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Grass Cutter and Pesticide Sprayer Solar Powered Spider Robot

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ABSTRACT
The grass cutter and pesticide sprayer spider robot, driven by Arduino and Bluetooth technology, signifies a groundbreaking advancement in autonomous agricultural and landscaping systems. This robotic platform combines spider-like mobility, precise control mechanisms, and user-friendly interfaces to autonomously perform grass cutting and pesticide spraying operations, orchestrated through the Arduino microcontroller and directed by user commands via Bluetooth. The grass cutting operation involves coordinated leg movements and a specialized cutting mechanism, ensuring efficient lawn maintenance. Simultaneously, the pesticide spraying functionality employs a pressurized pump system for even distribution of pesticides across designated areas, contributing to effective pest control. Looking forward, the future scope encompasses potential advancements in sensing technologies, artificial intelligence integration for decision-making, and sustainability considerations in energy sources and materials. The grass cutter and pesticide sprayer spider robot exemplify the evolving synergy between robotics and agriculture, paving the way for more advanced, efficient, and sustainable autonomous systems in the field.

Keywords

Solar panel, Grass cutter, Pesticide sprayer, Arduino, Bluetooth module, Servo motor

I. INTRODUCTION

Agricultural regions are changing the socio-economic environment of humans due to modernization and globalization. About 75% of human beings are living inside the rural areas and they are nonetheless dependent on agriculture. Agriculture has been the spine of the Indian economy. Spraying pesticides is an essential mission in agriculture for protecting vegetation from insects.

This encouraged us to layout and fabricate a version that is largely trolley primarily based sun powered Grass Cutter and Pesticide Sprayer in a single unit. Due to the use of Solar power for operating pump & grass cutter, there may be elimination of gasoline engine operated spray pump & cutter
by means of which there may be reductions within the pollutants. The elimination of fuel will make our version eco-pleasant. In this venture there is use of wireless technology for agriculture automation.

In this way, it saves electrical energy and human strength. IoT coverage may be very extensive and consists of kinds of gadgets like smart phones, tablets, etc. Once some of these gadgets are connected to each other, they permit more and more trendy processes and services that help and assist our basic requirements.

In the pursuit of sustainable and efficient lawn care solutions, we introduce our innovative creation: a solar-powered robot equipped with a grass cutter and pesticide sprayer. Harnessing the power of the sun and controlled by the versatile Arduino Nano microcontroller, this robotic system represents a harmonious blend of technology and environmental consciousness. The primary objective of this project is to offer self-governed and eco-friendly alternative to lawn maintenance practices. By integrating solar panels, rechargeable batteries, and intelligent control mechanisms, our robot not only minimizes its environmental impact but also provides a cost-effective and energy-efficient solution for homeowners and landscaping professionals. The heart of the system lies in the Arduino Nano microcontroller, which orchestrates the intricate dance between sensors, motors, and peripherals to navigate, avoid obstacles, and seamlessly switch between grass cutting and pesticide spraying modes.
The robot operates in distinct modes to cater to various lawn care needs. In grass cutting mode, activated either by user command or a predefined schedule, the Arduino Nano commands the grass cutter mechanism to efficiently trim the lawn using either rotating blades or a string trimmer. When the need arises for pesticide application, the robot seamlessly transitions to spraying mode, ensuring controlled and even distribution of pesticides across the lawn. For those who prefer hands-on control a wireless communication module allows remote guidance and monitoring [8].
We designed our robot based on a spider mechanism inspired by spider legs for increased flexibility and adaptability to uneven terrain. At the core of this operation lies a sophisticated system controlled by the Arduino Nano

microcontroller, orchestrating each component with precision. The robot's pesticide spraying system consists of reservoirs, storing the necessary quantity of pesticide for the designated lawn area[3]. The Arduino Nano commands a pump system, pressurizing the pesticide and enabling an even and controlled distribution. Moreover, the system is equipped with rain sensors, suspending the spraying process during wet conditions to prevent pesticide runoff and maximize efficiency.

II. BACKGROUND AND LITERATURE REVIEW

The solar-powered grass cutter and pesticide sprayer spider robot emerge from a pressing need to revolutionize traditional lawn care practices, aligning them with contemporary demands for sustainability, efficiency, and technological innovation. The solar-powered spider robot is guided by the Arduino Nano microcontroller, offers a sustainable alternative that can perform precise grass cutting and pesticide spraying without constant human oversight. The Arduino Nano commands the grass cutter mechanism to efficiently trim the lawn using rotating blades. When the need arises for pesticide application, the robot seamlessly transitions to spraying mode, ensuring controlled and even distribution of pesticides across the lawn.

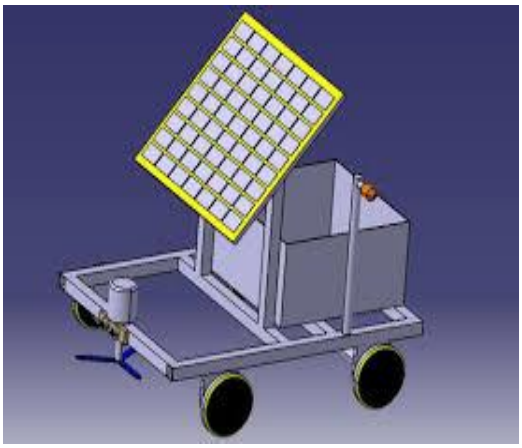

Fig no. 1: Layout of Solar Grass Cutter and Pesticides Sprayer Robot [4]

In [1], the author explained about the developments and invention of agricultural robots for field use. Agricultural robots must be capable of working in undesirable agricultural surroundings with the same working efficiency and power that is achieved by current methods when it is operated in field. Technology must be invented to control constantly changing conditions and environments to incorporate robotic systems [3].

In [2], the author described that the present design of agricultural robots relies on electronic and mechanical devices to perform advanced agricultural tasks. The agricultural field is cultivated or planted by the automated robotic system that is controlled remotely by using wireless communication and DC battery is charged by using solar panel. Further, the author also tried to reduce labor problems by using agricultural robots [5]. At the same time, environmental pollution can also be reduced by using solar energy.

In this article [3], the author developed a robot that can sow seeds, trim lawns, and spray insecticides. All the components of the system are powered by solar energy. The Bluetooth/Android App is used to operate the robotic system manually that provides signals to the robotic system for different functions and movement. Also, the ability of sowing seeds, insecticide spraying, and grass cutting is enhanced, as well as minimizing the difficulties that farmers face when planting the crops manually [11].

In [4], the author explained that the main use of robots in agricultural field is for cultivating, sowing the seeds, picking the fruits and spraying pesticides which are developed to remove human work. The main intention is to eliminate spraying of insecticides manually. It will be obtained by substituting human by a robot [7].

In [5], the author presents the management of vegetation consists of right inspection, particularly about the remedy of ailments, that can cause critical consequences after harvest. An analysis of disease and the amount of illness produced in vegetation is necessary for rich and productive crop cultivation [8]. This can be performed by using a camera which takes input images, analyzes them using the process of machine learning.

[6] Since there are always some drawbacks in the wheel with modifications in short-term changes such as tiny stairs, blocks, areas of agriculture and uneven rock piles so the robot has been designed in such a way that it can operate efficiently on ground and uneven rock piles [1]. The primary goal of the project is to replace the role of the wheels used in seed sowing, pesticides spraying and grass cutting with an alternative to solve the problems of travelling in agricultural regions.

[7] In this, wireless technology is used for home automation. By using home automation system, users can control electric appliances of different kinds. The android app is the basic requirement. It will reduce human energy and electric power. In this project, IoT technology is used which includes distinctive items like smart phones, tablets, etc. [2]. When majority of these devices are related to each other, they allow more smart processes and services.

Farming is one of the most essential areas of human existence. In this, the author focused on solving the problem in manual farming sector, such as grass cutting, planting of seeds and pesticide sprinkling [8]. The Atmega Microcontroller is used to control all the system process [9]. The robot is capable for cutting the grass, sowing seeds and pesticide spraying.

In [9], the author explained that there should be an advanced agricultural system which can lessen the efforts of the farmers. The agricultural device needs to be developed in one of these manners that it routinely sows the seeds,

spray the insecticides and trim the grass [10]. It represents the advanced gadgets for enhancing rural techniques based on robotic assistance.

The main aim is to make agriculture smarter enough to reduce human interference. Sensors will collect the data and this data is processed in controller and send it to the smartphone [10]. The farmer can analyze data such as current temperature, humidity, moisture content, battery levels, pump status etc. and perform further tasks. To increase the efficiency of the system, IoT technology is used[6].

III. HARDWARE AND SOFTWARE REQUIREMENTS

A. *Arduino Nano*

The Arduino Nano is a compact yet powerful microcontroller board that has become a staple in the world of electronics prototyping and DIY projects. Built around the ATmega328P microcontroller, the Nano offers a wealth of features in a small form factor, making it particularly suitable for projects where space is at a premium. Its popularity stems from its versatility, ease of use, and compatibility with the Arduino ecosystem.

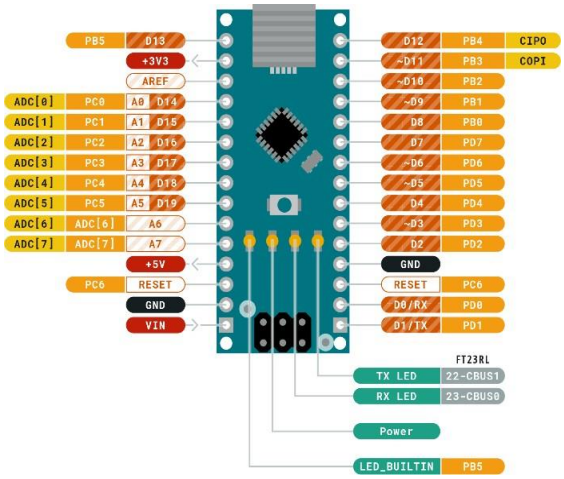

Fig no. 2: Arduino nano pinout diagram[13]

B. *Nano 328P Expansion Adapter Breakout Board Input Output Sheild*

The Nano 328P Expansion Adapter Breakout Board is a valuable accessory designed to enhance the capabilities of the Arduino Nano 328P microcontroller.

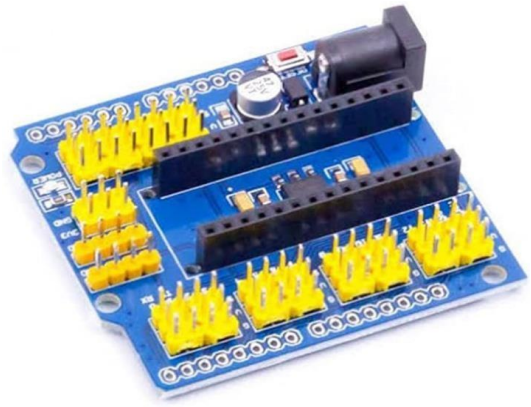

Fig no. 3: Nano 328P Expansion Adapter Breakout Board[14]

This breakout board acts as an interface expansion, providing additional features and flexibility for a wide range of projects. With extended GPIO pins, users can easily connect a variety of sensors, actuators, and other electronic components, expanding the possibilities of their Arduino Nano-based applications. One of the notable features of this breakout board is its inclusion of specialized interfaces for common sensors, simplifying the integration of environmental, motion, or other sensor types.

C. *HC-05 Bluetooth Module*

The HC-05 Bluetooth module is a compact and cost-effective wireless communication solution widely employed in electronics projects. Operating on the Bluetooth 2.0 standard, the HC-05 module allows seamless serial communication between microcontrollers, sensors, or other electronic devices. With its versatile features, including a built-in Bluetooth stack and support for both Master and Slave modes, the HC-05 enables bidirectional data transfer over short distances. The module is equipped with a range of security features, such as password protection, ensuring secure and reliable communication. Popular for applications ranging from Arduino-based projects to robotics and home automation, this Bluetooth module continues to be a popular choice for enabling wireless connectivity in the realm of electronics prototyping and development.

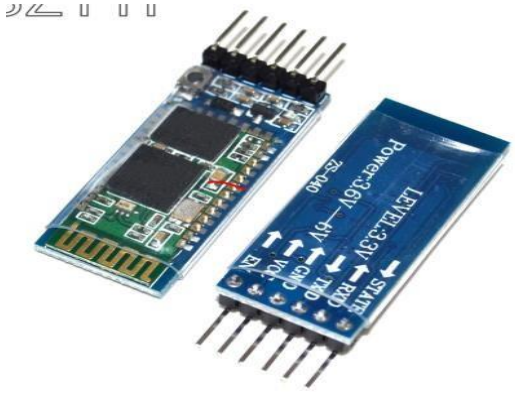

Fig no. 4: HC-05 Bluetooth Module[15]

D. SG90 Mini Servo motor

The SG90 servo motor is a widely utilized micro servo known for its compact size, lightweight design, and versatility in a variety of electronic projects. Operating within a voltage range of 4.8V to 6V, the SG90 is well-suited for applications where precise angular movements are required. With a moderate torque, this servo motor is commonly employed in robotics, model airplanes, cars, boats, and other projects requiring controlled motion in confined spaces.

Fig no. 5: SG90 Mini Servo motor[16]

E. Buck Converter L2596

The L2596 is a commonly used buck (step-down) voltage regulator integrated circuit, widely employed in electronic projects and power supply applications. Operating as a switch-mode power supply, the L2596 is designed to efficiently lower a higher input voltage to a lower output voltage. With its versatile capabilities and compact form factor, this buck converter is favoured for its ability to provide a stable and adjustable DC output. The L2596 incorporates features that make it suitable for a variety of voltage regulation tasks. It typically includes an adjustable resistor divider network that allows users to set the desired output voltage within a specified range. Additionally, it integrates a feedback loop mechanism to maintain the output voltage at the desired level, enhancing its precision and stability.

Fig no. 6: Buck Converter L2596[17]

F. Arduino IDE

The Arduino Integrated Development Environment (IDE) is an accessible software program that plays a crucial role in programming and developing projects with Arduino microcontrollers. It is designed to ease the method of writing, compiling, and uploading code to Arduino boards, the software provides a comprehensive environment for both beginners and experienced developers. With a straightforward interface, a basic text editor, and a variety of built-in functions and libraries, the Arduino IDE software allows users to write programs using the Arduino programming language, which is a simpler version of C and C++. It supports a wide range of Arduino boards, each catering to specific project requirements.

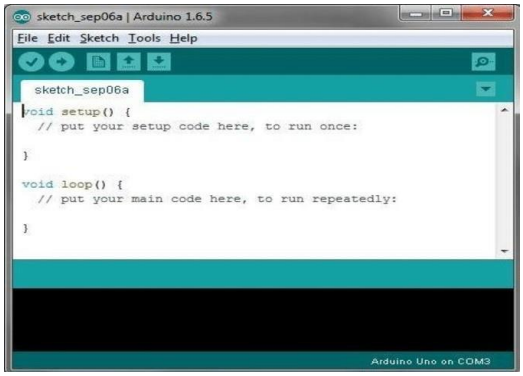

Fig no. 6: Arduino IDE[18]

The IDE includes features such as a serial monitor for debugging, a library manager for easy integration of additional functionalities, and a vast community-contributed library of pre-written code snippets called "sketches." These features streamline the programming process and enable rapid prototyping for a multitude of applications, from simple LED flashing projects to complex robotics and IoT systems. As an open-source platform, the Arduino IDE fosters a collaborative and supportive community, making it a go-to choice for both educational purposes and professional projects. Its accessibility, versatility, and strong community support contribute to the widespread popularity of Arduino in the world of electronics and embedded systems development.

G. Android Application

Arduino Bluetooth Control is an application that allows to control Arduino board via Bluetooth, allowing to create cool projects, completing projects with new features available within the app. The settings section allows to adapt the application according to the requirements, with the help of very fast and simple interface. The application additionally remembers the Bluetooth module and it tries to establish connection automatically to the brand new one you have got used, so that you won't must choose it every time you use it[10].

IV. METHODOLOGY

The block diagram of the suggested system is shown in Fig. It consists of Arduino Nano, Solar Panel, HC-05 Bluetooth module, Buck converter, SG-90 Servo motor, DC motor, Pump motor, Grass cutter and sprayer. The rechargeable batteries are used to power the system. These batteries are charged by using the sun energy from the solar panel.

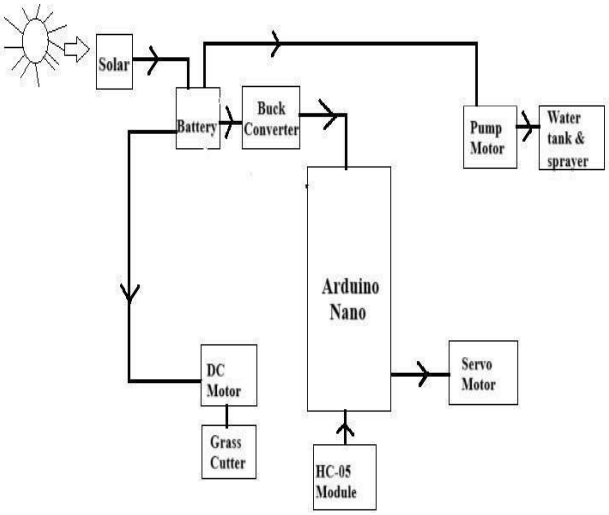

Fig no. 7 : Block Diagram

Our proposed machine is a moving robot having spider legs controlled by the servo motor mechanism. The system uses the grass cutter to cultivate the field which is attached to the front side of robot. We have used pesticides for spraying pesticides which control the weeds using chemicals. A solar panel and battery for power supply is used and the system will work on both solar power and AC to DC charging system. There is a water tank and pump mounted on the spider robot for spraying pesticides.

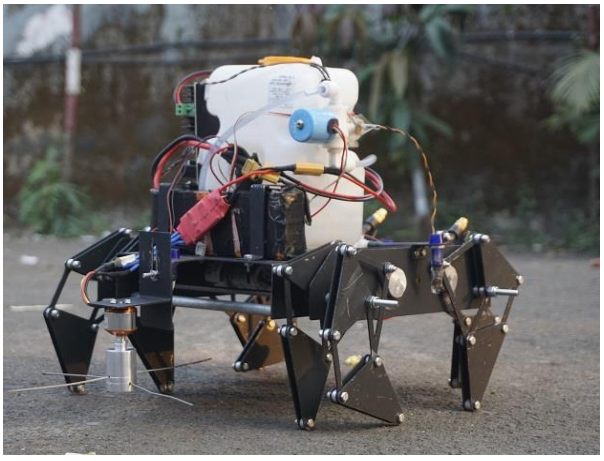

Fig no. 8: Grass Cutter and Pestiside Sprayer Solar Powered Spider Robot[12]

The water tank and pump mounted on the spider robot for spraying pesticides. Arduino Nano is used for controlling the spider robot which directs the servo motor to run its leg properly. Bluetooth HC-05 is used for establishing wireless communication between machines and android phones. Arduino Nano will receive the data from Android phone and move the spider robot backward, forward, left, right. Nano 328P Expansion Adapter Breakout Board input output shield is acting here as a breakout board for Arduino Nano [12].

Here Arduino Nano is placed on this adapter which facilitates an easy connection between Arduino Nano and other devices and connecting devices in trouble free manner. The grass cutter motor is directly connected with battery and switch for controlling. The pesticide water pump is directly connected with the battery and the pesticide tank is having pesticide sprayer for sprinkling the pesticides.

V. WORKING

The grass cutter and pesticide sprayer spider robot, controlled by Arduino and Bluetooth, operates through a carefully orchestrated combination of mechanical, electronic, and software components. The mechanical design of the robot features spider-like legs driven by servo motors, ensuring stability and mobility. Power is supplied by a rechargeable battery, and the Arduino serves as the central controller for seamless coordination .The Arduino is programmed to interpret commands received via Bluetooth, facilitated by a Bluetooth module like HC-05. This wireless communication allows users to control the robot remotely using a Bluetooth-enabled device such as a smartphone[1]. The user interface, typically a custom mobile app or a Bluetooth terminal app, facilitates intuitive control, enabling commands like forward, backward, grass cutting, and pesticide spraying. The grass cutting mechanism, often a rotating blade, is activated based on user commands, providing an effective means of lawn maintenance. Simultaneously, the pesticide sprayer mechanism, equipped with a container, pump, and spraying components, is triggered as needed for pest control.

VI. APPLICATIONS

- ***Mobility and Navigation:***

The robot uses its servo-driven spider-like legs to move across the designated area. The Arduino processes Bluetooth commands to control leg movements, enabling forward, backward, and turning motions. This mobility ensures efficient coverage of the lawn or agricultural field. The mobility and navigation system of the grass cutter and pesticide sprayer spider robot is a critical aspect of its operational functionality. The coordination of leg movements is orchestrated by the Arduino microcontroller,

which processes commands received via Bluetooth from a user interface, typically a smartphone or tablet.

- ***Grass Cutting***

Upon receiving specific user commands, the grass cutting mechanism is activated. This mechanism, often comprising a rotating blade, trims the grass to the desired height as the robot traverses the area. The cutting operation contributes to lawn maintenance and landscaping. Activated through user commands communicated via Bluetooth, the grass cutting mechanism engages with precision and efficiency. Whether applied to residential lawns, commercial landscaping, or agricultural fields, this autonomous grass cutting capability showcases the robot's efficiency, adaptability, and user-friendly design in contributing to the maintenance and aesthetics of green spaces.

- ***Pesticides Spraying***

The robot's pesticide sprayer system is engaged based on user commands. This involves activating a pump to pressurize the pesticide within a container, and a spraying mechanism is triggered to evenly distribute the pesticide across the designated area. This operation aids in pest control and crop protection. The pesticide spraying operation of the spider robot represents a targeted and efficient approach to pest control in agricultural and landscaping contexts. Upon user input, typically facilitated through a user-friendly mobile app, the robot activates its pesticide spraying system. This system includes a reservoir containing the pesticide solution and a pressurized pump mechanism. In essence, the pesticide spraying functionality of the spider robot embodies a technological solution to enhance precision and efficiency in pest management. This autonomous approach streamlines agricultural practices and contribute to sustainable and responsible pest control strategies in diverse environments.

VII.CONCLUSION

The grass cutter and pesticide sprayer spider robot, controlled by Arduino and Bluetooth technology, shows a vital advancement in the field of autonomous agricultural and landscaping systems. The robot's ability to perform grass cutting and pesticide spraying operations autonomously enhances efficiency as well as it also contributes to sustainable and eco-friendly practices. The successful implementation of this robotic system highlights its adaptability to various terrains, its responsiveness to real-time user inputs, and the incorporation of safety features for secure operations. The combination of mechanical precision and technological control positions this robot as a valuable device for maintaining green spaces, optimizing agricultural processes, and promoting responsible pest control practices.

VIII. FUTURE SCOPE

The ongoing research and development in robotics and automation hold the potential for further enhancements in the capabilities of such spider robots. Future iterations may incorporate advanced sensing technologies, artificial intelligence for improved decision-making, and even more sophisticated control systems. Integration with smart agriculture systems and data analytics could enable the robot to make informed decisions based on environmental conditions and crop health. Additionally, exploring renewable energy sources for powering the robot and incorporating sustainable materials in its construction could align with the global push for environmentally conscious technologies. In conclusion, the grass cutter and pesticide sprayer spider robot serve as a testament to the evolving synergy between robotics and agriculture. The future holds the promise of even more advanced, efficient, and sustainable robotic solutions that can revolutionize the way we approach tasks in agricultural and landscaping domains.

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