the number of trees. We therefore considered using a tree-planting robot, which would significantly lessen the loss of trees. We can plant several kinds of saplings from this. We have attempted to reduce its cost by utilizing various processing techniques, making it become reasonably priced for everyone. To keep things simple for users, we have made it extremely straightforward to control.

Keywords*:* tree planting, seed sowing, agriculture, robot, automation, horticulture, planting, gardening, agronomy.

1. Introduction

Have you ever envisioned a robot planting trees? But thanks to this project, it might now be feasible. Indeed, a tree-planting robot that operates automatically. This is the solution that can support preserving the environment's sustainability while restoring the ecosystem. However, since this labor-intensive and tiresome task, humanity should turn to robots that plant trees.Have you ever thought what would happen if one person could do all of this work? After some consideration, we devised the concept of a tree-planting robot. Every day, new technologies are developed to improve and simplify our lives. The method focuses on the areas where seeds and trees need to be planted.

Furthermore, we are free to change what and where we plant. Compared to humans, this robot is able to plant a larger number of trees in a shorter amount of time. India's economy depends heavily on agriculture, however many continue to use outdated techniques rather than adopting more modern, more efficient ones. For many Indians, agriculture serves as their principal source of work and income. However, there are currently very few technical innovations in the primary planting and farming procedures. The Indian populace still ploughs and sows by hand or with a tractor. Therefore, this initiative brings new technologies and advancements related to plantations and agriculture in order to benefit the people.

This technology is especially designed and developed to help the people in reducing their back-breaking efforts while doing the agricultural and planting activities. We need to restore the trees so the it covers basically a huge amount of region in India, but at this rate it looks very scary. That’s why we need to improvise and adopt the innovations. When people learn how to give back to the land, the land gives them back. So, it’s very essential to plant trees for a better tomorrow. Basically, this robot has one mission that is to plant trees for a better future. Here is the block diagram of the model along with its working. It also includes the hardware implementation, selection of components and controllers.

This robot's primary goal is to plant trees in order to improve the future. This is the model's block diagram showing how it operates. It also covers controller selection, component selection, and hardware implementation. Essentially, it's a four-wheeled robot that will come in handy for planting trees and scattering seeds.

2. Literature Survey

In addition to books and websites, we evaluated the following research papers to help us reach our project's final goal: "Tree Planting for Reforastation." The majority of the publications dealt with the technology that we employed in this project.

Agri-bot is a technology described in [1] that uses computer programming to make typically challenging agricultural tasks simpler. It is a more effective way to achieve the same objectives as compared to the conventional methods. Many advancements in the agriculture industry have been made possible by the extensive use of automated systems, which have also helped farmers save time and money. An Android smartphone can use Bluetooth to track the agricultural robot. The sensors interfaced with the motors and microcontroller design all of the computing, monitoring, and processing.

In [2], it is stated that agriculture is a major industry in India. Out of the overall population, sixty-five percent work in agriculture in this country. It is the only significant job that is essential to ensuring food security for the whole country. A crucial part of cultivating crops in this agricultural country of India is the spreading of seeds. Depending on the kind of soil, the kind of weather, and the kind of place, the type of seed matters. The kind, diameter, and planting depth of a seed all have a substantial impact on its germination and growth

According to [3], farming is the most prudent endeavor since it will ultimately bring about the greatest amount of actual riches, morality, and happiness. Since farming requires a lot of labor and personnel, the Agrobot was created to make the process easier. The "Internet of things" will play a significant part in networking in the upcoming generations, and since this agrobot has numerous sensors for tracking the crop and the soil, the "Internet of things" is primarily utilized in this project. There are six steps in the classic farming method: leveling the land, irrigating, fertilizing, harvesting, and plowing. Large machinery is typically used by farmers to carry out these tasks. They employ a lot of machinery, and each machine is very expensive.

Strong agricultural equipment with remarkable soil- clearing qualities is the suggested robotic vehicle in [4]. This adaptable system is a helpful tool that offers an innovative way to plant, plough, and water crops with the least amount of labor. The suggested method has a strong emphasis on using microcontrollers to perform all aspects of farming, including seed sowing, harvesting, water pumping, plowing, and soil moisture measurement. The Blynk application media can also be used to operate the vehicle.

According to [5], India's agriculture sector is its main source of revenue and employment for a large number of people. India's economy is based on agricultural development, which raises the nation's economic standing. Farmers in India are having difficulty finding labor, and using conventional farming methods that require a lot of time and money for labor is another issue. The concept of using robotic technology in agricultural tasks contributes to increasing planting sample production. The robot is a moving machine that can carry out planting tasks without assistance from a human. The controller gives commands to the robot, and it follows them. Agriculture automation has the potential to be an efficient and successful environment, but the work is extremely labor-intensive and tiresome.

The purpose of the paper in [6] is to build and construct robots for use in agriculture. The farmer uses the robot to assist with tasks like leveling the soil, planting seeds, sprinkling water and pesticides, and harvesting the crop. Its primary goal is to reduce the amount of labor farmers must perform while simultaneously boosting productivity and precision. We are giving the robot input through an Android application. A link is being established between the robot and the application via Bluetooth. The robot will carry out the tasks as directed by the user. Due to the early domestication of crops and animals as well as the cultivation of plants, Indian agriculture dates back to 9000 BCE.

Within [7], Based on decades of scientific and industrial research, agricultural robot technology is rapidly advancing in response to the conflict between the growing demand for agricultural products and the dramatic decline in agricultural resources and labor force. Given the intricate and unique nature of agricultural robot technology development, it is crucial to compile a comprehensive overview of its development features and render rational assessments of its trajectory. The kind of agricultural robot systems was initially covered in this work.

Within [8], The fundamental need for our project is that an automatic tree planting robot be dependable and efficient, fit for any type of tree plantation job. Our project's primary goal is to decrease the amount of labor required to plant trees. People are too preoccupied with their jobs these days to plant trees, which means that in the near future, there will be a significant decline in the number of trees. Thus, we considered using a tree-planting robot, which would significantly lessen the loss of trees.

The main objective of the research in [9] is to create and build a plant sapling planting robot that will make it easier to plant on bare ground and expand the amount of forestation. The majority of the planting operation is currently carried out by laborers by hand. Therefore, having a sapling planting robot is crucial to minimizing manual labor and solving related challenges in this industry. These kinds of creative approaches can also be used to address the issue of labor scarcity and effective replanting. The study's scope is such that, while the problem is broad, the solution is somewhat specialized, taking into account not just effective replanting but also ergonomics and aesthetics in design.

In 10] This method focuses on creating agricultural robots that can do a variety of jobs. Robots undoubtedly play a significant role in agriculture by enabling autonomous farming practices. The use of robots in agriculture is increasing production, and they are becoming more prevalent in the field. The suggested system uses a microcontroller, Bluetooth versions HC-05 and H 06, a variety of sensors, etc. to implement every aspect of farming, particularly seeding and plowing.

3. Methodology

Planning and Research: Become well-versed in the current technology and methods for planting trees. Determine the intended settings in which the robot that plants trees will function. Ascertain which tree species are appropriate for the locations that are being targeted.

Conceptual Design: Based on the determined needs and limitations, develop a conceptual design for the tree-planting robot. Describe the robot's main features and functions.

Detailed Design: Create a thorough design plan that takes into account the robot's software, electronics, and mechanical parts. Make use of MPLAB software to simulate and model 3D objects.

Testing and Prototyping: Using the comprehensive design as a guide, create a prototype. To make sure the robot is efficient and functioning, test it thoroughly. Evaluate the robot's performance using testing instruments like sensors, data loggers, and simulation software.

4. Block Diagram

The robot that plants trees is usually employed to grow crops. Through their navigation and mapping of the planting area, it determines the point at which we must plant that crop at a specific distance that we have established. Robots are powered by batteries, which have a 12 volt DC voltage. The majority of the 5 volt DC power supply's components.

Here, we're using a 7805 regulator to convert and distribute a 5V DC supply to the buzzer, LCD display, controller, Bluetooth module, and obstacle sensor. The obstacle sensor is an ADC (Analog to Digital Converter) device. It has a transmitter and receiver that measure the length of the obstacle and determine whether it exists. If it does, a motor will either start or shut off. Limit switch: When the mechanism presses the limit switch, the system will stop, or if you want to halt the mechanism or it is about to go into any situation. Following that, the microcontroller needs to be reset in order to program it. Press the Emergency switch if you wish to end the system's emergency. The microcontroller and Bluetooth are connected serially, and Bluetooth sends data to the microcontroller serially. The microcontroller is connected to the Bluetooth model, the microcontroller's receiver is connected to the Bluetooth model's transmitter, and the microcontroller's receiver is connected to the Bluetooth model.

A manually driven template row planter was created, and data was transmitted serially to the microcontroller. The microcontroller is linked to the Bluetooth model, and the Bluetooth model's transmitter is attached to both the micro controller's receiver and its receiver are linked to the Bluetooth model.The micro-controller can function and activate after receiving data and receiving an instruction (1). Following robot operation, motors 1 and 2 will turn on. Pressing button two will cause the robot to reverse. When you press the number three, the robot moves to the left; when you hit the number four, it moves to the right; and when you press the number five, it begins to dig up and down. Pressing number 6 initiates the plant's mechanism, and pressing number 7 causes the robot to stop. Small-scale cropping machines should meet the following fundamental specifications: they should be easy to use in a variety of agricultural operations, simple in design and technology, and appropriate for small farms. In order to increase planting productivity and lessen the laborious nature of the manual planting process, a manually operated template row planter was created and built. It is also feasible to plant seeds of varying sizes at varied depths and distances apart. Additionally, it improved seeding and fertilizer distribution accuracy and was constructed of inexpensive, long-lasting material that was within the means of small-scale peasant farmers.

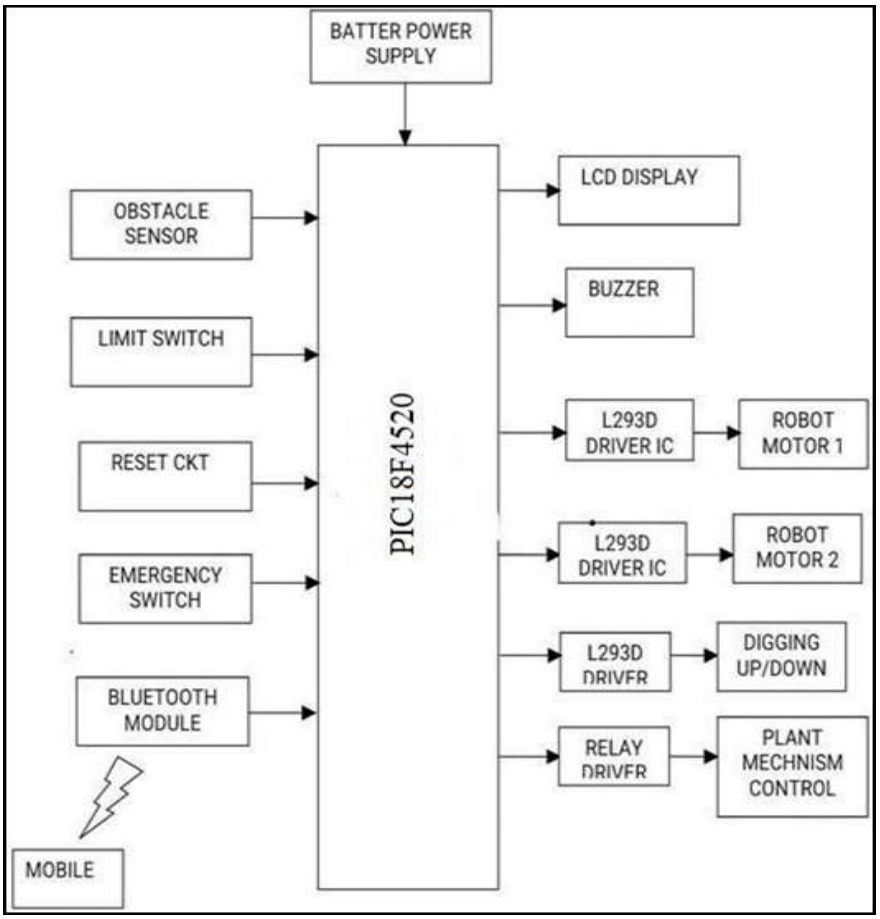

Figure 1: Block Diagram

5. COMPONENT DESCIPTION

PIC18F4520: The PIC18F4520 is an 8-bit, completely static microcontroller device that is inexpensive, low-power, and fast. It has 40 pins total, 36 of which can be utilized as I/O pins. It contains Extended Watchdog Timer (WDT) circuitry, which may be programmed for 4ms to 131s, in addition to Power-on-Reset (POR) circuitry.

Module for Bluetooth: HC-05 4 Pin Wireless Any microcontroller can utilize the Serial Bluetooth Module for Bluetooth functionality. It makes wireless data transmission and reception simple by utilizing the UART protocol.

Piezoelectric Buzzer: An electronic device that emits a tone, alarm, or sound is called a piezo buzzer. It is usually inexpensive, lightweight, and has a straightforward design. In addition, depending on the parameters of the piezo ceramic buzzer, it can be built in a variety of sizes and operate over a range of frequencies to provide various sound outputs.

Relay: An electrically powered switch is called a relay. A mechanical switching mechanism is powered by an electromagnet in many relays, although other principles of operation are also employed. Relays are employed when multiple circuits need to be controlled by a single signal or when a low-power signal is required to control a circuit (with total electrical isolation between the controlled and control circuits.)

Obstacle Sensor: The HC-SR04 ultrasonic ranging module offers a non-contact measurement function between 2 and 400 cm, with a ranging accuracy of up to 3 mm. Ultrasonic transmitters, receivers, and control circuits are included in the modules.

L293D Motor Driver IC A motor driver is an integrated circuit chip which is usually used to control motors in autonomous robots. Motor driver act as an interface between microconytroller and the motors . The most commonly used motor driver IC's are from the L293 series such as L293D, L293NE, etc.

6. CIRCUIT DIAGRAM

The tree planting robot circuit diagram involves a complex but well-organized structure of components that work together to automate the planting process. At the core of the circuit is the PIC18F4520 microcontroller, which serves as the central controller, managing all operations within the robot. The microcontroller is powered by a 5V DC supply from the LM7805 voltage regulator, which steps down the 12V DC battery supply to the appropriate voltage for the microcontroller and other 5V components such as the HC-05 Bluetooth module, 16*2 LCD display, 5V DC ultrasonic sensor, and 5V DC buzzer. The 12V DC battery (3A) serves as the primary power source for the entire system, powering the robot's DC motors, relay, and other higher-voltage components. The battery connects to the input of the LM7805 voltage regulator, which converts the 12V supply to a stable 5V DC output for the microcontroller and other low-voltage components.The microcontroller communicates with the HC-05 Bluetooth module using UART (serial communication), allowing for wireless control of the robot from an external device such as a smartphone or computer.

The TX and RX pins of the Bluetooth module are connected to the RX and TX pins of the microcontroller, respectively.The microcontroller is also connected to the 16*2 LCD display, which is powered by the 5V rail. The LCD display provides visual feedback and information to the user, such as status updates and sensor data. Additionally, the 5V DC ultrasonic sensor is used for obstacle detection and navigation, with its Trig (trigger) and Echo (echo) pins connected to GPIO pins on the microcontroller.

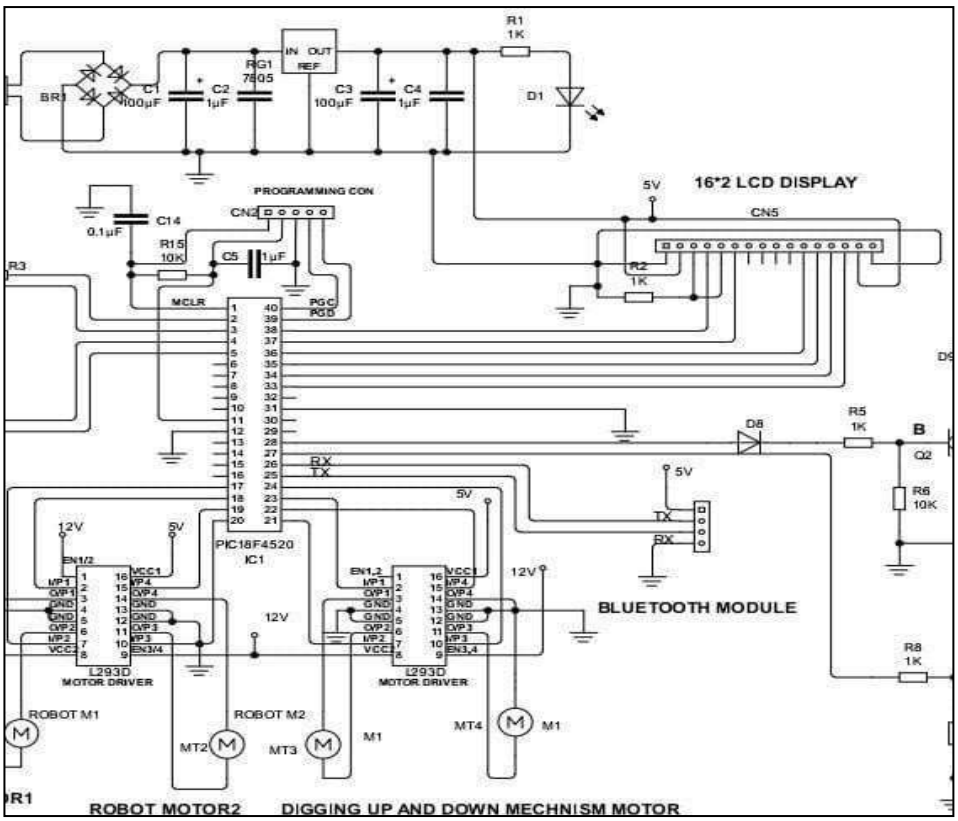

Figure 2: Circuit Diagram Of the system

The microcontroller controls the robot's movement using DC motors with various RPMs (10, 60, or 200 RPM), which are driven by the L293D motor driver ICs. The motor driver ICs receive control signals from the microcontroller and provide the necessary current and voltage to operate the DC motors. These motors enable the robot to navigate its environment and control the planting mechanism.The robot uses an SPDT 12V DC relay, controlled by a BC547 transistor, to manage high-current devices such as the planting mechanism. The relay coil is connected to the 12V DC supply, while the switching of the relay is managed by the microcontroller through the transistor. This allows the robot to control components that require higher power, such as the planting mechanism. The 5V DC buzzer is connected to a GPIO pin on the microcontroller, allowing the microcontroller to activate the buzzer for audible feedback or alerts based on the system's status or events. The buzzer is powered by the 5V DC supply. Resistors (1k, 10k) are used in the circuit for pull-up and pull-down configurations, current limiting, and other signal conditioning tasks. Diodes (1N4007) are used in the circuit to protect components from reverse voltage and voltage spikes, particularly around inductive loads such as motors.Overall, the tree planting robot circuit diagram consists of an intricate yet well-coordinated assembly of components that work together to automate the planting process. The microcontroller orchestrates the system's operations, processing inputs from sensors, controlling motors, relays, and other components, and communicating wirelessly with external devices for enhanced control and monitoring. This robot holds great potential for revolutionizing reforestation efforts and agricultural planting with its precision and efficiency.

6.1 Circuit Diagram for microcontroller

The PIC18F4520 microcontroller serves as the central control unit in your tree planting robot for reforestation, managing communication, sensor inputs, and motor control. It is powered by a 5V DC supply from the LM7805 voltage regulator, with its Vdd pin connected to the 5V DC rail and the Vss pin connected to the common ground rail. An external oscillator or crystal provides the clock signal for the microcontroller, ensuring precise operation. The microcontroller interfaces with digital inputs, such as the ultrasonic sensor, through GPIO pins, processing sensor data for navigation and obstacle avoidance. It sends digital output signals to control the motors, planting mechanism, and other actuators. Additionally, the microcontroller supports serial communication via UART, allowing it to connect with the Bluetooth module for wireless data exchange and control with external devices. The PIC18F4520 also manages the LCD display for visual feedback and the buzzer for audible alerts, and it can handle programming and debugging through the ICSP interface. Overall, the microcontroller coordinates the robot's operation, enabling it to perform autonomous planting tasks and navigate its environment efficiently.

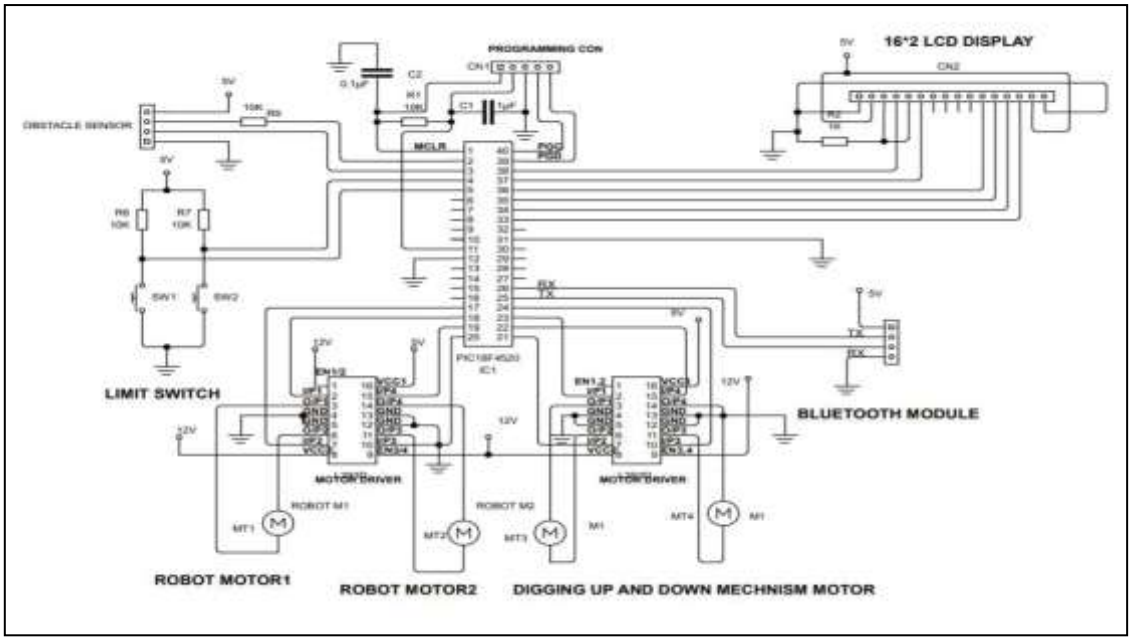

Figure 3: Circuit Diagram for microcontroller

6.2 Circuit Diagram for Buzzer

In the tree planting robot, the buzzer is a 5V DC component that provides audible alerts and notifications during operation. It is powered directly from the 5V DC rail, ensuring it receives the necessary voltage for functioning. The microcontroller controls the buzzer by connecting one terminal to a GPIO pin, while the other terminal is connected to the common ground. When the microcontroller sets the GPIO pin HIGH, current flows through the buzzer, causing it to emit sound and signal an event or status change. Conversely, setting the GPIO pin LOW turns off the buzzer. This simple yet effective setup allows the microcontroller to use the buzzer for various purposes such as indicating successful planting, warning of obstacles, or providing feedback for other events during the robot's operation.

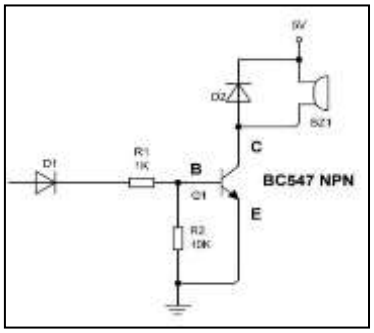

Figure 4: Circuit Diagram for Buzzer

6.3 Circuit Diagram for power supply

In your tree planting robot, the power supply circuit is designed to provide stable and appropriate voltages for the various components of the system. The main power source is a 12V DC battery with a current capacity of 3A, which serves as the primary power supply for the robot. This 12V DC power is used to drive high-power components like the DC motors and relay.

The circuit also includes a voltage regulator (LM7805) to step down the 12V DC from the battery to a stable 5V DC output. This regulated 5V DC power is necessary to operate lower voltage components such as the microcontroller (PIC18F4520), Bluetooth module, LCD display, ultrasonic sensor, and buzzer.

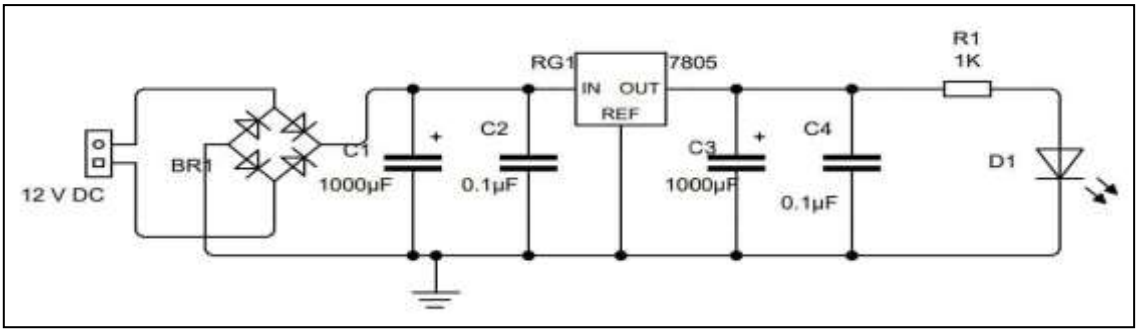

Figure 5 : Circuit Diagram for power supply

LM7805 Voltage Regulator:

- The input pin of the LM7805 is connected to the positive terminal of the 12V DC battery.
- The output pin of the LM7805 supplies 5V DC, which powers the 5V rail in the circuit.
- The ground pin of the LM7805 is connected to the common ground.
- Capacitors are typically used at the input and output of the regulator to smooth out voltage fluctuations and ensure stable operation.

Distribution of Power:

- The 12V DC power from the battery is used directly for high-power components like the DC motors and relay.
- The 5V DC output from the LM7805 regulator is distributed across the 5V rail in the circuit, providing power to components like the microcontroller, Bluetooth module, ultrasonic sensor, buzzer, and LCD display.

Protection:

- The circuit includes various protective measures, such as capacitors, to filter and stabilize the voltage supply and maintain smooth power delivery.
- Diodes might be used for reverse polarity protection and to prevent voltage spikes from affecting the circuit components.

The power supply circuit ensures that all components in the system receive the correct voltage levels for safe and efficient operation. By providing stable and regulated power to the microcontroller and other peripherals, the power supply circuit forms the foundation for the robot's functionality and reliability.

7. Flowchart

Start power ON, then the robot waits for the starting command from the operator via. Bluetooth and performs a check if everything is okay. Initiates system HCOS start pairing or communicate with mobile Bluetooth app.

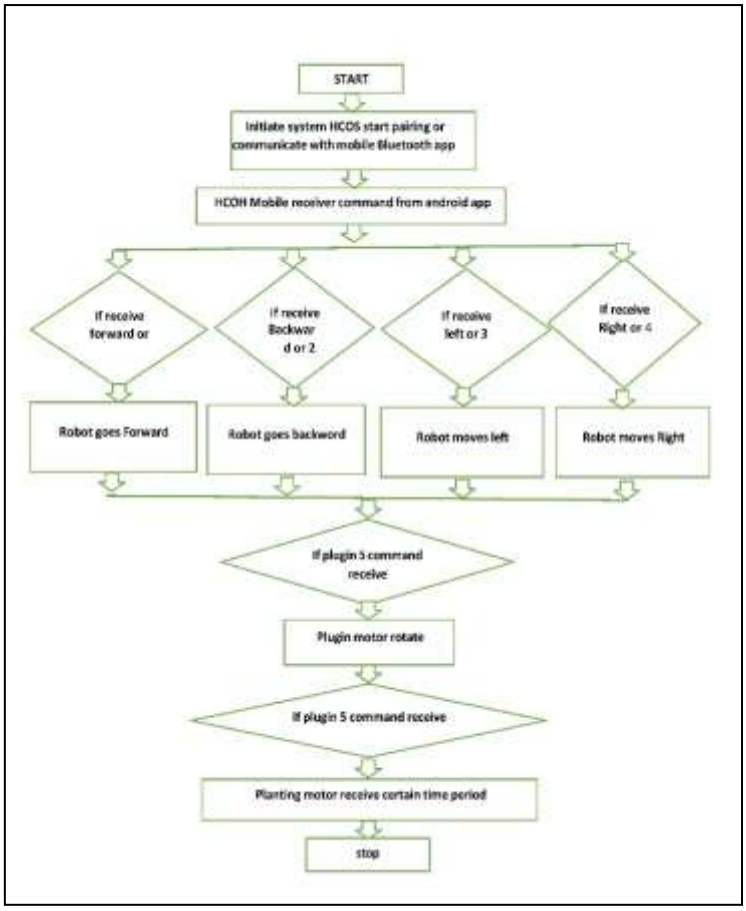

Figure 6: Flowchart

When it receives command 1,robot goes forward, when it receives 2 robot goes backword,when it receive 3 robot moves left and when it receive 4 robot moves right. After the starting command is given digging bit come at position by dc gear motor, then the digging bit comes down by the help of limit switch and the motor for digging is turned on. Similarly the digging bit comes up by the help of limit switch after digging the ground. Now, sliding pipe come at position by dc gear motor and plant magazine move one position and then it checks if the sampling is available or not. If the magazine is empty the robot stops and alarm is ON .If sampling is there then sliding pipe move down by the help of limit switch, after the sampling is planted the sliding pipe move upward by the help of limit switch and soil press mechanism is turned ON. Finally the robot moves to next position (as per set revolution). If obstacle arrives it stops and alarm is ON.

8. Result

Based on the commands , our tree planting robot will perform different operations corresponding to each input command. Here's a description of each command and its real-time or actual result.

Figure 7: Forward Robot **Figure 8**: Turn Left **Figure 9**: Turn Right

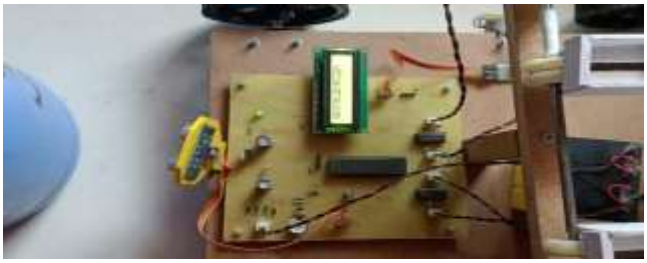

Figure 10: Check Obstacle and show distance of obstacle

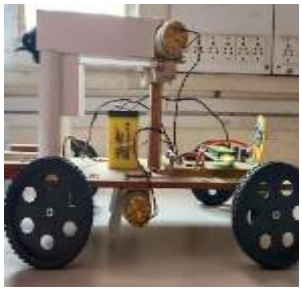

Figure 11: Dig Down **Figure 12:** Plant Mechanism Start

Sr. No	Command	Description	Result
1	F0	Stop	The robot comes to a halt, ceasing all movements and operations.
2	F1	Forward	The robot moves forward in a straight line.
3	F2	Backward	The robot moves backward in a straight line.
4	F3	Left Turn	The robot turns to the left.
5	F4	Right Turn	The robot turns to the right.
6	F5	Plant Mechanism Start	The robot activates the planting mechanism, planting seeds as intended.
7	F6	Dig	The robot performs a digging operation to prepare the soil for planting.
8	F7	Double Dig	The robot performs two consecutive digging operations, ensuring thorough soil preparation.

8.1 Application

1. Farming: An intuitive platform offering precision farming techniques and real-time data analytics for optimizing crop production.

2. Gardening: A user-friendly app providing expert advice, plant care reminders, and community support for hobbyist and professional gardeners alike.

3. Plantation: A comprehensive toolset for managing large-scale plantations, including inventory tracking, yield forecasting, and sustainability metrics.

4. Forest: An ecosystem management application offering forest inventory assessments, biodiversity monitoring, and wildfire risk analysis for sustainable forestry practices.

5. Agriculture Universities: A specialized platform catering to the academic needs of students and faculty, offering course materials, research resources, and networking opportunities within the agriculture community

8.2 Advantage

1. Economical, long-lasting, easily made, and portable :-It is about designing and producing cost-effective, durable, easily manufacturable, and portable products or solutions.

2. Beneficial for farmers in sowing seeds efficiently :-It pertains to developing tools or techniques aimed at enhancing the efficiency of seed sowing for farmers, resulting in increased productivity and reduced labor.

3. Reduces manpower/labour needed for tree planting:-It focuses on creating methods or technologies that decrease the amount of manual labor required for tree planting, thereby improving efficiency and potentially increasing the scale of reforestation efforts.

4. Saves time and reduces back-breaking labor:-It involves the development of strategies or innovations that minimize the time spent on tasks and alleviate physically demanding work, thereby improving overall efficiency and worker well-being.

5. Operable by a single person via smartphone for easy control : This revolves around creating systems or devices that can be controlled remotely by a single individual using a smartphone, enabling convenient and accessible management**.**

8.3 Disadvantage

1. Costly to make or buy :- To goods or services that incur significant expenses either during production or purchase.

2. Requires maintenance:- Implies the need for regular upkeep or repairs to ensure optimal functionality and longevity of a product or system.

3. Poor farmers may lack access :- to essential resources such as land, capital, technology, and markets, hindering their ability to improve productivity and livelihoods**.**

4. The significant research and development costs :- In agriculture underscore the investment needed to innovate and improve farming techniques, technologies, and crop varieties.

5. Farmers may lose jobs:-The potential consequence of farmers losing their jobs highlights the economic impact of shifts in agricultural practices or technologies impact of shifts in agricultural practices or technologies

8.4 Conclusion

This may be a very helpful equipment to work smoothly, efficiently, and effortlessly; it will also aid in saving time, the project will help to overcome various challenges in the agriculture and forest department.

Anyone lacking technical expertise does not need to operate this robot; it is really easy to use. It might lead to less waste than manual operation.

Therefore, we believe that this initiative is beneficial to the modern world, has merit, and ought to be taken into account. We anticipate that this tool will lessen the challenges associated with the labor scarcity in reforestation

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