

Obstacle Detecting Multifunctional AGRIBOT Driven By Solar Power

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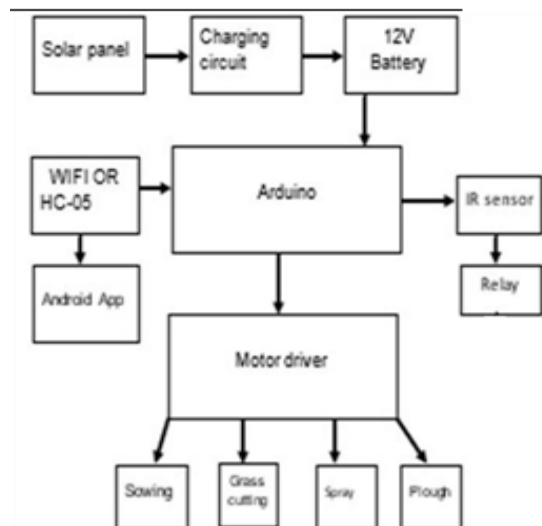
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ABSTRACT: This paper introduces AGRIBOT, an agricultural robot designed to help farmers safeguard their livelihoods by taking on chores such as digging, sowing, spraying pesticides, cutting grass, ploughing—and spotting obstacles in its path. Earlier machines were often complex and costly, out of reach for many smallholders. AGRIBOT takes a different approach: it runs on renewable energy — solar panels fixed to the unit recharge an on-board battery — and carries a visual obstacle detector plus a Bluetooth module that pairs with a simple terminal app so an operator can send remote commands. The result is an affordable, easy-to-use machine; you don't need to stand in the field all day—who wouldn't welcome that? It lightens backbreaking work, saves time and fuel, and, frankly, removes some of the drudgery from routine tasks. AGRIBOT is built to operate day or night and in varied weather — even light rain or overcast conditions. Compared with other robots, it delivers clear advantages: a multitasking platform with practical innovations meant to make farming smarter, faster and more efficient.

1. Introduction

This project centres on an AGRIBOT — a compact field assistant built to save farmers time, cut labour and costs, and automatically log its tasks. Small, steady and practical, it takes on the daily grind so the farmer can focus on the big picture; who wouldn't welcome that extra pair of hands when the season gets hectic. The AGRIBOT multitasks: seed sowing, ploughing, pesticide spraying, grass cutting and obstacle detection. It runs on six motors in total — two for steering and four dedicated to the tools (sowing, cutting, spraying and ploughing). All motors feed into a microcontroller and IC circuitry, with a proximity sensor mounted up front to spot obstacles and steer clear of collisions. Think of the electronics as the brain and the sensor as the eyes; wiring is routed into a weather-proof housing so the system keeps working despite dust, rain or mud.

BLOCK DIAGRAM:



Every motor and attachment is powered by solar-charged energy: panels top up a battery that stores power and runs the whole system. The design emphasizes safe, secure operation while staying easy to handle over ruts and uneven ground. Farmers control the AGRIBOT from their Android phones via a Bluetooth HC-05 link

— a simple app lets them send commands and check on the bot without fuss. When the command is given, it accepts the command and performs the operation. The use of solar panels in agricultural fields reduces the wastewater as excessive and continuous flow of water is not required it also reduces pollution in which burning of fossil fuels is minimized and it is economically generated directly from sun. In the paper explains the different complex methods like sowing seeds, spraying pesticides along with grass cutting. This system of robot is powered by solar energy, where the solar panel provides the energy to the robot, which is operated using Bluetooth or android, it gives the signal to the robot to perform the required function and the movement of the robot. The main disadvantage of this system is ploughing operation is not done. In these robots are hand free with fast data input operation and the farmer receives messages through Bluetooth about the performance of the robot. The major drawback of this system is it operates in manual mode for purpose. In [3] paper the operation was done only on android application which is used only with assistance of WLAN network which consists of two sensors, first measures the distance to the object and other measures the earth's magnetic field. The machine is charged using battery which runs on solar energy. The main drawback is that it operates only in one direction. In [4] the author explains the development of precision farming which includes requirement of farming based on electric sensing sensors on the low-cost principle. The drawback system is farmers need to control the vehicle by itself. In the project is designed for saving time and energy of the farmers for the repetitive tasks, for increase in the production of yield .it is a four wheeled robot which is controlled using LPC2148.here the drawback is it is single functioning robot it doesn't perform multitask. In [6] the project is designed for performing operations such as automatic ploughing, sowing of seeds and picking of fruits , it's also allows to operate manually this project

also consists of a humidity sensor which examines the humidity of the atmosphere and sends it to the farmer via SMS using the GSM module. Here the system doesn't know how to respond when an obstacle is detected .In the paper is based on robot which consists of sensors, which is a visual robot with a GPS which helps the robot to guide it to the agricultural land and it also helps to determine its self-location .the disadvantage of the paper it bumps up to 3cm. It also senses whether seeds are being dropped or not accurately. In the project the DTMF technologies are used, where the robot is controlled using the mobile phone from a faraway distance where the moisture of soil sowing of seeds is examined the drawback it requires Sim card to command the robot. In this paper shows the smarter water management point on productiveness and rational usage of environmental assets the water irrigation control is one of the typical usages of computer system in agriculture. The disadvantage is it only performs the operation of water irrigation system. In [12] this paper the more focus is on DC motors which are widely used for variable speed drive systems in industrial application. GSM, Wi-Fi, Zigbee and Bluetooth. The speed control is controlled by Bluetooth for communication the drawback is Bluetooth controls only the motors. In [13] the proposed work in agriculture employs low cost with the low data rate, low power consumption and large covering area. The disadvantage is the Wi-Fi is necessary and if the electricity is cut off commands cannot be given.

2. Architecture Description

2.1 System Architecture Overview

The proposed IOT-enabled Obstacle-Detecting Multifunctional AGRIBOT is a compact, solar-driven agricultural robot designed for small-scale industries and rural farming units. It integrates renewable power generation, real-time environmental sensing, autonomous navigation, agricultural task modules, and cloud-based IOT monitoring into a unified system.

The architecture is organized into six major subsystems:

1. Solar Power & Energy Management Subsystem
2. Perception & Obstacle Detection Subsystem
3. IOT-Integrated Processing & Control Subsystem
4. Locomotion & Mechanical Drive Subsystem
5. Agricultural Task Execution Subsystem
6. IOT Communication & Cloud Services Subsystem

3. Perception & Obstacle Detection Subsystem

3.1 Obstacle Detection Sensors

- Ultrasonic sensors at front, left, and right for collision prevention.
- IR proximity sensors for close-range detection (pits, edges).
- Optional: Low-cost LIDAR for enhanced mapping.

3.2 Environmental Sensors

- Soil moisture
- Temperature & humidity
- Light intensity

3.3 IOT Sensor Node Integration

All sensor data is streamed to the cloud through the IOT module for:

- Real-time farm monitoring
- Predictive analytics
- Logged datasets for decision making

3.4 Sensor Fusion Layer

- Combines ultrasonic, IR, and motion feedback.
- Filters noise using lightweight algorithms suitable for low-cost hardware.

4. Proposed Methodology

As per the working of the proposed AGRIBOT, the solar panel uses heat generated from the sun which is transformed into an electrical energy and stores it in a battery from this +5V is supplied to Arduino and +12v to DC motor driver. Moreover, in this AGRIBOT six motors are used, two motors are used for forward and backward, then the next two motors are used for ploughing and sowing, and other two are used for grass cutting and spraying these are connected with motor driving circuit [L29-3D IC] which controls the speed of the AGRIBOT. It is controlled by a Bluetooth application HC-05 module for wireless communication. The RX-TX pin of Bluetooth module is connected to TX-RX pin of Arduino then the power is shared from Arduino module to Bluetooth module by connecting VCC ground pin and then it is connected it to the IR proximity sensor for detecting the obstacles in front of the AGRIBOT while performing operations. The movements of robot is controlled by the Bluetooth app by giving the instructions such as forward, backward, left, right, ploughing, sowing, spraying, cutting and also it gives an instruction whenever an obstacle is detected. Hence operations like sowing of seeds, spraying pesticides, grass cutting along with ploughing are successfully performed.

4.1 Arduino Microcontroller (AT mega 328)

The ATmega3289 is a microcontroller designed in a mega AVR family. It has a redesigned Harvard architecture 8-bit RISC processor core. It has 28 pins in total, where there are 13 pins for input and output where 5 pins are used for pulse width modulation outputs and 5 for Analog inputs



4.2 Solar Panel

The solar panel is a photo voltaic cell which absorbs sunlight as a source of energy and converts it into an electrical energy. It is also known as solar plates. The solar panel is an assembly of solar cells that can convert light directly into energy.

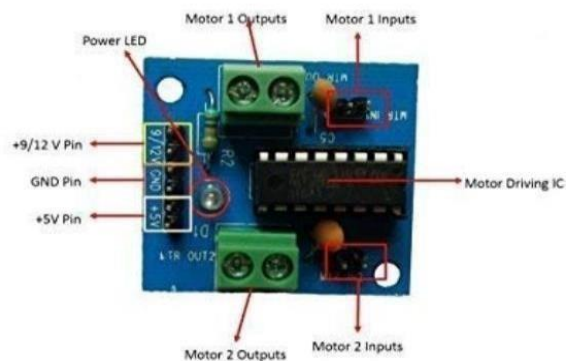


4.3 Bluetooth Module

The Bluetooth is a technology designed for wireless communication between two micro controllers like Arduino or to communicate between mobiles and laptops. It works on serial communication (UART).It has 5 pins .it is a cool module which can add two way wireless functionality to the project working with HC-05 is easy as it works using SPP(serial port protocol).

4.4 Motor Driver

The L293D is a typical motor driver which allows DC motor driver to drive on either direction. L293C is 16 pin motor driver IC which provides bidirectional drive currents at voltages ranging from 5 V to 36 V. The L293D which consists of 8 pins on both sides with 2 DC motors and it has 4 input and output pins and 2 enable pins for the motors.



4.5 Relay

Relay is a switch which works on electromagnetism as relatively small electric current as it turns ON or OFF in huge amount of electric current. Relays are used by a split lower power signal which controls a circuit, by a single signal to multiple circuits. Relays were used widely to perform logical operations in telephone interchange and early in computers.



4.6 Battery

Battery contains electrochemical cells which are used to generate power to the electronic devices. Mainly it transforms chemical energy into electrical energy. They are majorly two types of batteries such as primary and secondary, the primary battery are non-rechargeable and disposable batteries, whereas the secondary battery is chargeable and can be used numerous time, these battery differentiates in the size, shapes and also the charging capacity units. The battery used in this project is of 12v and 1.3 Ah which is sealed rechargeable lead acid battery.



4.7 Obstacle Detection

In this AGRIBOT the IR infrared obstacle avoidance sensor module is used for detection of obstacles of the project. This sensor consists of a pair of infrared tubes of which one is the transmitting tube and the other one is the receiving tube. The receiver tube will receive the reflected IR waves when transmitting light waves are reflected back and the green light indicator gets on. This module consists of three interfacing pins i.e. VCC, ground and output pins.

4.8 Flowchart

Step 1: Start

Step 2: Power On

Step 3: Bluetooth Ready

Step 4: Forward Command received-robot move forward

Step 5: backward command received-robot move backward.

Step 6: left command received-robot move left.

Step 7: right command received-robot move right.

Step 8: ploughing command received robot ploughing on.

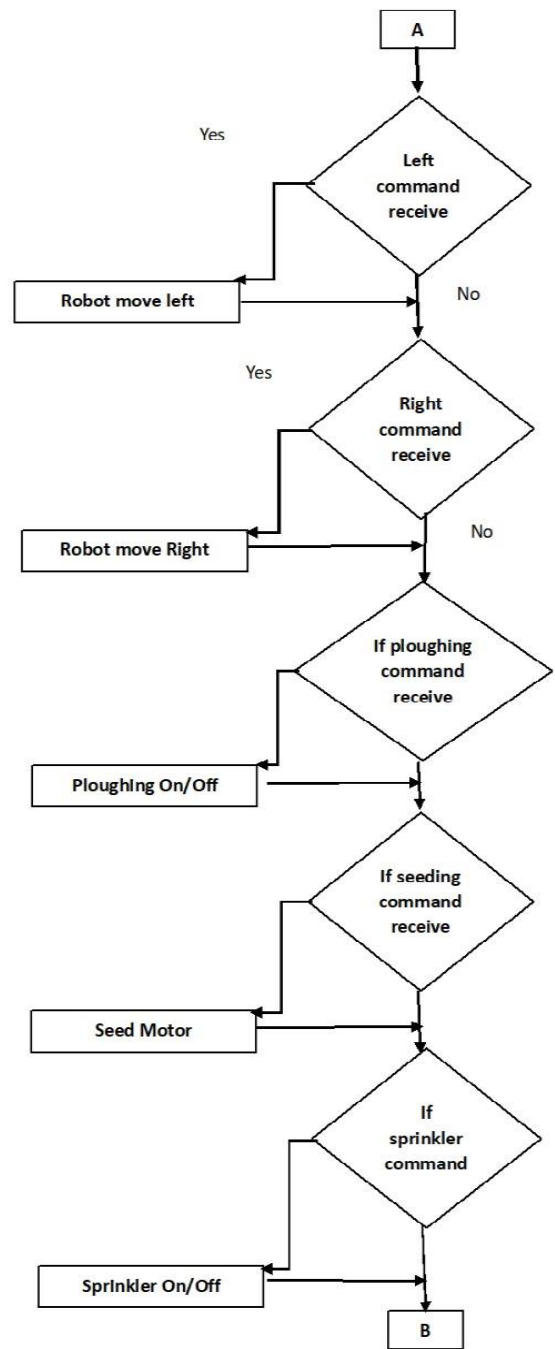
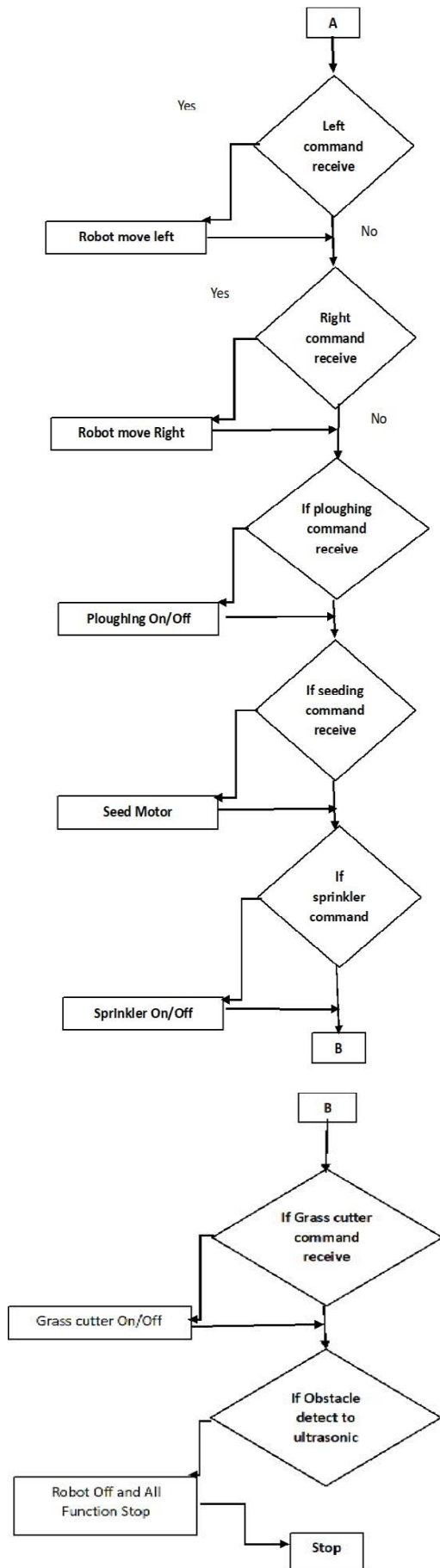
Step 9: seed command received-seed motor on.

Step 10: sprinkler command received- sprinkler on.

Step 11: grass cutter command received- grass cutter on.

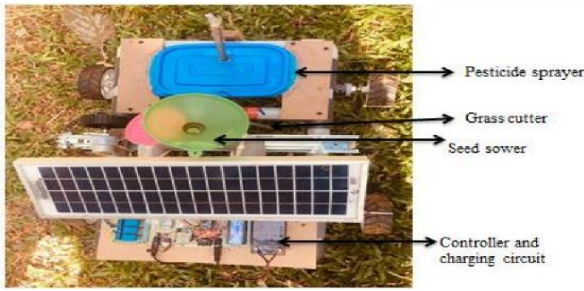
Step 12: obstacle detected-robot stop and all function stop.

Step 13: stop



4.9 Prototype Result and Discussion

The prototype already handles a handful of field chores — sowing seed, spraying pesticides, even trimming grass — and it does so reliably. It runs on a built-in solar charger, so you don't need mains power. A no-frills Bluetooth app lets users steer it or kick off routines without fuss. The machine reacts quickly to commands and will automatically brake if something — an animal or stray tool — wanders into its path. All told, it proves you can build an inexpensive automated farm helper from simple embedded hardware.



Snapshot of the Automated Seed Sowing, Grass Cutting and Pesticide Sprayer Robot Using Bluetooth/Android App. The solar panel shown in Fig.9 stores and converts the solar energy into electrical energy which is given to charging circuit in order to charge the battery to 12 V which will give the necessary power to controller, DC motor and different mechanisms.



The Bluetooth/android app which is used to control the robot is as shown in Fig.10. It consists of 12 keys. Scan key are used for pairing of app with HC-05 module and set keys is used to add further grass, spray, see dare used to activate keys if required. The stop, right, left, forward and backward keys are used to control the movements of the robot. The remaining keys like the mechanisms. All OFF key is helpful in deactivating the mechanisms and it will stop the movement of robot.



Figure 1: Snapshot of solar charging

Comparison with Existing Agricultural Robotic Platform

Feature	Proposed ABRIBOT	FarmBot	Naïo Technologies	DJI Agriculture
Power Source	Solar-powered	Grid power	Battery recharge	Battery swap
Cost Suitability	Low-cost for small industry	High	Very high	High
Functionality	Multifunctional (sow/spray/monitor)	Fixed tasks	Mostly weeding	Spraying only
Mobility & Obstacle Detection	Low-cost ultrasonic/IR fusion	No autonomous mobility	Advanced but expensive	No obstacle detection on ground
IOT Connectivity	Yes (remote monitoring & control)	No	Limited/proprietary	Limited
Target Users	Small-scale farms & small industry	Hobby/precision gardening	Large farms	Commercial aerial spraying

Future Work Directions: Future Work Area	Proposed Enhancement
Autonomous Navigation	Integration of GPS, vision-based mapping, and advanced path-planning algorithms to enable fully autonomous movement beyond basic obstacle avoidance.

Future Work Directions: Future Work Area	Proposed Enhancement
AI-Based Decision Making	Use of machine learning for crop health detection, automated spraying decisions, soil prediction, and adaptive task scheduling.
IOT Expansion	Improved cloud dashboards, predictive maintenance alerts, long-range communication (LORA/GSM), and remote multi-robot coordination.
Advanced Obstacle Detection	Addition of stereo cameras, low-cost LIDAR, and classification algorithms for better terrain mapping and safer navigation.
Modular Tool Development	Designing new attachments for weeding, micro-fertilizer application, monitoring, or harvesting to increase multifunctionality.
Energy Optimization	Incorporation of solar-tracking mechanisms and energy-aware operation algorithms to maximize efficiency under varying sunlight.

5. Conclusion

The proposed solar AGRIBOT reduces human effort and improves farming efficiency by automating important agricultural tasks. It can operate during both day and night and in different environmental conditions. The use of solar power makes it economical and eco-friendly. This system is especially useful for small farmers as it saves time, reduces labour dependency and increases productivity. The project proves that embedded system technology can be effectively applied in smart agriculture and can contribute to the future of automated farming.

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