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Solar-Powered Autonomous Multipurpose Agricultural Robot with Pesticide Sprayer

Ananthan M.[1,*], Balu S. Kumar[1], Vaishnav R.D.[1], Dhanya C.S.[2]

Abstract

Plowing and sowing are just a few of the many chores that take place in the agricultural field. The equipment needed to do the aforementioned tasks is expensive and difficult to use. Therefore, the Indian agricultural system should be supported by developing a system that will save time and labor. The goal is to create a robot that runs totally on solar power and is capable of seeding seeds, plowing, and spraying water. A solar panel powers the constructed robot, which is operated by an Android or Bluetooth software to move and do other necessary functions. This boost reduces the difficulty of hand planting and boosts the effectiveness of the sowing of seeds. The objective is to design a robot that can perform operations including plowing, seed dispensing, pesticide spraying, and grass cutting. It also employs humidity sensors to track the humidity and offer manual control when needed. The crucial component is the Arduino's AVR, which manages everything. The field is first tilled by the robot, which then ploughs and distributes seeds. The navigation device is an ultrasonic sensor that continually sends data to the Arduino. The robot operates in autonomous mode within the field and only uses human intervention when not in use. A Bluetooth connecting app may be used to manually operate the robot, which also helps with maneuvering it outside of the building.

Keywords: Grass cutting, pesticide spraying, dispensing seeds, and ploughing

INTRODUCTION

Designing multimodal agricultural equipment to carry out important agricultural tasks like plowing, seeding, leveling, and water sprayed is the main objective of the endeavor. We can control the robot from android mobile phone through Bluetooth and with a set of commands from the microcontroller, the robot can move left or right, forward or backward. Here, we may fasten the soil leveling and plowed tools to the robot's body so that they move independently. Here, we are using a relay to connect the water motor to the microcomputer [1].

When the user controls the water spray through Bluetooth, then the HC-05 module receives that and processes this data to microcontroller. The microprocessor then puts the water motor on or off as necessary. In this case, the relay serves as a switch to turn the water motor on and off. The microcontroller serves as a control unit in this project, monitoring every device that is interfaced with it. A microcontroller that has been programmed using embedded C instructions is used in this project. Both the transmitting and receiving modules can interact with this microcontroller [2].

***Author for Correspondence**
Ananthan M.
E-mail: ananthanm2002@gmail.com

[1]Student, Department of Electrical and Electronics Engineering, Universal Knowledge Foundation College of Engineering and Technology, Parippally, Kollam, Kerala, India
[2]Assistant Professor, Department of Electrical and Electronics Engineering, Universal Knowledge Foundation College of Engineering and Technology, Parippally, Kollam, Kerala, India

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Two DC motors are interfaced with the controller that control the robot's direction. The microcontroller is additionally interfaced with a third motor. The pipe that is connected to the third motor revolves when it is automatically rotating. The pipe has a hole in it. The seeds only fall forth when the valve is lowered. A funnel was fixedly positioned above the pipe's holder configuration. Now, as the pipe rotates, there comes a moment when the hole sinks, and the funnel is positioned through the holder precisely at that moment. The funnel's seeds drop through the gap.

User can access this deice with his mobile phone by using credential though IoT. When the user presses the button from Blynk app, this data is received by esp8266 wi-fi module and fed as same to the microcontroller. Then microcontroller takes the appropriate decision on robot.

LITERATURE REVIEW

"Solar Powered Autonomous Multipurpose Agro-robot Using Bluetooth", by Sujitha *et al.* [3]

The robot does kinetic picking, plowing, seed pouring, and spraying. An app that pairs with Bluetooth is used to manually operate the device in question [3]. It can be controlled by android or Bluetooth app. It reduces human intervention. A pesticide sprayer and grass cutter are absent. Solar panels should receive regular checks to guarantee that they work effectively.

P Rama Mohan "A Novel Solar Power Based Liquid Sprayer for Agricultural, Environmental and Health Care Application"

The solar panel generates electricity, which is used to charge the battery. The motor that propels the nozzle to spray the liquid is powered by the battery. Solar energy is copious. It helps in pest control. It has no other features of ploughing, dispensing seeds, humidity sensor, etc. It also requires manpower [4, 5].

"Using Solar Energy to Power a Harvesting Robot" by Rosen Ivanon, Georgi Komitov, Donka Ivanova, and G K Gergana Staneva (2022)

They developed and described a solar charging system and studied the variation of charging output power based on solar radiation intensity. They analyzed the possibilities of obtaining the necessary electric energy for the robot's motion, and chances for rusting of components. Climate change affects the efficiency [7].

BLOCK DIAGRAM OF AGROBOT

This innovative agricultural project integrates a range of functionalities, encompassing ploughing, seed sowing, leveling, grass cutting, pesticide spraying, and water distribution, all within a multipurpose equipment framework (Figure 1). The incorporation of solar power introduces an environmentally friendly dimension, where energy is captured and stored in a rechargeable battery through an intricate charging circuit. This stored energy serves as the vital power source for propelling the agricultural vehicle. Control over the various components: robot, water motor, and seed drop motor, is intelligently executed through an Android mobile phone, leveraging both Bluetooth and Wi-Fi connectivity. The convenience extends to the Blynk mobile application enabling users to manage the robot's movements, water distribution, and seed dropping remotely through an Internet of Things (IoT) platform. The mobility of the robot is facilitated by the coordinated operation of two DC motors, skillfully managed by the L293D motor driver. At the core of this intricate system is the PIC microcontroller, functioning as the central command unit, ensuring the seamless and efficient execution of tasks across the entire agricultural apparatus [6, 7].

CIRCUIT DIAGRAM OF AGROBOT

We can control the robot from android mobile phone through Bluetooth and IOT, with a set of commands from the microcontroller that the robot can move left or right, forward or backward. Here, we may fasten the soil leveling and plowing tools to the robot's body so that they move self-sufficiently. Here, we are using a relay to connect the water motor to the microcomputer.

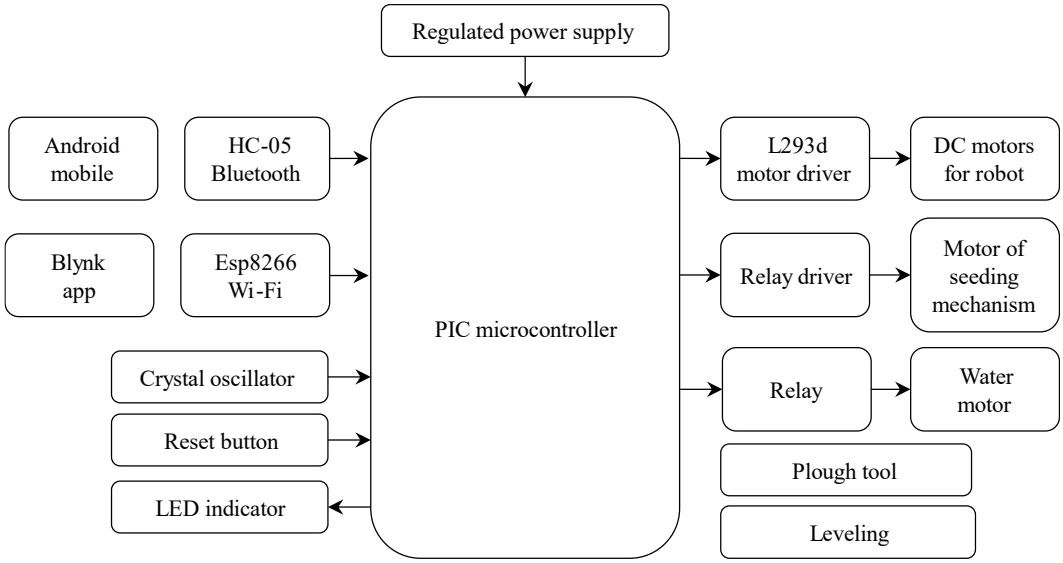

Figure 1. Block diagram of Agrobot.

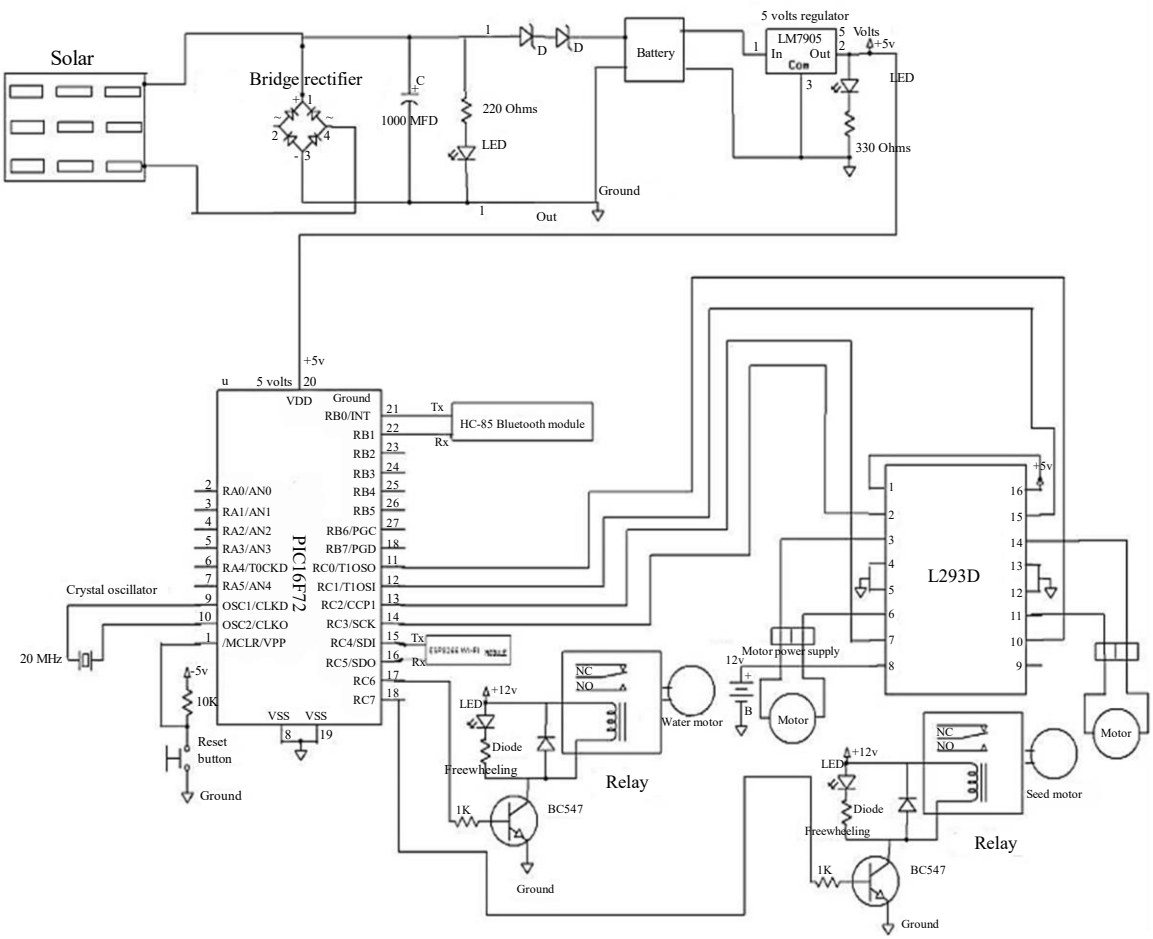

Figure 2. Circuit diagram of Agrobot.

When the user controls the water spray through Bluetooth, then the HC-05 module receives that and processes this data to microcontroller. The microprocessor then turns the water motor on or off as requested. In this case, the relay serves as a switch to turn the water motor on and off (Figure 2). The microcontroller serves as a control unit in this project, managing all equipment that is interfaced with it. A

microcontroller that has been programmed using embedded C instructions is used in this project. Transmitter and receiver circuits can communicate with this microcontroller. Two DC motors are interfaced with the controller to regulate the robot's direction. The microcontroller is additionally interfaced with a third motor. The pipe that is connected to the third motor spins whenever it is turning independently [8].

The pipe has a hole in it. The seeds only fall into when the opening is lowered. A funnel was fixedly positioned above the pipe's holder setting it up. Now, as the pipe rotates, there comes a moment when the hole descends, and the funnel is positioned through the holder precisely at that time. The funnel's seeds drop through the opening [9].

User can access this deice with his mobile phone by using credential though IOT. When the user presses the button from Blynk app, this data is received by esp8266 wi-fi module and fed as same to the microcontroller. Then the microcontroller takes the appropriate decision on robot [10].

WORKING OF CHARGING CIRCUIT

A solar cell, also known as a photovoltaic cell, is a device that uses the photovoltaic effect to transform solar energy into electrical power. Photovoltaic arrays, solar panels, and solar modules are all made of cell assemblies. The technique and research area pertaining to the use of solar cells for solar energy is known as photovoltaics (Figure 3).

From the circuit diagram is charging circuit which we can use to charge the battery which is coming from solar energy. The solar (12 V, 10 W) output is given to the rectifier. With the usage of a capacitor, these spikes are reduced. If the LED illuminates, we can see that the output pin is receiving 12 V steady DC [11]. In this robot we are using 12 V rechargeable battery to store the energy from solar and to give the power supply to the robot.

MICROCONTROLLER PIC16F72

The PIC16F72 contains 28 pins in total. Although it can also be discovered in SMD cases, which are smaller than DIPs, it is most commonly seen in DIP28 cases. Dual in Package is shortened to DIP. Surface Mount Devices, or SMD for short, implies that soldering this kind of circuit does not require holes for pins to pass through when mounting. Microcontroller PIC16F72 has 28 pins (Figures 4). The majority of them are IO pins. Others already serve specific purposes. The pin functions are as follows [12].

The 8-bit microcontroller PIC16F72, which has its foundation on CMOS FLASH, can be used with PIC16C72/72A and PIC16F872 devices. It has self-programming capabilities, an ICD, two comparators, five channels of 8-bit Analog-to-Digital (A/D) conversion, two capture/compare/PWM functions, a simultaneous serial port that may be set up as a 2-wire I2C bus or a 3-wire SPI bus, a USART, and a parallel slave port. It also executes directives in 200 ns [3].

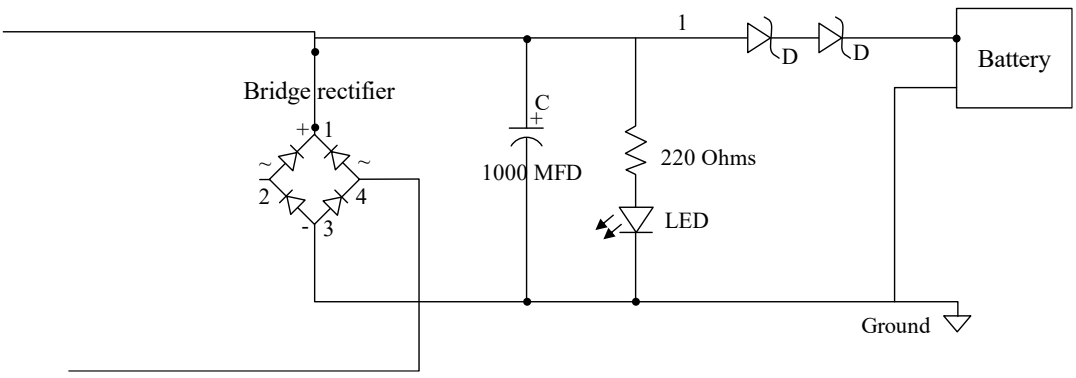

Figure 3. Charging circuit.

MOTOR DRIVER (L293D)

The L293 and L293D are high-current half-H drivers for bidirectional drive currents up to 1 A and 600 mA respectively, operating from 4.5 to 36 V. They are suitable for driving inductive loads like relays, solenoids, and motors, with TTL-compatible inputs and totem-pole drive circuits. The drivers can be enabled in pairs, and each pair forms a fully reversible drive for solenoid or motor applications. External clamp diodes are recommended for inductive transient suppression on the L293.

HC-05 BLUETOOTH MODULE

Designed for a transparent wireless serial connection setup, the HC-05 module is a simple serial port protocol (SPP) Bluetooth module. The HC-05 Bluetooth Module is an excellent wireless communication solution because it can be used in either a Master or Slave configuration. With a full 2.4 GHz radio transceiver and baseband, this serial port Bluetooth module is completely eligible for Bluetooth V2.0+EDR (Enhanced Data Rate) 3 Mbps modulation. With CMOS technology and AFH (Adaptive Frequency Hopping Feature), it makes use of the CSR Bluecore 04 External Single Chip Bluetooth platform (Figure 5).

A MASTER/SLAVE module is the Bluetooth module HC-05. The factory setting is SLAVE by default. Only AT COMMANDS has a capacity to configure the module's role (Master or Slave). While they can accept connections, the slave modules cannot manage to establish a connection with another Bluetooth device. Other devices can be connected by the master module. It can be used as a simple serial port substitute to connect a PC in an embedded project, an MCU to a GPS, etc.

DC MOTOR

A DC motor converts electrical energy into mechanical energy, typically through magnetic field interactions with current-carrying conductors. Conversely, electrical energy can be generated from mechanical energy by alternators, generators, or dynamos. Many electric motors can function as generators and vice versa. A DC motor absorbs current and voltage as its inputs and outputs, torque, or speed.

Its basic parts include the armature (rotating) and the field coils (stationary or stator). The armature consists of wire coils around a core with an extended rotating shaft. The commutator, where brushes make electrical contact, is located at the ends of the armature coils. Assembling of four DC motors and corresponding wheels is shown in Figure 6 for the robot.

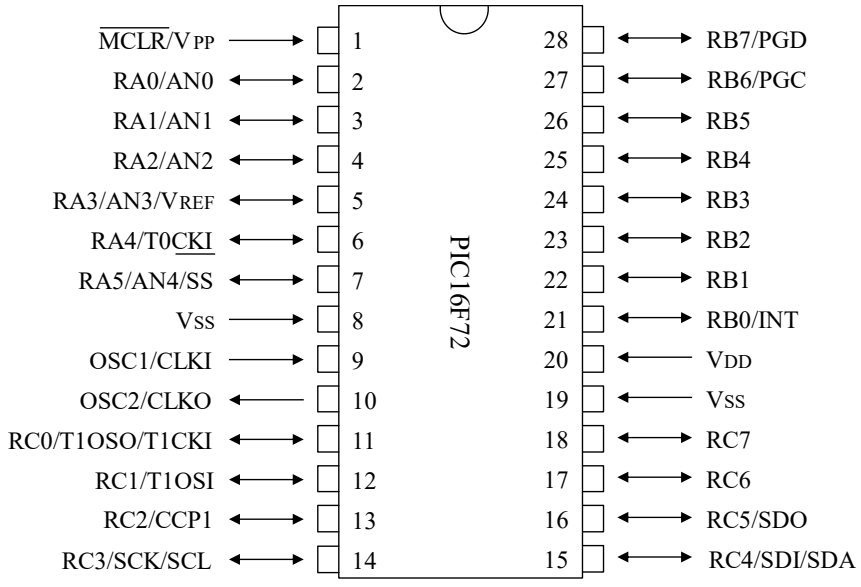

Figure 4. Microcontroller PIC16F72.

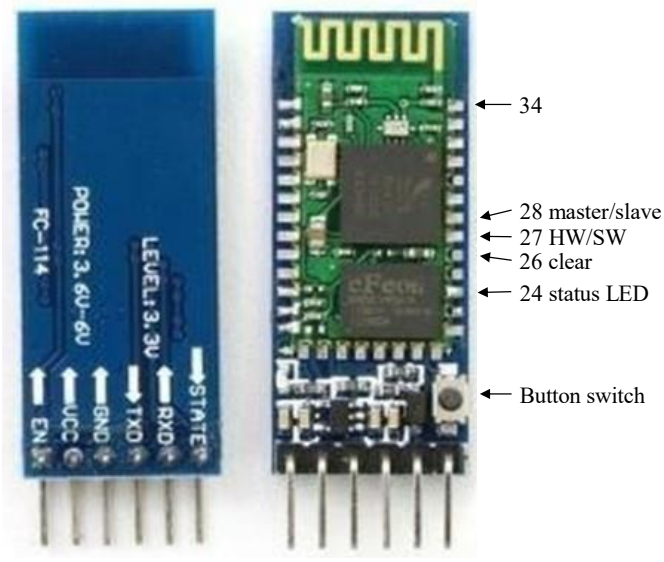

Figure 5. HC05 Bluetooth module.

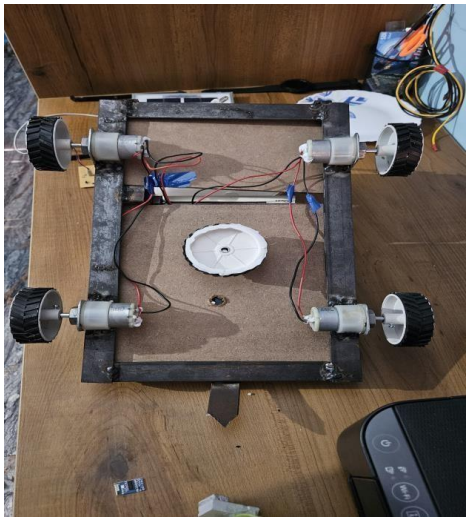

Figure 6. Assembling of wheels.

SEED DROPPING

With the help of a conical funnel and DC motor, we are dropping the seed in the plowed land, controlled by the user from mobile over Bluetooth. Through the relay, a DC motor and pipe were interfaced with the MCU.

When the user controls the seed sowing motor through Bluetooth application, then the HC-05 module receives that and processes this data to the microcontroller. Then microcontroller turns on/off the seed drop motor through the relay. The pipe connected to the third motor rotates automatically when the motor is in operation. The pipe has a hole in it. The seeds only fall forth when the opening is lowered. A funnel was fixedly mounted above the pipe's holder configuration. Now, as the pipe rotates, there comes a moment when the hole descends, and the funnel is positioned through the holder precisely at that moment. The funnel's seeds drop through the aperture. Same process can be done with the Blynk app.

WATER SPRAY

Here, we apply a relay to connect the water motor to a microcontroller. When the user controls the water motor through Bluetooth application, this data is received by Bluetooth module which processes

this data to microcontroller. A microprocessor then turns the water motor on or off as desired. In this case, the relay serves as a switch to turn the water jet on and off. Same process can be done with Blynk app.

ADVANTAGES

- The pumped water maintains a higher flow.
- Effective working principle.
- Initial and maintenance costs is less.
- Easy to use.
- Using solar; it is economically free.
- Uniform spraying.
- Portable and ergonomic.
- Both Bluetooth and IOT devices can be used to handle it.

CONCLUSION

Our design's main priority is the cost and ease of operation for small farm units. Therefore, the goal of this multifunctional piece of apparatus is to bring down the cost of seed feeding, spraying, and plowing. We have used historical facts and methods in the construction of this multipurpose equipment. This keeps the design of multifunctional agricultural equipment safe. These human-powered machine solutions are going to significantly improve small and middle-class farmers' profitability and enhance profitability per acre.

A new type of Wi-Fi and Bluetooth controlled multipurpose mechanism is proposed. It has been created with features that integrate all of the hardware components used. Each module's presence has been carefully assessed and positioned to maximize the unit's functionality. Second, the project has been successfully executed with the aid of new and very sophisticated ICs. Consequently, the project's design and testing were successful. Our design's main objective is on cost and ease of operation for small farm units. Therefore, the goal of this multifunctional piece of equipment is to lower the cost of seed feeding, spraying, and plowing. We have used historical facts and methods in the construction of this multi-equipment. This makes the design of multimodal agricultural equipment safe. These human-powered machine solutions will substantially increase small and middle-class farmers' profitability and enhance worker efficiency per acre. A new type of Wi-Fi and Bluetooth controlled multipurpose mechanism is proposed.

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