DESIGN AND DEVELOPMENT OF PROTOTYPE OF SENSOR BASED AUTOMATIC SPOT SPECIFIC SPRAYER FOR ORCHARDS

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PAKISTAN

2023

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by

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A report submitted in partial fulfillment of

the requirement for degree of

BSc Agricultural Engineering

BSc.

in

Agricultural Engineering

DEPARTMENT OF LAND AND WATER CONSERVATION ENGINEERING

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CERTIFICATION

I hereby undertake that this report is an original one and no part of this report falls under plagiarism, if found otherwise at any stage, we will be responsible for the consequences.

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DEDICATION

We dedicate this project, “DESIGN AND DEVELOPMENT OF PROTOTYPE OF SENSOR BASED AUTOMATIC SPOT SPECIFIC SPRAYER FOR ORCHARDS," to our esteemed mentor Engr. Dr. MJM Cheema, Engr. Saira Anwer, Engr. Dr. Naveed Anjum, Engr. Dr. Tahir Iqbal, Engr. Dr. Shoaib and Engr. Ubaid-ur-Rehman. Their unwavering dedication, tireless efforts, and valuable contributions have been instrumental in the successful completion of this project.

We would also like to express our heartfelt gratitude to our parents, whose unwavering support and encouragement have been the driving force behind our pursuit of knowledge and excellence.

May this project serve as a testament to the collective commitment and collaborative spirit that has defined our journey. We are grateful for the guidance, wisdom, and inspiration provided by our mentors and the unending support from our loved ones.

With utmost respect and appreciation.

(Adeel, Irfan, Saqib)

Table of Contents

CHAPTER 1 1

INTRODUCTION 1

1.1 Spot Specific Sprayer.....2

1.2 Importance of Spot Specific Sprayer 3

1.3 Working of Spot Specific Sprayer 4

1.4 Component of Spot Specific Sprayer.....5

CHAPTER 2 6

LITERATURE REVIEW 6

2.1 Agricultural Sprayer.....6

2.2 Precision Agriculture 8

2.3 Related Work 9

CHAPTER 3 12

PROBLEM STATEMENT AND OBJECTIVE.....12

3.1 Problem Statement.....12

3.2 Objective of Project 12

CHAPTER 4 13

MATERIALS AND METHODS.....13

4.1 Methodology.....13

4.2 Block Diagram and Flow Chart 15

4.3 Block Diagram Explanation.....16

4.4 Project Components.....16

4.4.1 Arduino Nano.....16

4.4.2 RC Controller.....17

4.4.3 Solenoid Valve.....17

4.4.4 LED Light 18

4.4.5 Gear Motor.....18

4.4.6 Hollow Cone Nozzle.....19

4.4.7 Battery 3AH 20

4.4.8 Dual Motor Water Pump 12 Volts 20

4.4.9 Buck Converter 21

4.4.10 Power Booster.....22

4.4.11 Ultrasonic Sensor 22

4.4.12 Motor Driver 23

4.4.13 RC Controller Transmitter 24
4.4.14 RC Controller Receiver 25
4.4.15 Relay Switches 25
4.5 Source Code (Arduino IDE) 26
4.5.1 Description 26
4.6 Code 27
4.6.1 Code Explanation 30
4.7 Project Progress 31
4.7.1 Literature Review 31
4.7.2 Basic Knowledge about Existing Spot Specific Sprayer 32
4.7.3 Specification of Existing Spot Specific Sprayer 33
4.7.4 Visit to Koont Farm 34
4.7.5 Diagram of Proposed 3S 34
4.7.6 Schematic Diagram of Proposed 3S 35
4.7.7 Circuit Explanation 36
CHAPTER 5 41
RESULTS AND DISCUSSIONS 41
5.1 Results 41
5.2 Discussions 42
CHAPTER 6 45
CONCLUSIONS AND RECOMMENDATIONS 45
6.1 Conclusions 45
6.2 Recommendations 46
Literature Citied 48
APPENDIX A 50

ABBREVIATIONS

RC	Radio Control
PPPs	Plant production products
VRT	Variable Rate technology
DRT	Drift reduction technology
VA	Variable Application
UA	Uniform applications
SVRS	Smart variable rate sprayer
PA	Precision agriculture
SSA	Site specific input application
VRA	Variable rate application
PTO	Power take off
TRV	Tree row Volume
AH	Ampere hours
SMPS	Switch mode power supply
RF	Radio frequency.

List of Figures

Fig 4.1: Field Testing of 3S 14
Fig 4.2: Working of 3S and Flow of data 14
Fig 4.3: Flow of data 15
Fig 4.4: Arduino Nano 16
Fig 4.5: Solenoid Valve 17
Fig 4.6: LED Light 17
Fig 4.7: Gear Motor 12V 18
Fig 4.8: Hollow Cone Nozzle 19
Fig 4.9: Volta Battery 3 AH 19
Fig 4.10: Dual Water Pump 20
Fig 4.11: Buck Controller 21
Fig 4.12: Power Booster 22
Fig 4.13: Ultrasonic Sensor 22
Fig 4.14: RC Controller 23
Fig 4.15: Relay Switches 24
Fig 4.16: Schematic Diagrams of Proposed 3S 33
Fig 4.17: Visit to Koont Farm 33
Fig 4.18: AutoCAD Diagram of 3S 34
Fig 5.1: Testing field area for Spot Specific Sprayer 41
Fig 5.2: Graph Representation of Lag time 43

List of Tables

Table 1: Specifications of existing Spot Specific Sprayer..32
Table 2: Outdoor Readings 40
Table 3: Indoor Readings...40
Table 4: Readings of Lag Time and Distance from Plant...42

ACKNOWLEDGEMENT

First of all, we are thankful to Allah, who gave us the strength and the ability to complete our thesis without His divine help, we would have never been able to complete it. In fact, there are many people to whom we must express our gratitude for their contributions to the successful completion of this dissertation.

We would like to express our sincere appreciation and thanks to our main supervisor, Engr. Dr. Muhammad Jehanzeb Masud Cheema, who greatly supported us in completing our work. We will be grateful for his assistance and guidance forever. We would also like to thank our co-supervisor, Engr. Saira Anwar. We appreciate their comments and encouragement throughout this research work. Thanks to all our friends and colleagues who have provided invaluable help and exchanged fructiferous views from time to time that has been vital to our progress. Our heartiest thanks are due to our highly respected parents and our dearest thanks go to project committee, without whose constant support and encouragement, particularly in difficult times, the whole endeavor of writing our thesis would not have been fruitful.

Moreover, we are also thankful to our workshop assistants, and other workshop workers for their continuous supports and encouragements during our project completion last but certainly not least, we wish to express our special gratitude to Engr. Dr. Naveed Anjum, Engr. Dr. Tahir Iqbal, Engr. Dr. Shoaib and Engr. Ubaid Ur Rahman for their regular insistence for keeping up our handwork.

ABSTRACT

The usage of conventional sprayers results in decay of applied chemicals, which not only increases the economic losses but also pollutes the environment. Lost agrochemicals cause harm the plants near to the field, pollution of ecosystem, reducing spray efficiency and farming cost. Gaps or overlaps in the spraying patterns can result in under or over application of pesticides thus causing environmental danger. The objective of project is to reduce possible losses and guarantee productivity, farmers depend more and more on the application of agrochemicals in their crops. In this way, new technologies have been developed to make agricultural spraying more effective, reducing the amount of pesticide applied and dosing its use according to the need of the crop. Spot-specific sprayers often utilize advanced sensor technologies, such as ultrasonic sensors to detect and identify specific targets or characteristics. These sensors can identify orchards for precise targeting. In the case of pest management, it can be done using spot specific sprayers or using on or off application with individual nozzle control. The spot specific spray allows the farmers to apply pesticides only on the target, using only essential amount on the canopy size and growth phase of the plants. The use of spot-specific sprayers offers several potential benefits, including reduced chemical usage, minimized environmental impact, and increased efficiency. Spot-specific sprayers allow farmers to target only the areas or plants that require treatment, rather than applying pesticides uniformly across the entire field. The reduced chemical usage associated with spot-specific sprayers can have positive environmental impacts. By minimizing the amount of agrochemical applied, the risk of chemical runoff into water bodies or leaching into the soil is reduced. This can help protect aquatic ecosystems and promote sustainable farming practices. Spot-specific sprayers enable precise targeting of pests, diseases, or weeds. This precision can result in more effective control measures, as the concentrated application directly targets the problem areas.

Keywords; precise targeting; spot specific sprayer; individual nozzle control; ultrasonic sensors; reduced chemical usage.

CHAPTER 1

INTRODUCTION

According to **Lee and Ehsani, 2008** that Spot-specific spray technology, also known as precision spray technology or targeted spray technology, has emerged as an innovative approach in the field of agriculture. Traditional methods of applying pesticides or other agrochemical often involve uniform broadcasting, leading to inefficiencies, excessive chemical usage, and potential environmental harm. The Ultrasonic Spot Specific Sprayer is a cutting-edge solution designed to optimize resource utilization, reduce chemical waste, and maximize crop yields. Built upon the principles of precision and efficiency, this remarkable technology harnesses the power of ultrasonic waves to deliver targeted and accurate application of agrochemicals. However, spot-specific spray technology revolutionizes the way we deliver agricultural chemicals by focusing on specific areas or individual plants that require treatment. Traditionally, conventional sprayers have been the go-to method for distributing pesticides, fertilizers, and other agricultural substances. However, this indiscriminate approach often leads to excessive usage, causing environmental harm and unnecessary expenses. The Ultrasonic Spot Specific Sprayer challenges this status quo by precisely delivering the required amount of chemicals to specific areas of the crop, ensuring minimal wastage and maximum efficacy.

(Yarborough, 2006) described about precision-based approach utilizes advanced sensor technologies, variable rate application, and automated control systems to deliver the spray accurately and effectively. He told that at the heart of this breakthrough technology lies the ultrasonic spray nozzle, which generates an ultra-fine mist composed of millions of tiny droplets. These droplets are uniform in size, allowing for consistent and controlled dispersion. By leveraging ultrasonic waves, the sprayer achieves unparalleled precision, enabling farmers to precisely target pests, diseases, or nutrient deficiencies on a plant-by-plant or even leaf-by-leaf basis. By minimizing waste and optimizing resource utilization, spot-specific spray technology aims to enhance crop protection, reduce environmental impact, and improve overall agricultural practices. The benefits of the Ultrasonic Spot Specific Sprayer extend beyond precision and efficiency. The reduced chemical usage not only minimizes environmental impact but also leads to significant cost savings for farmers. Additionally, by minimizing chemical exposure to non-target areas, this innovative tool contributes to the preservation of soil health and the protection of beneficial organisms, creating a more sustainable and eco-friendly approach to agriculture

Heege, H.J. (2013). He told that Ultrasonic Spot Specific Sprayer is equipped with advanced sensors and imaging technology, allowing farmers to gather real-time data on crop health, growth patterns, and pest infestations. This invaluable information empowers farmers to make data-driven decisions, implement proactive measures, and optimize crop management strategies for improved yields and overall farm profitability. Our project is about "Design and Development of prototype of sensor based automatic spot specific sprayer for orchids". Thus, this project proposes a low-cost prototype in a modular solution of agricultural sprayers. This project will help to facilitate industry to convert on technology. This technology is used for spot specific agrochemical sprayers in field for Orchards.

1.1 SPOT SPECIFIC SPRAYER

Oberti et al. (2016). His research was to discuss about the spot specific sprayer. He told that Spot Specific Sprayer is a groundbreaking device designed to revolutionize precision agriculture by delivering agrochemical. Unlike traditional sprayers that employ a blanket approach, this innovative technology takes a focused and precise approach to crop treatment. By precisely targeting specific areas of the field or individual plants, the Spot Specific Sprayer minimizes chemical wastage, reduces environmental impact, and improves overall crop health. Spot Specific Sprayer is a precision sprayer used for the efficient usage of agrochemicals to fields. This Sprayers comprises of ultrasonic sensor which detects the orchard, microcontroller for controlling the system functioning, and solenoid valve assisted spraying nozzles. It help to Prevents competition from weeds, and by using spot spraying, the risk of weeds getting resistant to herbicides is also minimized. With spot spraying it is possible to save up to 95% on chemical cost compared to a full field spray job. Moreover, the Spot Specific Sprayer is compatible with various types of agrochemicals, including pesticides, herbicides, fertilizers, and growth regulators.

This versatility allows farmers to tailor their treatments based on specific crop requirements, resulting in improved plant health, reduced crop loss, and ultimately higher yields.

The Spot Specific Sprayer represents a significant leap forward in precision agriculture. By leveraging advanced sensors, intelligent algorithms, and precision delivery mechanisms, this innovative technology empowers farmers to make informed decisions, optimize resource utilization, and enhance overall crop management. With its potential to minimize chemical waste, reduce environmental impact, and increase crop yields, the Spot Specific Sprayer is poised to revolutionize the way we approach crop cultivation, bringing about a more sustainable and efficient future for agriculture. The spot specific spray allows the farmers to apply pesticides only on the target, using only essential amount on the canopy size, season, and growth phase of the plants. Real-time target detection spray Systems used for the spotting of the geometric properties of Orchards are reviewed in details.

1.2 IMPORTANCE OF SPOT SPECIFIC SPRAYER

The importance of spot-specific sprayers lies in their ability to provide targeted and efficient application of liquid substances. Here are some key reasons why spot-specific sprayers are important:

(Latif *et al.*, 2018) defined the importance of spot specific sprayer in his research paper that Spot-specific sprayers enable precise and accurate application of substances to specific target areas, such as individual plants, weeds, or problem spots. This level of precision ensures that the intended areas receive the necessary treatment while minimizing waste and potential negative effects on non-target areas. By delivering substances only to the required spots, spot-specific sprayers reduce chemical usage and overall costs. This targeted approach avoids unnecessary application in unaffected areas, optimizing the use of resources and minimizing expenses associated with excessive chemical use. Spot-specific sprayers contribute to environmental protection by reducing the amount of chemicals released into the environment. By minimizing off-target spraying, these sprayers help prevent contamination of water sources, minimize air pollution, and reduce the impact on beneficial organisms, such as pollinators and natural predators

(Cheema *et al.*, 2018). Spot-specific sprayers ensure that substances are applied directly to the target areas where they are needed most. This enhances the efficacy of the treatment, whether it is controlling pests, managing weeds, or applying fertilizers. By delivering substances precisely to the problem spots, spot-specific sprayers can achieve better results compared to broader application methods. Spot-specific sprayers offer flexibility in targeting specific areas or plants, making them suitable for a wide range of applications. They can be used in various industries, including agriculture, horticulture, forestry, and pest control. This adaptability allows for tailored and site-specific treatments, addressing specific needs and challenges efficiently. By minimizing chemical usage and targeting application, spot-specific sprayers help reduce the overall environmental impact associated with liquid substance application. They minimize the potential for chemical runoff, contamination of groundwater, and unintended effects on non-target organisms and ecosystems. Spot-specific sprayers enable operators to treat specific target areas quickly and effectively, reducing the time required for application. This time-saving benefit enhances operational efficiency, allowing for increased productivity and the ability to cover larger areas within a given timeframe. Spot-specific sprayers are important tools in precision agriculture and other industries where targeted application is crucial. They provide precision, cost-effectiveness, environmental benefits, and enhanced treatment efficacy, contributing to sustainable and efficient practices.

1.3 WORKING OF SPOT SPECIFIC SPRAYER

The sprayer contains a tank or container where the liquid substance, such as a pesticide or fertilizer, is stored. The tank should be of sufficient capacity to hold the required amount of liquid for your application. The sprayer is equipped with a pump that draws the liquid from the tank and pressurizes it. The pump can be powered by an electric motor, a gasoline engine, or other power sources, depending on the specific sprayer design. The pressurized liquid from the pump is directed through a hose, which is connected to a specific nozzle or a set of nozzles. The nozzle determines the spray pattern and droplet size, which can be adjusted based on the application requirements. The operator positions the nozzle or directs the sprayer to the specific target spot that requires treatment. The sprayer delivers the liquid substance precisely to the intended spot, ensuring accurate application. The sprayer may have a control mechanism to activate and deactivate the spraying process. This can be a manual switch, a foot pedal, or an electronic control system that allows the operator to control the timing and duration of the spray. Before using the sprayer, it's essential to calibrate and adjust the sprayer settings. This involves verifying the spray pattern, adjusting the pressure and flow rate, and ensuring that the sprayer is delivering the intended amount of liquid accurately to the desired spot. It’s crucial to follow safety guidelines while operating the spot-specific sprayer. Spot-specific sprayer ensures precise and targeted application of liquid substances to specific areas, minimizing waste and maximizing the effectiveness of the treatment. The operator has control over the spray pattern, pressure, and timing, allowing for efficient and accurate spot-specific spraying.

1.4 COMPONENTS OF SPOT SPECIFIC SPRAYER

There are different components we are using for project .It includes the RC controller car , Microcontroller, ultrasonic sensor, Nozzles, Solenoid Valve ,Buck converter, voltage booster, alloy steel. Radio control (RC) car is the use of control signals transferred by radio to remotely control .The transmitter enables control through radio waves and the receiver operates the motors. When we press a button on the transmitter to mark the RC toy go forward or backward, a pair of electrical contacts touch. Receiver identifies signals, sends it to circuit. We are using 8 bit Atmega328 Nano microcontroller for controlling the functions of embedded systems in Spot Specific Sprayer. It controls the working of the different components like solenoid valve, pressure nozzles, and ultrasonic sensor. We are using ultrasonic sensors for the detection of the orchids.

CHAPTER 2

LITERATURE REVIEW

2.1 AGRICULTURAL SPRAYERS

According to **(ANNET & Naranjo, 2014)** in his research paper variable rate sprayer for spot-application of agrochemicals in wild blueberry. In this he describe that Pesticide consumption worldwide exceeds 2. 2 billion kg annually. Because conventional spraying methods were used, numerous sprays went missing in the fields. In order to prevent environmental contamination and reduce costs, plant protection products (ppps) must be administered as effectively as possible and in accordance with local field circumstances. The main objective of spray administration technologies was to use the correct amount of insecticide in the right place at the right time to lower pest levels beyond the economically viable level and increase agricultural yield. Achieving high spray dispersal and consistency was another goal while designing the spray application system.

(Terra et al., 2020) had vast experience and work on variable rate spray technology .he briefly define on variable rate spray technology many of his paper. He describe that, technological advancement of spray technologies has accelerated recently and has been crucial in reducing crop-free buffer zones as well as maintaining the biological efficacy of pesticides below levels that provide an acceptable risk to the environment. The operational efficiency of sprayers had been enhanced by the adoption of modern technology for minimizing spray losses. Variable spray rate technology (VRT) as well as drift reduction technology (DRT) are the two main strategies that were employed to cut down on spray losses. While DRT had been employed to create spray quality as well as had the capacity to endure the effects of crosswinds, VRT defines a method whereby the technique of spraying process relies on whether there is any existence or lack of the plant & selectively switches the spray nozzles between on and off modes.

In order to control weeds and/or disease infections that were prevalent in the orchard, site-specific use of variable rate herbicides (va) has been suggested over uniform application (UA). According to (Ranji et al., 2014) and uniform deployment of agrochemicals leads in low sprayer use efficiency, affects the environment, increases agricultural costs, as well as threatens human health. With the aid of a sensor-based controlled system, a smart variable rate sprayer (SVRS) leveraged existing electronics along with automation in agricultural equipment to optimize pesticide applications **(Terra et al., 2020).**

(Gil et al., 2009) described his paper that how we saved agrochemicals. In this he describe that Agrochemicals were sprayed on crops in developing nations, such as Pakistan, to control pests and weeds without taking into account substantial shifts in plant populations as well as canopies. High spectral resolution has enabled daily real-time crop health monitoring, allowing us to real-time spray chlorophyll content in accordance with vegetation indices.

(Busleyki et al., 2014) In this paper he describe about how excessive use of agrochemical effect the ground water through leaching of spray. He also told how we reduce this effect .He told that excessive usage of expensive agrochemicals and environmental hazard could result from extensive use throughout non-vegetated areas. The ecosystem and groundwater supplies were under danger from the leaching and drifting of applied agrochemicals. Due to the operator's close contact to the chemical, conventional sprayers employed by farmers also caused health effects.

According to **Cheema et al. (2018)**. He have a lot of experience in precision agriculture. He gave us facts and figure how much cost we saved from (VRT).He described that oil spraying devices have become complicated for spraying crops for instance cotton, rice in addition sugarcane as well as fruit orchards. Unequal or late spraying may have had an impact on 40% of all crops. Additionally, there is a financial hazard due to the rising expense of agrochemicals and the unprecedented reliance on them for greater production, while improper application would reduce crop yield. This leads to the conclusion that in order to prevent environmental contamination while lowering costs, plant protection products (ppp) should be applied with maximum efficiency and in a methodical manner in accordance with field conditions. Such accurate application methods could save up to 5% on input.

2.2 PRECISION AGRICULTURE

According to **Zhang and Pierce (2016).** He described that precision agriculture (pa) is a modern agricultural practice that has been evolving since the late 1980s. Precision agriculture was a management-based approach centered on sensing or observing crop variability in both time and space and even acting accordingly. Its main objective was to manage field variability by identifying it. Site-specific input application (SSA), which was required once it was discovered because the cultivation land was not uniform, was needed. Both offline and real-time weed detection and mapping are possible. On/off application or a variable rate system (VRA) could be used to apply local pesticides with offline as well as real-time detection. The approach put forth in this work depended on real-time detection and utilized as an on/off interface to control certain nozzles. In the development of automatic orchard sprayers, there were primarily two pressing concerns: the first was to allow machines to navigate orchards autonomously without manual control in orchards with closed canopies and blocked vision. The second was to accomplish efficient pesticide invasion in low-density canopies as well as minimize chemical solution losses.

Because of the support provided by the air of the air-driven sprayer, the left of the fruit tree could be fully sprayed and spun via the blowing of a centrifugal fan. Since the result was generally superior to hydraulic atomization, the wind support approach was more frequently employed in the orchard. The development process for air-powered orchard sprayers was somewhat more prosperous in Europe than it was in developed nations, where advancement historically has been focused on resolving environmental issues like pesticide pollution of the soil and atmosphere as well as reduced spray pesticide consumption. Following each other, small orchard air-driven spray, the multi-airway orchard spray along with porous orchard air bag have been invented **(Gurumita Naidu & Ramesh, 2022)**. At this point, orchard planting practices had been standardized together with converted correspondingly, promoting advancement and use of air-assisted sprayers in medium- to small-sized orchards and turning them into a key component of the plant protection management system in orchards planted in dwarf dense regimes **(Sidike et al., 2018).**

According to the typical literature **(Khot et al., 2014)** that Implementing autonomous driving was a critical issue with orchard spraying. Numerous sensors and positioning systems may be prone to poor accuracy or even failure in the intricate and enclosed environment of an orchard. In the orchard, the development of a trustworthy autonomous driving system had been carefully examined. A full schematic of an autonomous system with a "perception-decision-control" progression had been constructed after decades of research. At the "perception" levelled, sensors were primarily used to gather environmental data from orchards, such as information about fruit trees, roads, etc., which would later be used for decision-making in the subsequent stage. At the "decision-making" levelled, the gathered environmental data was further processed, and then a travel route was extracted to determine whether there were obstacles. At the "control" levelled, the system's controller was designed to control the system. According to the findings of this study, the most difficult challenge in the entire procedure of autonomous driving was to accurately assess the orchard environment, carry out real-time location, and effectively avoid obstacles. Typically, radar or visual sensors were employed for the purpose of perception.

2.3 RELATED WORK

(Gurumita Naidu & Ramesh, 2022) worked on different component of VRT. They briefly describe about software and hardware components in research paper .A prototype for applying pesticides at a variable pace in a vineyard with an aerial sprayer. In order to determine when to open the valve releasing the pesticide, ultrasonic sensors used to identify plants laterally calculate their volume. In the tractor cab, they employ a LabVIEW laptop running on a laptop, I/O modules, an NI Compact Field Point Controller, as well as other equipment. The authors set forward a number of presumptions while acknowledging that the execution may have been flawed. The solution is still highly intriguing. As a result, they came to the conclusion that farmers urgently needed a simple, affordable answer.

Mercaldi et al. (2017) presented that In order to validate their computational framework for the spray bench, conduct laboratory tests. They came to the conclusion that the model can accurately predict system performance and that it may be used to create suitable controllers, such as those that can change the application speed based on a prior map. A model that correlates both flow and pressure in a spray system. They employ a proportional valve in every segment to modify the fluid resistance, so indirectly manipulating the flow by means of the nozzles, and examine the variations in linear velocity associated with every nozzle for curved trajectories of the tractor. Each electronic control unit that handles each valve is used throughout the investigations, which are carried out on a lab bench and connected via the CAN bus.

Ferreira et al. (2018) proposed how to control the spray pump's rotation speed is intriguing from an academic perspective, particularly in terms of energy efficiency, it is not feasible for field implementation because conventional spray systems are connected to tractors and powered by the PTO tractor. Additionally, **Terra et al. (2019)** provided a testing bench for spray nozzles that was created in a lab. They employ various gadgets, talk about some current methods for automating nozzle opening and closing, and advise using low-cost solenoid valves. They give a mathematical explanation of the test stand's fluid resistances, assess the behavior of relative pressure and flow, and then suggest a technique to sustain a stable boom pressure. In relation to family farming, there appears to be little actual information on low-cost modular systems that can be modified to work with current small agricultural sprayers, which is an interesting area for further study. Additionally, it is thought that a modular and generic approach can create new possibilities for this field's scientific and technological advancement.

Byers et al. (1971) told about the financial and environmental costs associated with their use, agrochemicals along with particularly plant protection product (PPP) administration methodologies have been extensively studied. Agrochemical doses were originally expressed as dose rates per unit of soil area with the goal of uniformly dispersing them throughout orchards. For years, several scholars have studied and created dosage models for groves, vineyards, orchards, and other plantations. It is crucial to take into account the canopies' proportions and other geometrical characteristics as early as the 1960s. Tree-row-volume (TRV), a technique devised is a way of calculating how much vegetation there is in each square foot. Using manual measurements of tree width, tree height, as well as total row distance, TRV was calculated. The total quantity of water that needed to be sprayed to serve as a carrier for PPP spraying doses was calculated using a coefficient. It showed that product deposits in crowns were significantly different when applied to crowns with various foliage densities at rates dictated by TRV.

Sutton and Unrath (1984) describe and accommodate for canopy density, adjusted a volumetric application rate on the basis of TRV utilizing an arbitrary coefficient. However, manual measures have some inherent inaccuracy that can cause dosing mistakes. A total rate for the entire plot is also provided by the outcomes of all earlier rate adjustment procedures for tree crops. The geographic diversity of canopy factors within an orchard, vineyard, or grove is thus not taken into consideration by them. This variability is now being taken into account by precision agriculture as well as site-specific management techniques (also known as precision crop protection), which have now started to adjust spray technologies to account for crop variability (also known as crop-adapted spraying). Over the past 20 years, precision agriculture has advanced quickly, but horticulture has not yet benefited from it **(Esau et al., 2014)**.

CHAPTER 3

PROBLEM STATEMENT AND OBJECTIVES

3.1 PROBLEM STATEMENT

In Pakistan or in other developing countries most of the farmers doing manually spraying in their fields, the cost of spraying increase and reduce in profit. There is a need of a project to develop prototype of spot specific Sprayer to introduce or demonstrate the farmers about the spot specific spraying technology. There is a requirement of lab base prototype, which helps farmers to know about its performance and working. Farmer needs attraction to invest in the product before allocating any resources needed for implementation. It is proposed to add some intelligence to the boom sprayer, using low-cost technology equipment, such as pressure Nozzles ultrasonic sensors, Solenoid valves, and microcontroller, allowing more effectiveness in pest control and less amount of agrochemicals applied.

3.2 OBJECTIVES OF PROJECT

Following are the objectives of the project:

1. Design and Development of spot specific sprayer prototype (3s).
2. Performance evaluation of prototype in different operating conditions.
3. Evaluation of lag time between the sensor detection and nozzles opening.
4. To reduce the usage of agrochemicals for economical production of agriculture.

CHAPTER 4

MATERIAL AND METHODS

4.1 METHODOLOGY

The methodology for the design and development of a prototype of a sensor-based automatic spot-specific sprayer for orchards include the following steps:

System Design: Based on the requirements, design the system architecture, including the sensors and control system for the sprayer. Selected appropriate sensors for detecting the target area for spray application and for controlling the flow rate of the spray.

Prototype Development: Developed a working prototype of the sprayer, incorporating the selected sensors and control system. Test and validate the system performance to ensure accurate and efficient spray application.

Field Testing: Conducted field tests of the prototype in real-world conditions, evaluated its performance and reliability in different orchard types and environments. Collected and analyzed data to identify any system improvements and optimize the performance.

Data Analytics and Visualization: Integrated data analytics and visualization tools into the system to provide real-time data analysis and insights. Ensured that the data can be accessed and visualized in a user-friendly manner, providing actionable information to farmers.

Commercialization: Based on the results of the field tests, refined and commercialize the sprayer, incorporating any necessary improvements. Offer training and support to farmers to help them effectively use the system.

This methodology will ensure that the developed sprayer is reliable, accurate, and user-friendly, providing valuable benefits to farmers for improving crop health and yields, while reducing the environmental impact of pesticide applications.

Figure 4.1: Field Testing of 3S

4.2 BLOCK DIAGRAM AND FLOW DIAGRAM

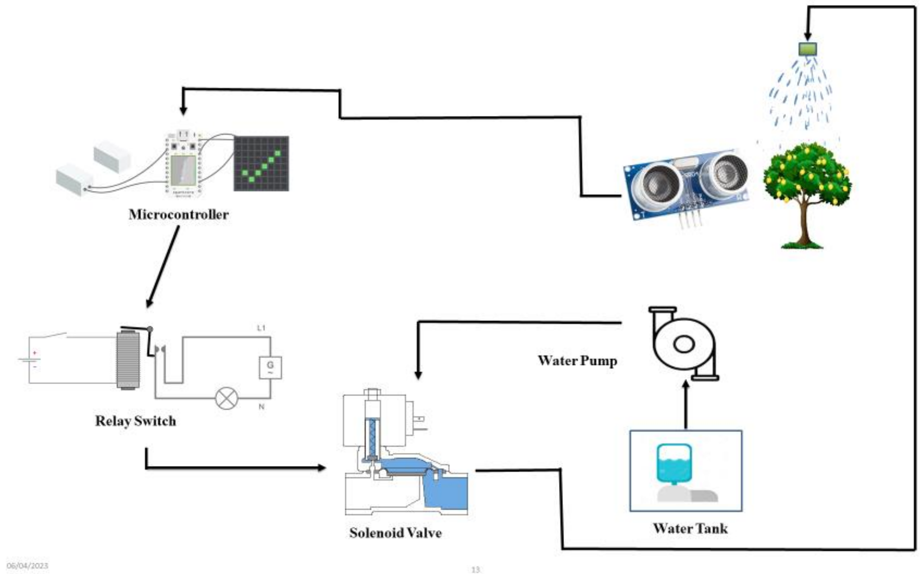

Figure 4.2: Block Diagram of Spot Specific Sprayer

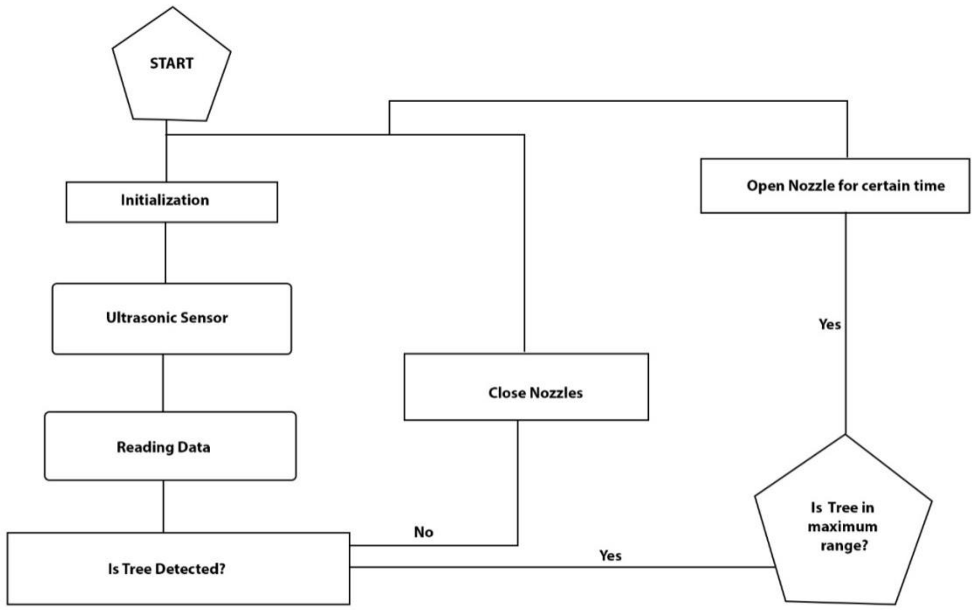

Figure 4.3: Flowchart of 3S working

4.3 BLOCK DIAGRAM EXPLANATION

1. Detection: The ultrasonic sensor continuously detects the presence or absence of the target area. When the target area is within range, the sensor sends a signal to the Arduino microcontroller.
2. Arduino Processing: The Arduino microcontroller receives the sensor data and processes it. Based on predefined conditions or programming logic, it determines whether spraying is required.
3. Solenoid Valve Activation: If the Arduino determines that spraying is needed, it activates the solenoid valve by sending an electrical signal. The solenoid valve opens, allowing the liquid to flow from the tank through the nozzle(s) and onto the target spot.
4. Spraying: With the solenoid valve open, the liquid flows through the nozzle(s) and sprays onto the target spot. The nozzle(s) deliver the liquid in the desired spray pattern and droplet size, ensuring accurate and effective application.

5. Deactivation: Once the target area is no longer within range or the predefined spraying conditions are met, the Arduino sends a signal to deactivate the solenoid valve. The valve closes, stopping the flow of liquid and ending the spraying process.
6. This working sequence repeats as the ultrasonic sensor continuously detects the presence or absence of the target area, allowing for automated and spot-specific spraying. The Arduino microcontroller serves as the control center, coordinating the operation of the ultrasonic sensor, solenoid valve, and nozzles based on the predefined programming logic.

4.4 PROJECT COMPONENTS

4.4.1 Arduino Nano

The Arduino Nano is similar to other Arduino boards, but it is smaller and more compact, making it easier to use in projects with limited space. It has a microcontroller that can be programmed to control various electronic components, such as sensors, motors, and lights. The Nano can be programmed using the Arduino software and can be powered by USB or an external power source.

Figure 4.4: Arduino Nano

4.4.2 RC controller

An RC controller (or remote control) is a device that is used to wirelessly control remote-controlled vehicles, such as cars, boats, and airplanes. The controller typically has a transmitter and a receiver. The transmitter is held by the user and sends signals to the receiver, which is located on the vehicle. The receiver then translates the signals into actions, such as turning the wheels or moving the vehicle forward or backward. RC controllers can have various features, such as multiple channels, trim adjustments, and digital displays.

4.4.3 Solenoid valve

A solenoid valve is an electromechanical device that is used to control the flow of fluids or gases. It consists of a coil of wire that generates a magnetic field when an electric current is passed through it. This magnetic field moves a plunger or armature, which opens or closes a valve. When the valve is open, fluid or gas can flow through it. When the valve is closed, the flow is stopped.

Figure 4.5: Solenoid Valve

4.4.4 Led Light

A LED light is a type of light that uses a semiconductor to emit light when an electric current flows through it. LED stands for "light-emitting diode." LEDs are more energy-efficient and have a longer lifespan than traditional incandescent bulbs. They are used in a wide range of applications, such as in traffic lights, electronic displays, and household lighting. LEDs come in different colors and can be used to create different lighting effects.

Figure 4.6: LED Light

4.4.5 Gear motor

A gear motor is a type of electric motor that has a gearbox attached to it. The gearbox consists of a series of gears that are used to reduce the speed of the motor and increase its torque. The motor and gearbox are usually housed in a single unit. Gear motors are used in a wide range of applications, such as in robotics, automation, and industrial machinery. They are often used in applications that require high torque and low speed, such as conveyor belts or heavy machinery. Gear motors can be designed to have different gear ratios, which can affect their speed and torque characteristics.

Figure 4.7: Gear Motor 12V

4.4.6 Hollow cone nozzles

Hollow cone nozzles are a type of spray nozzle that are used to produce a hollow cone-shaped spray pattern. They are commonly used in applications where a fine mist is required, such as in humidification systems or in agricultural spraying. The nozzle has a hollow cone-shaped orifice, which is surrounded by a ring of small holes. When liquid is forced through the orifice, it is broken up into small droplets by the holes, producing a fine mist. The size and shape of the droplets can be adjusted by changing the size of the orifice and the number and size of the holes. Hollow cone nozzles are often used in applications where a uniform distribution of liquid is required, such as in cooling towers.

Figure 4.8: Hollow Cone Nozzle

4.4.7 Battery 3AH

A 3AH battery is a battery that is capable of delivering a current of 3 amperes for one hour. The “AH” stands for “ampere-hours,” which is a unit of measurement for the amount of electric charge that a battery can deliver. The higher the AH rating, the longer the battery can deliver a given amount of current. A 3AH battery can be used in a wide range of applications, such as in portable electronic devices, power tools, and electric vehicles. The actual runtime of the battery will depend on the amount of current being drawn from it, as well as other factors such as temperature and age.

Figure 4.9: 3AH Battery

4.4.8 Dual motor water pump 12 volt

The pump is powered by a 12-volt electric motor, which is typically powered by a battery. The pump consists of two diaphragms that are connected to a common shaft. When the motor is turned on, the diaphragms move back and forth, creating a pumping action that draws water into the pump and then forces it out. Dual-action water pumps are commonly used in applications where water needs to be moved quickly and efficiently, such as in RVs, boats, and agricultural applications. The 12-volt power supply makes them easy to use in remote locations where access to AC power is limited.

Figure 4.10: Dual Water Pump 12V

4.4.9 Buck controller

A buck controller, also known as a buck converter or step-down converter, is an electronic device used to regulate and control the output voltage of a DC (direct current) power supply. It is a type of switch-mode power supply (SMPS) that efficiently converts a higher input voltage to a lower output voltage.

The buck controller operates by rapidly switching an input voltage on and off using a transistor (usually a MOSFET) to control the flow of current through an inductor.

The inductor stores energy when the transistor is on, and releases energy to the load when the transistor is off. By controlling the duty cycle (the ratio of on-time to off-time) of the transistor, the buck controller can regulate the output voltage.

The main advantage of a buck controller is its high efficiency. Since it operates in a switching mode, it minimizes power dissipation and heat generation compared to linear regulators, which simply dissipate excess voltage as heat. This makes buck converters suitable for applications where power efficiency is crucial, such as in battery-powered devices, power supplies for electronics, and voltage regulation in various systems.

Buck controllers can be found in a wide range of electronic devices, including computers, smartphones, LED lighting, automotive electronics, and industrial applications. They offer advantages such as compact size, low cost, and the ability to handle a wide range of input voltages while delivering a stable output voltage to power the load.

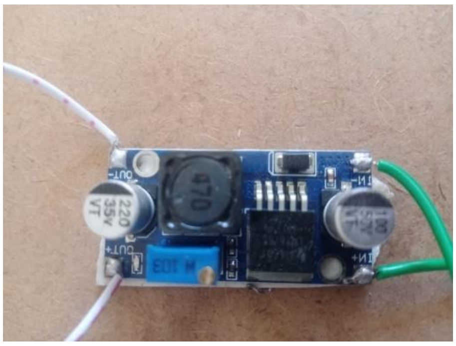

Figure 4.11: Buck Controller

4.4.10 Power booster

A power booster is a device that is used to increase the power output of an engine. It is typically used in high-performance vehicles to improve acceleration and overall performance. The booster works by increasing the amount of air and fuel that is delivered to the engine, which in turn increases the power output. There are many different types of power boosters, ranging from simple air filters and exhaust systems to more complex turbochargers and superchargers. The choice of power booster will depend on the type of engine and the desired level of performance. Power boosters can be expensive and may require modifications to the engine, so they are typically used by serious enthusiasts or professional racers.

Figure 4.12: Power Booster

4.4.11 Ultrasonic sensors

Ultrasonic sensors are devices that use sound waves to detect the presence of objects. They work by emitting high-frequency sound waves, which bounce off nearby objects and return to the sensor. The sensor then measures the time it takes for the sound waves to return, and uses this information to calculate the distance to the object. Ultrasonic sensors are commonly used in applications such as parking sensors, proximity sensors, and level sensors. They can be used to detect both solid and liquid objects, and are often used in harsh environments where other types of sensors may not be suitable. Ultrasonic sensors are also used in robotics and automation applications, where they can be used to detect obstacles and navigate around them.

Figure 4.13: Ultrasonic Sensor

4.4.12 Motor driver

A motor driver is an electronic device that is used to control the speed and direction of a motor. It is typically used in applications such as robotics, automation, and electric vehicles. The motor driver works by receiving signals from a microcontroller or other control system, and using these signals to adjust the voltage and current that is supplied to the motor. This allows the motor to be controlled with precision, and enables it to perform a wide range of tasks. Motor drivers can be designed to work with different types of motors, such as DC motors, stepper motors, and servo motors. They are often used in applications where precise control is required, such as in manufacturing and industrial settings.

4.4.13 RC controller’s transmitter

An RC controller’s transmitter is a device that is used to remotely control an RC vehicle or other device. It works by transmitting radio signals to a receiver that is located on the RC device. The transmitter typically consists of a handheld controller that contains a number of buttons, joysticks, and switches. These controls are used to send signals to the receiver, which then interprets the signals and adjusts the speed, direction, or other parameters of the RC device. The transmitter and receiver must be paired and tuned to the same frequency in order to work together. RC transmitters are available in a wide range of styles and configurations, ranging from simple two-channel controllers to complex multi-channel systems with advanced features such as telemetry and programmable settings. They are commonly used in applications such as RC cars, boats, airplanes, and drones.

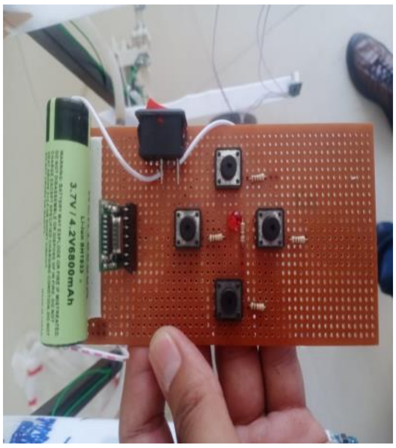

Figure 4.14: RC controller

4.4.14 RC controller’s receiver

An RC controller’s receiver is a device that is located on an RC vehicle or other device and receives radio signals from the transmitter. The receiver works by picking up the radio signals that are sent by the transmitter and converting them into electrical signals that can be used to control the RC device. The receiver typically consists of an antenna, a radio frequency (RF) amplifier, and a demodulator. The demodulator converts the radio signals into electrical signals that can be used to control the speed, direction, or other parameters of the RC device. The receiver and transmitter must be paired and tuned to the same frequency in order to work together. RC receivers are available in a wide range of styles and configurations, ranging from simple two-channel systems to complex multi-channel systems with advanced features such as telemetry and programmable settings. They are commonly used in applications such as RC cars, boats, airplanes, and drones.

4.4.15 Relay switches

A relay switch is an electrical switch that is operated by an electromagnet. It works by using a small amount of power to control a larger amount of power. When a current is applied to the electromagnet, it creates a magnetic field that attracts a metal armature. This armature then moves to close or open a set of contacts, allowing or blocking the flow of electricity. Relay switches are commonly used in applications such as industrial control systems, automotive electronics, and home automation. They are often used to control high-power devices such as motors, heaters, and lights, and can be controlled by a variety of input signals such as switches, sensors, and microcontrollers.

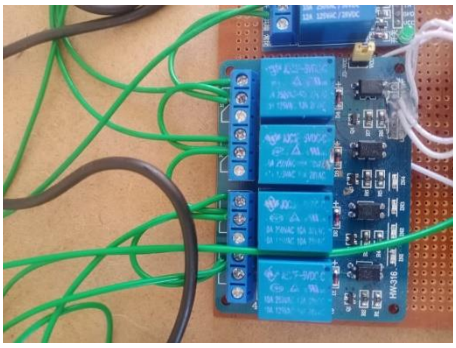

Figure 4.15: Relay Switches

4.5 SOURCE CODE (ARDUINO IDE)

4.5.1 Description

The Arduino IDE (Integrated Development Environment) is a software tool used for programming Arduino boards. It provides an interface for writing, compiling, and uploading code to Arduino microcontrollers. Here are some key points about the Arduino IDE:

Installation: To use the Arduino IDE, you need to download and install it on your computer. It is available for Windows, macOS, and Linux operating systems. You can download the latest version from the official Arduino website (https://www.arduino.cc/en/software).

Code Editor: The Arduino IDE offers a simple code editor where you can write your Arduino programs. It supports the C++ programming language with some specific Arduino libraries and functions.

Libraries and Examples: Arduino IDE comes with a collection of pre-installed libraries and example codes. These libraries provide ready-to-use functions for various purposes, such as controlling sensors, actuators, and communication modules. The example codes can help you understand how to use different features of the Arduino boards.

Sketches: In Arduino terminology, a program is referred to as a "sketch." The Arduino IDE uses the .ino file extension for sketches. Each sketch consists of two main functions: setup() and loop(). The setup() function is called once when the board is powered on, while the loop() function runs repeatedly as long as the board has power.

Compilation and Upload: The Arduino IDE compiles your sketch into a binary file that can be understood by the Arduino board. You can then upload this binary file to the board via a USB cable or other supported communication interfaces. The IDE handles the communication between the computer and the Arduino board during the upload process.

Serial Monitor: Arduino IDE includes a Serial Monitor tool that allows you to communicate with the Arduino board through the serial port. It can be used for debugging, printing sensor data, and receiving user input from the computer.

Third-Party Hardware Support: While Arduino boards are the primary target of the Arduino IDE, it also supports a wide range of third-party boards. You can install additional board definitions to enable programming and uploading code to these boards using the Arduino IDE.

Extensibility: The Arduino IDE is extensible, meaning you can add additional functionality and features through plugins and libraries. These extensions can enhance the capabilities of the IDE and provide support for specific hardware or programming tasks.

4.6 CODE

```
#define SV1_RL A5
#define SV2_RL A4
#define SV3_RL A3
#define SV4_RL A2
#define Pump_RL A1
#define Delayy1 1000 // after
#define Delayy2 3000 // for
#define Dist_Limit 30 // in cm
const int trigPin1 = 2;const int echoPin1 = 3;const int trigPin2 = 4;const int
echoPin2 = 5;const int trigPin3 = 6;const int echoPin3 = 7;
const int trigPin4 = 8;const int echoPin4 = 9;

long duration1,duration2,duration3,duration4;
int distance1,distance2,distance3,distance4;
void setup() {
```

```
  pinMode(trigPin1, OUTPUT);pinMode(trigPin2, OUTPUT);pinMode(trigPin3, OUTPUT);pinMode(trigPin4, OUTPUT);
  pinMode(echoPin1, INPUT); pinMode(echoPin2, INPUT);pinMode(echoPin3, INPUT);pinMode(echoPin4, INPUT);
  Serial.begin(9600);

analogWrite(SV1_RL,1023);analogWrite(SV2_RL,1023);analogWrite(SV3_RL,1023);analogWrite(SV4_RL,1023);analogWrite(Pump_RL,1023);
}
void loop() {
  dist_check();

  Serial.print(distance1);Serial.print("  :  ");Serial.print(distance2);Serial.print("  :  ");Serial.print(distance3);Serial.print("  :  ");
  Serial.println(distance4);

   if(distance1<Dist_Limit )
   {
     delay(Delayy1);
     analogWrite(SV1_RL,0);analogWrite(Pump_RL,0);
     delay(Delayy2);
     analogWrite(SV1_RL,1023);analogWrite(Pump_RL,1023);
   }
    else if(distance2<Dist_Limit )
   {
     delay(Delayy1);
     analogWrite(SV2_RL,0);analogWrite(Pump_RL,0);
     delay(Delayy2);
     analogWrite(SV2_RL,1023);analogWrite(Pump_RL,1023);
```

```
  }
   else if(distance3<Dist_Limit )
  {
    delay(Delayy1);
    analogWrite(SV3_RL,0);analogWrite(Pump_RL,0);
    delay(Delayy2);
    analogWrite(SV3_RL,1023);analogWrite(Pump_RL,1023);
  }
   else if(distance4<Dist_Limit )
  {
    delay(Delayy1);
    analogWrite(SV4_RL,0);analogWrite(Pump_RL,0);
    delay(Delayy2);
    analogWrite(SV4_RL,1023);analogWrite(Pump_RL,1023);
  }
}

void dist_check()
{
  digitalWrite(trigPin1, LOW);delayMicroseconds(2);digitalWrite(trigPin1,
HIGH);delayMicroseconds(10);digitalWrite(trigPin1, LOW);
  duration1 = pulseIn(echoPin1, HIGH);distance1 = duration1 * 0.034 / 2;
  digitalWrite(trigPin2, LOW);delayMicroseconds(2);digitalWrite(trigPin2,
HIGH);delayMicroseconds(10);digitalWrite(trigPin2, LOW);
  duration2 = pulseIn(echoPin2, HIGH);distance2 = duration2 * 0.034 / 2;
  digitalWrite(trigPin3, LOW);delayMicroseconds(2);digitalWrite(trigPin3,
HIGH);delayMicroseconds(10);digitalWrite(trigPin3, LOW);
  duration3 = pulseIn(echoPin3, HIGH);distance3 = duration3 * 0.034 / 2;
```

```
  digitalWrite(trigPin4, LOW);delayMicroseconds(2);digitalWrite(trigPin4,
HIGH);delayMicroseconds(10);digitalWrite(trigPin4, LOW);
  duration4 = pulseIn(echoPin4, HIGH);distance4 = duration4 * 0.034 / 2;
}
```

4.6.1 Code Explanation

The provided code is an Arduino sketch that appears to control a system with four ultrasonic distance sensors (trigPin1-4 and echoPin1-4) and several actuators (SV1_RL, SV2_RL, SV3_RL, SV4_RL, and Pump_RL).

Here's an explanation of the code:

In the setup() function:

- The pinMode() function sets the trigPin and echoPin pins as either INPUT or OUTPUT.
- Serial.begin(9600) initializes the serial communication at a baud rate of 9600.
- analogWrite() is used to set the initial output value (1023) for the actuators connected to SV1_RL, SV2_RL, SV3_RL, SV4_RL, and Pump_RL.

In the loop() function:

- The dist_check() function is called to measure the distances from the ultrasonic sensors and update the corresponding distance variables.
- The distances are printed to the serial monitor.
- The code then checks each distance against the Dist_Limit value using multiple if-else statements.
- If any of the distances are less than the Dist_Limit, the code performs a series of actions:
- It introduces a delay of Delayy1 milliseconds.
- It sets the output of the corresponding SV_RL and Pump_RL to 0 (off).
- It introduces a delay of Delayy2 milliseconds.

- It sets the output of the corresponding SV_RL and Pump_RL back to 1023 (on).

The dist_check() function:

- It triggers the ultrasonic sensors one by one and measures the time it takes for the echo signal to return.
- The distance is calculated based on the duration using the speed of sound (approximately 0.034 cm/μs) and divided by 2 because the sound travels to the target and back.
- The calculated distances are stored in the respective distance variables.
- Overall, this code checks the distances measured by ultrasonic sensors and activates the corresponding actuators based on the distance thresholds defined by Dist_Limit. The purpose and specific application of this system can be better understood with additional context.

4.7 PROJECT PROGRESS

4.7.1 Literature Review

A literature review for a spot specific sprayer encompass the research and studies conducted on the topic of precision agriculture and the application of pesticides using specialized equipment. The aim would be to analyze the effectiveness, efficiency, and advantages of using a spot specific sprayer compared to traditional methods of pesticide application.

Studies have shown that the use of a spot specific sprayer can result in significant reductions in the amount of pesticides used, leading to cost savings for farmers. This is due to the precision application of the spray, allowing for targeted treatment of specific areas that require it, rather than blanket application over an entire field. This results in a reduction of pesticide exposure to non-target areas and wildlife, leading to a reduced risk of environmental impact.

In addition, the use of a spot specific sprayer can also result in increased crop yield and improved quality due to more precise control of the pesticide application. This is particularly important in areas where specific pests or diseases are present, as spot application of the appropriate pesticide can effectively manage the issue without damaging the surrounding crops.

There have also been studies on the effectiveness of various spray nozzle configurations and spray patterns in achieving optimal spot application, with some studies finding that certain nozzles can result in improved accuracy and coverage of the spray.

Overall, the literature suggests that the use of a spot specific sprayer can offer numerous benefits in precision agriculture, including cost savings, reduced environmental impact, increased crop yield and improved quality, and improved spray accuracy and coverage. Further research and development in this field is likely to result in even more advanced and effective spot specific spraying solutions for farmers.

4.7.1 Basic Knowledge about existing Spot Specific Sprayer

Spot specific sprayers are specialized agricultural equipment designed for the precise application of pesticides. These sprayers resulting in more efficient and effective use of pesticides. The sprayers are equipped with specialized nozzles that allow for precise control over the spray pattern and coverage, reducing the amount of pesticide required and minimizing exposure to non-target areas and wildlife. Spot specific sprayers can also result in improved crop yield and quality due to targeted pest and disease management. With advancements in technology, spot specific sprayers have become increasingly popular among farmers seeking to adopt precision agriculture practices.

4.7.2 Specifications of Existing Spot Specific Sprayer

Table 1: Specifications of existing Spot Specific Sprayer

Components	Specifications
Engine Power	A tractor of 85 HP is required
Pump (rpm)	800-1000
valves	6 solenoid
Sensors	3 Ultrasonic Sensors on Each Side
Discharge rate	103-106 (L/mins)
Liquid Output Pressure (approx.)	780-1320 L/hr
Nozzle to Nozzle distance	26 inches
Sensor to Nozzle distance	75 inches
Ground to nozzle distance	64 inches
Water Tank	500 litres
Battery	12V

4.7.3 Visit to Koont Farm

Figure 4.16: Visit to Koont Farm

4.7.4 Diagram of Proposed 3S

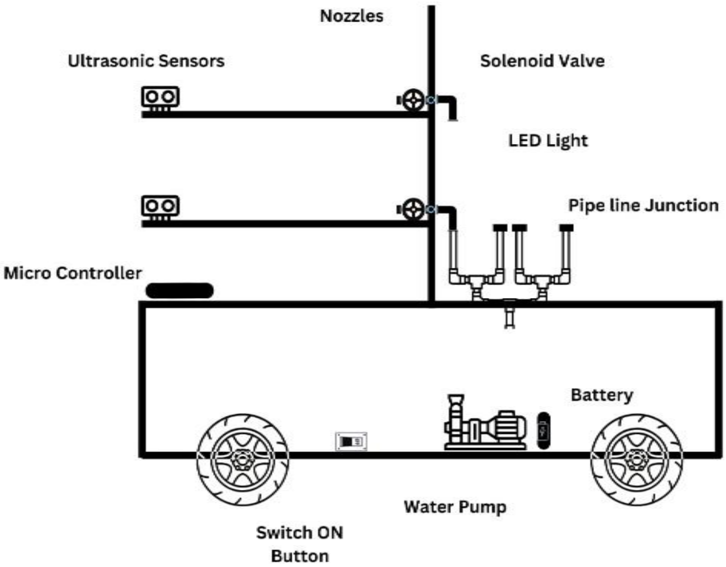

Figure 4.17: Autocad Diagram of Proposed 3S

4.7.5 Schematic Diagram of Proposed 3S

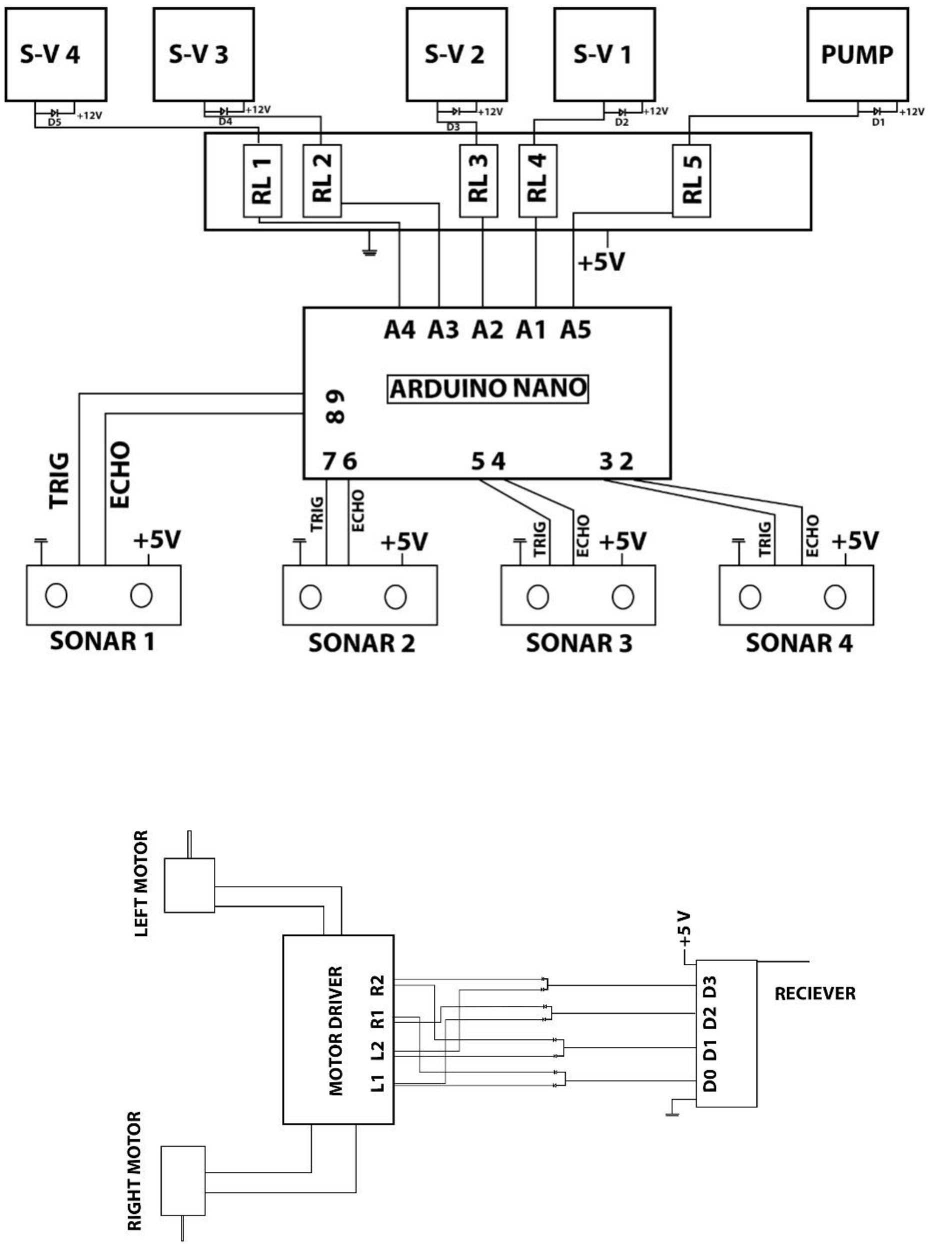

Figure 4.18: Schematic Diagram of 3S

4.7.6 Circuit Explanation

Arduino Nano

The Arduino Nano is a compact microcontroller board based on the ATmega328P microcontroller. It is a smaller version of the Arduino Uno board and offers similar functionality in a smaller form factor. The Nano is designed for projects that require a small footprint and is widely used by hobbyists, students, and professionals in various electronics and robotics applications.

Key features of the Arduino Nano include:

Microcontroller: It is equipped with an ATmega328P microcontroller, which operates at 5V logic levels and has 32KB of flash memory for storing the program code.

Digital and Analog Pins:

Digital Pins

- Digital Pins (D0 to D13):
- D0 (RX): Receive pin for serial communication.
- D1 (TX): Transmit pin for serial communication.
- D2 to D13: General-purpose digital input/output pins.

Analog pins

- Analog Pins (A0 to A7):
- A0 to A7: Analog input pins that can also be used as digital input/output pins (A0 is equivalent to D14, A1 is equivalent to D15, and so on).

Power Pins

- V_{in}: Input voltage pin (7-12V).
- 5V: Regulated 5V output pin.
- 3.3V: Regulated 3.3V output pin.
- GND: Ground pins.

Other Pins

- RESET: Pin used to reset the Arduino Nano.
- AREF: Reference voltage for analog inputs (can be used as a reference voltage for analog-to-digital conversion).

Power Pins:

- V_{in}: Input voltage pin (7-12V).
- 5V: Regulated 5V output pin.
- 3.3V: Regulated 3.3V output pin.
- GND: Ground pins.

Other Pins:

- RESET: Pin used to reset the Arduino Nano.
- AREF: Reference voltage for analog inputs (can be used as a reference voltage for analog-to-digital conversion).

Communication: The Nano supports serial communication via its built-in USB interface, allowing it to connect to a computer for programming and data transfer. It also has I2C and SPI communication capabilities for interfacing with other devices and modules.

Programming: The Arduino Nano can be programmed using the Arduino IDE (Integrated Development Environment), which supports a simplified programming language based on C/C++. It offers a wide range of libraries and example codes to facilitate rapid development.

Compatibility: The Nano is compatible with the Arduino ecosystem, which means it can run Arduino sketches and utilize various shields, modules, and libraries designed for Arduino boards.

Sonar Sensors:

The term "Sonar pin" generally refers to the pins used to interface with a sonar sensor module. Sonar, which stands for Sound Navigation and Ranging, is a technology used to measure distances using sound waves.

In the context of an Arduino or similar microcontroller, a sonar pin typically refers to two specific pins on the sensor module: the trigger pin and the echo pin.

Trigger Pin: The trigger pin is used to send an electrical signal to the sonar sensor module, initiating the process of sending sound waves. When the trigger pin receives a high or low signal (depending on the module), it triggers the sensor to emit a sound wave or a burst of ultrasonic pulses.

Echo Pin: The echo pin is used to receive the reflected sound waves from objects in the sensor's vicinity. After the trigger pin initiates the sound wave emission, the module measures the time it takes for the sound waves to bounce back from an object and return to the sensor. The echo pin detects this returned signal, which is then used to calculate the distance to the object.

These pins are typically connected to digital input/output (GPIO) pins on the Arduino or microcontroller, allowing it to control and receive data from the sonar sensor module.

Sonar connection with Arduino

Sonar Sensor 1:

Trigger pin: Connect to digital pin D9.

Echo pin: Connect to digital pin D8.

Sonar Sensor 2:

Trigger pin: Connect to digital pin D7.

Echo pin: Connect to digital pin D6.

Sonar Sensor 3:

Trigger pin: Connect to digital pin D5.

Echo pin: Connect to digital pin D4.

Sonar Sensor 4:

Trigger pin: Connect to digital pin D3.

Echo pin: Connect to digital pin D2.

Solenoid Valves and Pump:

The term "solenoid valve pin" refers to the electrical connection points used to control a solenoid valve. A solenoid valve is an electromechanical device that uses an electromagnetic solenoid to control the flow of fluids or gases.

In the context of an Arduino or similar microcontroller, a solenoid valve pin typically refers to a digital output pin that is connected to the control input of the solenoid valve.

To control a solenoid valve, the following connections are typically made:

Power Supply: The solenoid valve requires a separate power supply to operate, which is typically connected to a suitable voltage source. The power supply is responsible for supplying the necessary electrical power to energize the solenoid coil within the valve.

Control Pin: The control pin of the solenoid valve is connected to a digital output pin on the Arduino or microcontroller. When the digital pin is set to a HIGH or LOW state, it controls the activation or deactivation of the solenoid coil within the valve.

By sending an electrical signal to the solenoid valve pin from the microcontroller, the solenoid coil is energized, generating a magnetic field that opens or closes the valve mechanism, allowing or stopping the flow of fluid or gas.

Connection of Solenoid Valves and Pump with Arduino:

Connect the power supply for the solenoid valves and the pump.

Use 5 relays (one for the pump and four for the solenoid valves). Each relay should have a separate control pin connection to the Arduino Nano.

Relay 1 (solenoid valve 1):

Connect the control pin of Relay 1 to analog pin A1.

Relay 2 (Solenoid Valve 2):

Connect the control pin of Relay 2 to analog pin A2.

Relay 3 (Solenoid Valve 3):

Connect the control pin of Relay 3 to analog pin A3.

Relay 4 (Solenoid Valve 4):

Connect the control pin of Relay 4 to analog pin A4.

Relay 5 (pump):

Connect the control pin of Relay 5 to analog pin A5.

Connect the power supply for the pump and solenoid valves to the corresponding relay's power input terminals.

Connect the pump and solenoid valves to the normally open (NO) or normally closed (NC) terminals of the relays, depending on your specific requirements.

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 RESULTS

Table 2: Outdoor Readings

Sr.no	**Time**	**Distance from plant**	**Lag time**
1	12:07 pm	25cm	1.26 sec
2	12:13 pm	25cm	1.96 sec
3	12:21 pm	25cm	1.43 sec
4	12:32 pm	30cm	2.56sec
5	12:48 pm	30cm	2.03 sec
6	1:10 pm	30cm	2.68 sec

Table 3: Indoor Readings

Sr.no	**Time**	**Distance from plant**	**Lag time**
1	1:15 pm	25cm	1.46 sec
2	1:17 pm	25cm	1.32 sec
3	1:20 pm	25cm	1.62 sec
4	1:29 pm	30cm	2.82sec
5	1:32 pm	30cm	2.86 sec
6	1:35 pm	30cm	2.98 sec

5.2 DISCUSSIONS

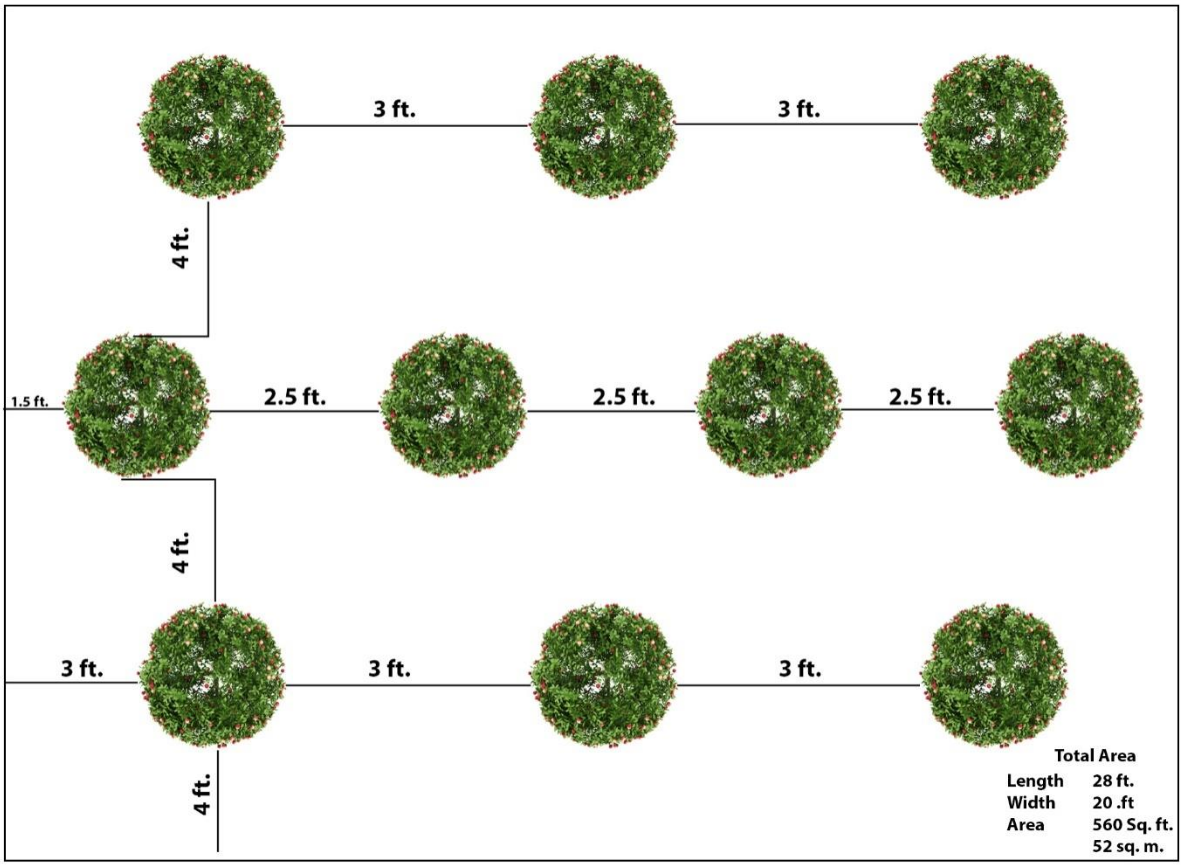

Figure 5.1: Testing field area for Spot Specific Sprayer

Using spot-specific sprayers in agricultural applications has shown promising results in terms of improving precision and efficiency. These sprayers are designed to selectively target specific areas of a field, delivering the appropriate amount of pesticides, herbicides, or fertilizers only where needed. Spot-specific sprayers provide precise application of agrochemicals, reducing wastage and minimizing environmental impacts. By targeting specific spots or individual plants, farmers can avoid over spraying and ensure that the chemicals reach their intended targets effectively. Spot-specific sprayers help in optimizing chemical usage by applying them only where required. This leads to a significant reduction in the overall volume of agrochemicals used, resulting in cost savings for farmers and minimizing the potential for environmental contamination. By precisely targeting pests, diseases, or weeds, spot-specific sprayers allow for more effective control measures. This targeted approach helps in maintaining crop health, reducing the competition for resources and minimizing yield losses caused by pests or diseases. Spot-specific sprayers enable farmers to cover larger areas in less time compared to traditional broadcast spraying methods. The ability to precisely target specific spots or plants reduces the time and effort required for manual spraying or applying chemical treatments to individual plants. With spot-specific sprayers, the overall environmental impact of agrochemical application is minimized. By reducing overspray and drift, these sprayers help protect non-target areas, water bodies, and beneficial insects. The precise targeting also minimizes the risk of chemical leaching into the soil. While spot-specific sprayers offer significant advantages, there are some challenges and limitations to consider. The initial cost of acquiring and maintaining these specialized sprayers can be higher compared to conventional sprayers. In conclusion, spot-specific sprayers have demonstrated positive outcomes in terms of precision, efficiency, reduced chemical usage, and environmental impact. However, further research and development are necessary to optimize these systems, improve affordability, and promote their widespread adoption among farmers.

Table 4: Readings of Lag Time and Distance from Plant

SR# NO	DISTANCE FROM PLANT	LAG TIME
1	30cm	2.56
2	30 cm	2.51
3	25	2.43
4	25cm	2.41
5	20cm	2.`22
6	20cm	2.18
7	15cm	1.60
8	15cm	1.61

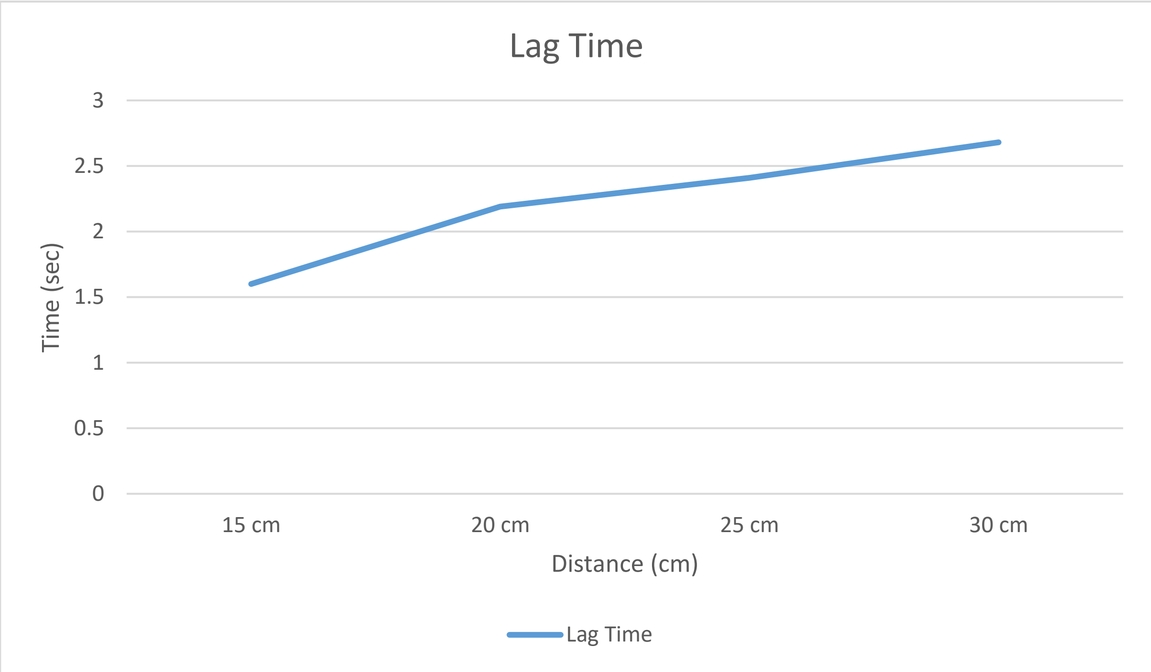

Figure 5.2: Graph Representation of Lag Time

CHAPTER NO 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The relationship between distance and lag time in spot-specific sprayers can vary depending on various factors such as the sprayer design, settings, and the specific application being carried out. However, in general, there are a few conclusions that can be drawn regarding the relationship between distance and lag time in spot-specific sprayers:

1. Direct Relationship: In our spot-specific sprayers, there is a direct relationship between distance and lag time. As the distance between the sprayer nozzle and the target area increases, the lag time, or the time it takes for the spray droplets to reach the target, tends to increase. This is because the spray droplets need more time to travel the longer distance.

2. Spray System Factors: The specific design and characteristics of the spot-specific sprayer's spray system can affect the relationship between distances and lag time. Factors such as nozzle size, spray pressure, and spray pattern can influence how quickly the droplets are propelled and their travel time to the target area.

3. Droplet Size and Velocity: The size and velocity of the spray droplets can also impact the lag time. Smaller droplets generally have lower inertia and are more affected by air resistance, which can increase the lag time. Similarly, higher droplet velocities can lead to shorter lag times as they cover the distance more quickly.

4. Environmental Conditions: Environmental conditions, such as wind speed and direction, can significantly affect the relationship between distances and lag time. Wind can cause drift, which may alter the trajectory and travel time of the spray droplets, making it more challenging to establish a consistent relationship between distances and lag time.

5. Applicator Skill and Technique: The skill and technique of the operator or applicator can influence the relationship between distances and lagtime. An experienced operator who can accurately control the spray application and adjust

the sprayer settings based on the target distance can mitigate some of the variations in lag time.

6.2 RECOMMENDATIONS

Here are some recommendations for using spot-specific sprayers effectively:

1. Before using a spot-specific sprayer, thoroughly assess the field conditions, including pest or weed infestations, disease prevalence, and variability across the field. This information will help determine the areas that require treatment and the appropriate chemical dosage.

2. Properly calibrate the spot-specific sprayer to ensure accurate delivery of the desired chemical dosage. Conduct regular tests to verify that the sprayer is functioning correctly, providing consistent droplet size and distribution. Calibrations and tests should be done before each use and periodically throughout the spraying season.

3. Consider integrating real-time sensing and monitoring systems into the spot-specific sprayer. These systems can detect target pests, weeds, or diseases and automatically adjust the spraying parameters accordingly. This helps ensure precise application and reduces the risk of under or over-application.

4. Take advantage of variable rate technology to adjust the application rate based on the specific needs of different areas within the field. This allows for tailored treatments, optimizing chemical usage and minimizing wastage.

5. Follow all safety protocols and guidelines when using spot-specific sprayers. Wear appropriate protective clothing, handle chemicals safely, and adhere to local regulations regarding pesticide use. Properly clean and maintain the sprayer to prevent cross-contamination and ensure its longevity.

6. Continuously evaluate the effectiveness of spot-specific spraying in your field. Monitor the results in terms of pest control, weed suppression, disease management, and overall crop health. Based on the observations and feedback, make necessary adjustments to the spraying strategy or equipment settings to achieve optimal results.

7. Stay updated on the latest advancements and best practices in spot-specific spraying. Attend workshops, conferences, or training programs related to precision agriculture. Seek advice from agricultural experts, agronomists, or extension services to gain insights into specific crop and region-specific recommendations.

By following these recommendations, farmers can maximize the benefits of spot-specific sprayers, including improved precision, reduced chemical usage, enhanced crop health, and minimized environmental impact.

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Appendix A

Specifications of Components

A): Microcontroller

Table 1: Specification of Microcontroller

Components	Specifications
Microcontroller	Arduino Nano
Digital /Input pins	14
Analog pins	8
Hardware serial ports	3UARTs
Crystal Oscillator	16MHz
USB connection	Mini-B USB
Power port	Yes
ICSP header	Yes

B): Sprayer specification.

Table 2: Sprayer specification

Components	Specifications
Voltage	12 Volts
Pump pressure	110 PSI
Suction volume	4(L/mins)

C): Pressure nozzles spray Booms

Table 3: Specifications of Pressure nozzles spray Booms

Components	Specifications
No of pressure Nozzles	4
Type of nozzles	Hollow cone nozzle
Pressure	3-6 Bar
Orifice diameter	1-2mm
Type of material	Plastic

D): Ultrasonic Sensor

Table 4: Specification of Solenoid Valve

Components	Specifications
Operating Voltage	5 Volts DC
Current	15 mA
Frequency	40 kHz
Measurement Range	2 cm – 400 cm

E): Solenoid Valve

Table 5: Specifications of Solenoid Valve

Components	Specifications
Voltage	12V
Port	½” Electric Valve 3 way T port
Mode	Motorized Valve
Specialty	Mini electric Valve for fluid regulator

F): ATV (All-Terrain Vehicle)

Table 6: Specification of ATV

Components	Specifications
Gear Motor Power	0.256 HP
Transmission	1 Automatic 4wd
Manufacturers	Locally made

G): Chassis

Table 7: Specifications of Chassis

Components	**Specifications**
Gauge	310mm
Material	Steel iron