IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 3, June 2023

Pesticide Spraying Robot with Electrostatic Sprayer

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Abstract: *In India, the agriculture sector holds the most important place in country's economy. Farmers are continuously searching for new technology to reduce efforts and increase crop yield. As a major player in the agriculture sector, pesticide spraying is the process of utmost importance. But as it has its list of advantages, there are many disadvantages too. With our prototype model we have tried to automate this process and make it more effective. While the robot makes the process semi-automated and convenient, the electrostatic sprayer is designed as it reduces the quantity of pesticide being used. The purpose of electrostatic sprayer is to make the pesticide spraying process more efficient. We have used Arduino for mapping the movements and actions of the robot. The Bluetooth module used is an important part of the robot and mobile interface. The model is designed to be used on a small scale but with components of higher rating the capacity and performance can be improved. The future scope being that we can install GPS and ultrasonic system to make it fully automatic. As with the existing the model the human efforts, time, expenses, and risk of organophosphate poisoning are highly reduced.*

Keywords: Agriculture, Robot, Electrostatic sprayer, Bluetooth module, Arduino, Organophosphate poisoning

I. INTRODUCTION

For yielding good amounts of crops, plant protection activities play important role. Pesticide spraying is the most periodic and important task in the plant protection activity. Traditional pesticide spraying practices have established an imbalance between environmental protection and economic growth. These practices also are observed to consume more time and pesticide. The direct & unprotected exposure to the pesticide can cause organophosphate poisoning. From this given situation, advancements in the spraying technology are the need of hour.

Spray robot can effectively be a solution to all these issues faced by common farmers in India. Not only does this make the pesticide spraying process more efficient, but it also reduces human intervention, and this time can be used for other important farming activities. Automated robots are argued to have an impact on employment but for small farmers it can be a proven boon.

Semi-automated robots can be operated through a distance thus reducing the risk of organophosphate poisoning. Electrostatic spraying technology is said to significantly reduce the amount of pesticide being used covering double the area efficiently. The height and direction adjustment feature makes it desirable as well as feasible for several different types of crops and fields.

As this robot will be controlled by an android mobile, there is no need to buy a separate remote control or take lessons on how to use it. Further in future, we can modify it by adding image processing feature and Ultrasound sensors making it more and more efficient.

II. LITERATURE REVIEW

The traditional spraying method in which the laborer carries the pesticide on his back eventually requires more effort. And the weeding process which usually requires bulls which are expensive may not be that economical for small farmers. So, to deal with the above two issues, an automated machine can be beneficial for spraying and weeding actions[1]. To provide a thorough insight into the technology, this paper presents an electrostatic sprayer in terms of aerosolization mechanism, electrostatic spraying techniques, and other important foundational parameters [2]. Robotics

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and automated agricultural spraying techniques likevariable rate sprayers, electrostatic spraying system, and UAV spraying system are bringing a growth in utilization rate of pesticides, reduce pesticide waste, less expensive, high efficiency plant protection activities[3]. According to accurate operations and records, significant management of pesticides can be expected, which means, required number of pesticides will be sprayed at only the required part of the crop, concluding that the robot would be giving maximum output out of minimum input in crop yield by implementing trace ability setup in the grape farms [4].

III. METHODOLOGY

Working Principle & System Block Representation

The core of the control system is the microcontroller board. Arduino UNO. The Bluetooth module connected to it receives signal from the mobile app and sends it to the servo motors which monitor and enable the directional and vertical movement of the sprayer. The motor driver is connected to the Arduino board and the all the four DC motors are connected to each wheel and two to each motor driver. The Battery terminal is connected to the Arduino board via buck converter. This converts the high voltage current into low voltage for proper current supply to the Arduino and so that it doesn't get overloaded. There is pump connected to the pesticide tank which regulates the flow of pesticide to the nozzle. The positive terminal of battery is connected to the sprayer as a part of electrostatic mechanism. There is an on/off switch for the battery for turning it on or off according to the required task and for power saving. Below shown is the block diagram for the robot. We have divided the hardware assembly and components into four modules: Control module, spraying action module, power supply module, movement module.

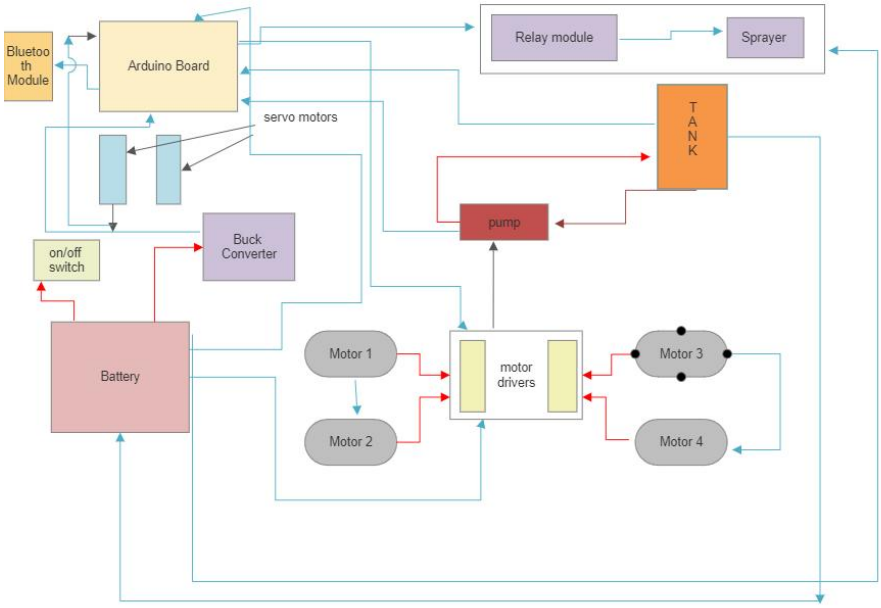

Fig. 1.1 Block Diagram

3.1 Hardware Design:

Control Module: The system control is held by microcontroller, Arduino UNO as the main controller which will give instructions to all connected modules. The Bluetooth module, HC-05, is used as an interface between Arduino, cellphone, and the robot.

Power Supply Module: The battery used 12V 12AH 20 A of capacity. As the battery used is of voltage as compared to the microcontroller board, that's why a buck converter is also used which can be seen in fig.1.1. An on/off switch for power saving means. The battery is rechargeable.

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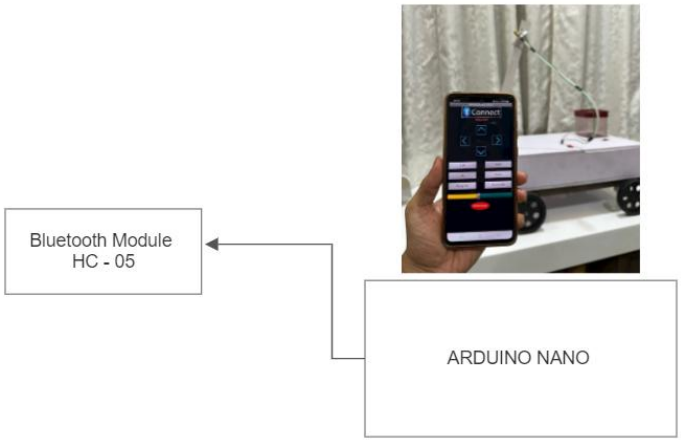

Fig. 1.2 UNO - HC-05 connection

Motion & Relocation Module: The four DC motor at each wheel of the robot ensure smooth motion and soft turning without any dynamic misbalancing. A motor driver is connected to each pair of motor. The connection of motor driver allowed us to manipulate the working speed and direction of motors.

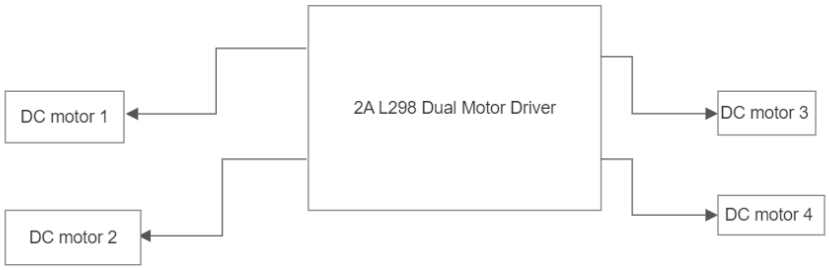

Fig. 1.3 – Motion & relocation module

Spraying Action Module: The main highlighted feature of our robot is that it can adjust its height and direction of spraying as and when needed. A dc motor pump is connected to the tank for supplying the pesticide to the sprayer, a single channel relay module is used for on/off the sprayer. The electrostatic mechanism is illustrated by connecting the positive terminal of battery to sprayer. The charged mist flow of pesticide covers the crop and infected area efficiently. The servo motor used is MG995.

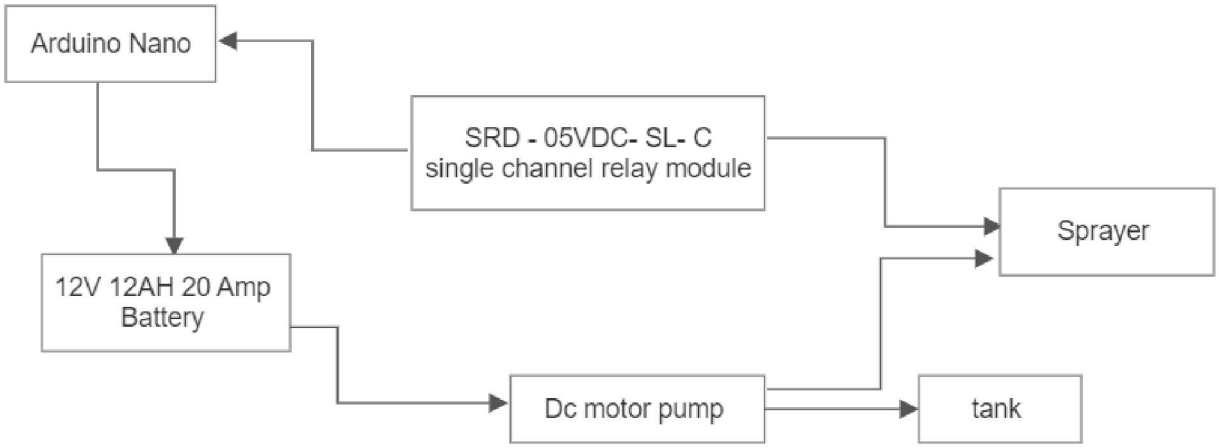

Fig. 1.4 –Spraying Action Module

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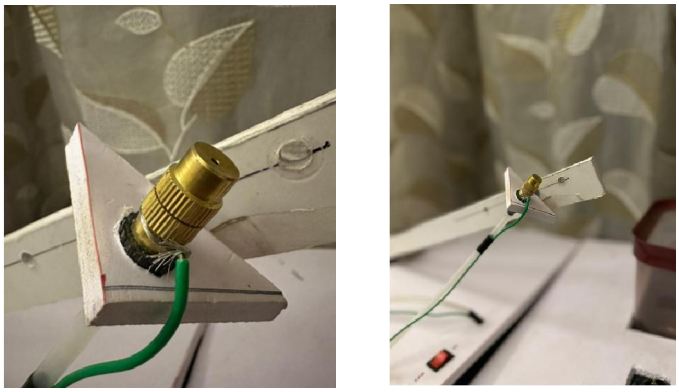

Fig. 1.5 – sprayer

Final Assembly & Setup: The manufacturing started as we finalized the dimensions of the chassis. The diameter of the tyres and ground clearance helped further in dynamically balancing the robot. The material used for the frame of chassis is mild steel. The outer body of robot in which the electronics components are placed is made of MDF.

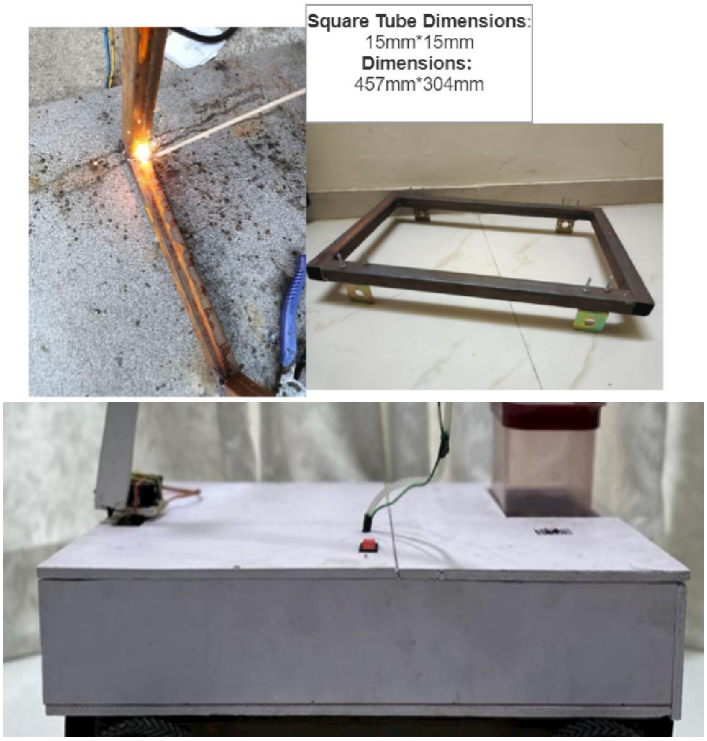

Fig. 1.6 – Chassis frame & Body

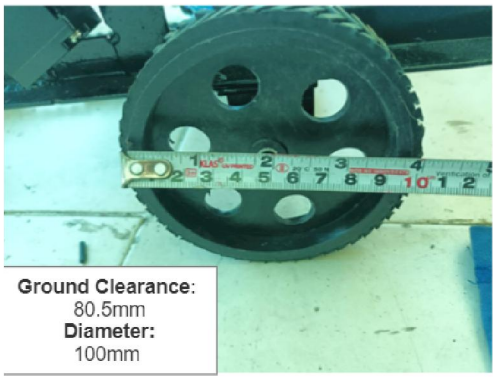

Fig. 1.7 – Tire Dimensions

Fig. 1.8 – Assembling electronics components.

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CAD Models &Drawings: The CAD models were designed on Solidworks software version 2021. We have used the components first approach i.e., we first designed the small components and imported some of them from GRABCAD. Then assembled the robot module wise.

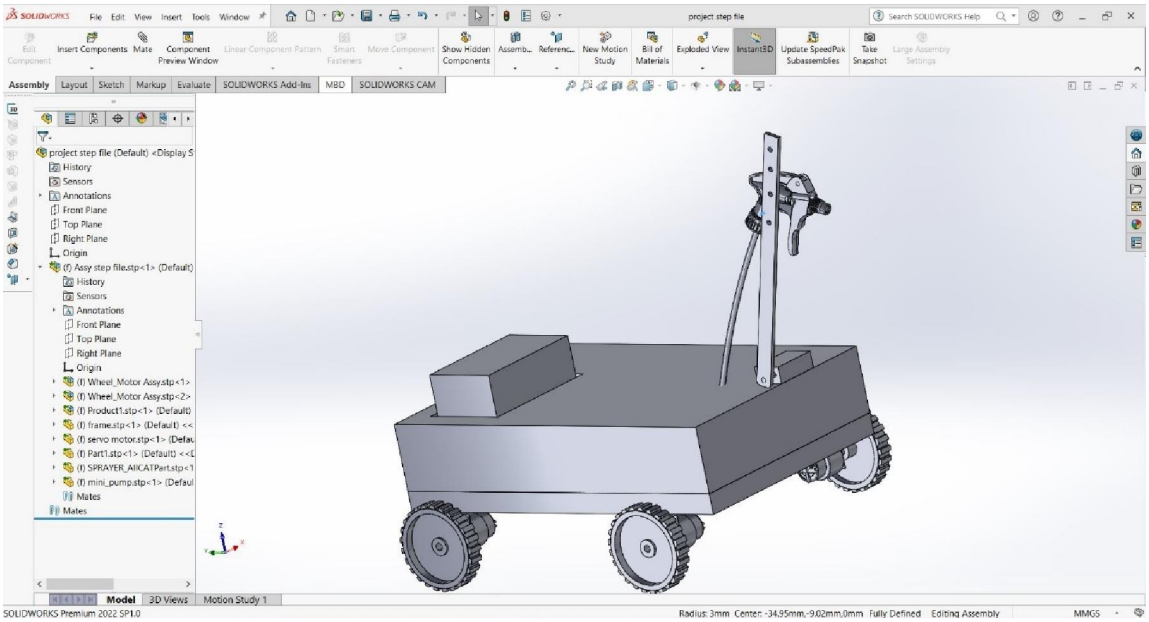

Fig. 1.9 – Fully assembled model

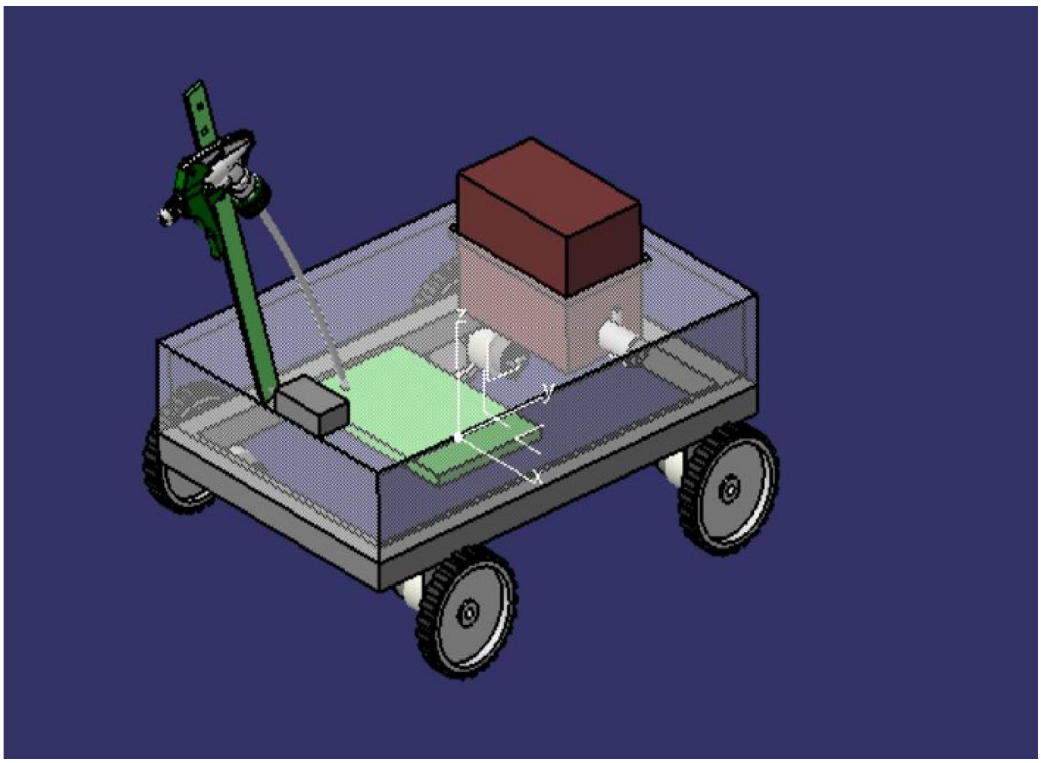

Fig. 1.10 – Hidden components view

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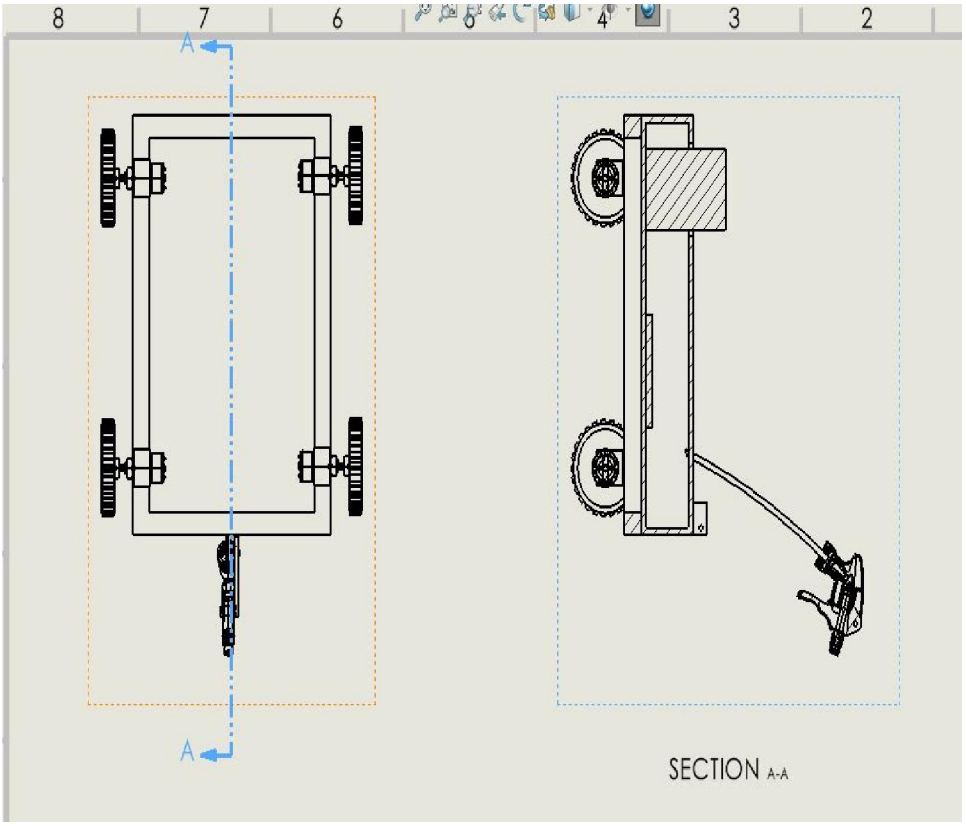

Fig. 1.11 – Drawing Template

IV. RESULTS & OBSERVATIONS

The observed range of Bluetooth connection is approximately 30 feet (10 meters). However maximum connection range will vary depending on the obstacles (turns, human intervention etc.) or electromagnetic environment. The spray range of the sprayer is approximately 1-1.5m when tested in a closed room. The battery takes 4 hours to fully charge. The response time is 2-3ms.

Fig. 1.12 – Final working model

V. CONCLUSION

This semi-automated robot can be successfully used to reduce the efforts required for pesticide spraying process while increasing the efficiency of infectant area being covered thus also saving the amount of pesticide required for the entire farm. As far as human intervention is concerned, this can be called a long-range operation robot which automatically

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reduces the risk of organophosphate poisoning. The main feature being the electrostatic sprayer which is our own modification in this type of agriculture robot, enhances the characteristics and capabilities of the robot like nothing else. The microcontroller, Arduino Nano, used is a cheaper option than other boards and many more electronic components are cheaper but no less in performance substitute of their expensive versions, thus making it economical. The ease of handling and controlling can be seen by using just the mobile as a remote control which everyone is already so practiced to used, thus making it easier to control, the battery is rechargeable, which saves a lot of maintenance efforts and costs.

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