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FINAL YEAR PROJECT REPORT

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POULTRY BOT: AUTONOMOUS SYSTEM

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DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at USMAN INSTITUTE OF TECHNOLOGY or other institutions.

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POULTRY BOT: MONITORING SYSTEM

ABSTRACT

Poultry Bot is a major technological breakthrough for the poultry industry as it provides solutions for the utmost problems faced in a poultry farm. The purpose of the poultry bot is to completely revolutionize the century-old farming practices used till now by introducing the latest technology for the 1,190 billion rupees turnover generating sector. The goal is to minimize the biosecurity risk to help improve production. Furthermore, assisting humans to make more informed and better decisions. The poultry bot is an autonomous self-driven robot that performs all the required operations in the poultry farm which includes monitoring, patrolling, litter-racking, and disinfectant spraying. Overall, the Poultry Bot's introduction to the poultry industry heralds a transformative era, promising higher levels of biosecurity, production enhancement, and informed decision-making.

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CHAPTER # 01

INTRODUCTION

1. Introduction:

Poultry as a farming activity already existed for ages, over the 20th century, it became a real profession. In that century, poultry farming underwent several major revolutions in which the production system was drastically changed. In today's poultry farming a significant part of the daily animal care is mechanized or automated like manure removal, climate control, automated medication, and litter racking. As these tasks contain limited complexity and variation, that are fulfilled using motors and simple control logic. The properly running poultry shed still requires good stockman ship with intensive monitoring and awareness of animal behavior and interactions as well as proper management and conscientiously performing of the daily task. This poultry bot comprises of implementation of IoT for monitoring important factors such as temperature, humidity, and air quality that can easily be detected by electronic discrete sensors that are particularly developed for single dedicated task. Another, innovative feature that is integrated with this robot is its autonomous movement which is to be done using a minicomputer which is specifically used to make this bot unique, efficient, and remarkable. Along with this, the technology of LIDAR is adopted to make the bot move precisely in the field area. Pesticide, that cannot be ignored when it comes to poultry care, is also integrated that will follow the defined scheduled spraying with controlled concentration according to the requirements of the shed.

1.1. Problem Statement

The poultry industry faces various challenges related to efficiency, productivity, and animal welfare. However, the major challenge facing poultry farming is reconciled productivity, biosecurity, and expectations of society where the environment and animal welfare are of major concern. To address these challenges, the development of a poultry robot is proposed. The objective of the poultry robot is to automate and optimize various tasks involved in poultry farming and management.

There are almost 15000 poultry farms in Pakistan despite having such a huge industry not a single poultry robot is present due to restrictions on self-import, uneconomical cost, and lack of after-sales services[1]. Poultry Bot will enable the farmer to enhance productivity while eliminating the need for physical vigilance. The goal of the poultry bot is to fully automate the process of monitoring and maintaining a poultry farm by providing tech-based solutions for daily faced problems.

By deploying poultry robots, farmers can significantly reduce the labor costs associated with poultry farming while maintaining high standards of animal welfare. The robot's ability to work continuously ensures round-the-clock monitoring and care for the birds, leading to better overall farm management. Moreover, the data collected by the robot's sensors can be analyzed to gain valuable insights into the birds' health, behavior patterns, and productivity, enabling farmers to make data-driven decisions and optimize their operations further.

1.2. Literature Review

As for the poultry robots available worldwide, different robots are introduced with capabilities of various problem-solving. Some of the available poultry robots are discussed as follows:

1.2.1. Poultry Patrol

By using thermal imaging, it enables the robot to detect disease and fatalities. The movement of birds is monitored to analyze their health[2].

Figure 1.1 Poultry Patrol

1.2.2. Octopus Robot

The bots continuously measure environmental factors, such as temperatures, humidity, carbon dioxide, and ammonia levels, alerting farmers in real time of deviations and potential problems[3].

Figure 1.2 Octopus Robot

1.2.3. Robot Egg Collector

Poultry farms that give chickens open space to move around face the problem of random eggs laying all over the farm. The robotic egg collectors use an array of sensors to find and collect eggs without disturbing the chickens[4].

Figure 1.3 Robot Egg Collector

1.2.4. Poultry Safe

It is capable of dealing with all types of substrates, turning and ventilating litter to prevent the exertion of ammonia gas and other diseases.

All the robots mentioned above are catering to a certain problem but there are certain limitations and challenges associated with poultry robots, including technological constraints, cost considerations, and integration with existing farm systems. However, poultry bot minimizes these problems[5].

Figure 1.4 Poultry Safe

1.3. Aims and Objective

The Poultry Bot aims to enhance daily poultry farm production conditions with advanced technologies focused on health, biosecurity, and productivity. Objectives include improving poultry quality by enhancing animal well-being and minimizing antibiotic use, sanitizing bedding to control multi-resistant bacteria and infectious diseases while reducing ammonia levels, and uniformly decontaminating buildings during fallow periods. Additionally, the Poultry Bot aims to increase yields through improved animal weight and reduced interim costs, promoting more efficient and sustainable poultry farming practices.

1.3.1. To Optimize the Working Time

The Poultry Bot aims to streamline and optimize the working time in poultry farming operations by employing its autonomous and connected features. The robot can efficiently perform tasks that would otherwise require significant manual labor and time. The Poultry Bot can complete essential functions such as decontamination, sanitization, and monitoring without the need for constant human supervision. This optimization of working time allows poultry farmers to focus on other critical aspects of their operations, leading to increased productivity and improved overall efficiency.

1.3.2. To Improve Animal Welfare

The robot's atomization technology allows the decontamination and sanitization of the poultry farm environment, creating a healthier and cleaner living space for the birds. By minimizing the presence of harmful bacteria, infectious agents, and ammonia concentrations in the bedding, the Poultry Bot promotes better health and comfort for the birds.

1.3.3. To Increase the ADGs (Average Daily Gain)

The Poultry Bot plays a crucial role in boosting the average daily gain (ADG) of poultry. By maintaining a clean and hygienic environment, the robot reduces stress factors that can hinder the growth and development of the birds. The optimized living conditions provided by the Poultry Bot contribute to improved feed conversion rates and nutrient absorption, leading to higher ADGs.

1.3.4. To Improve Litter Racking Quality

The Poultry Bot's technology for regularly cleaning and removing soiled litter ensures a high-quality decontamination process, including the sanitization of the bedding. By effectively reducing the concentration of multi-resistant bacteria and ammonia, the robot helps maintain cleaner and healthier litter-racking conditions. Improved litter quality not only benefits animal health and welfare but also facilitates easier waste management for poultry farmers, leading to more sustainable and eco-friendly practices.

1.3.5. To Minimize the Workforce

With its autonomous and connected features, the Poultry Bot minimizes the need for a large workforce in poultry farming operations. Once deployed, the robot can carry out its tasks independently, reducing the labor-intensive aspects of manual cleaning and decontamination. This cost-effective solution allows farmers to optimize labor resources, allocate manpower to more strategic tasks, and potentially reduce operational expenses.

CHAPTER # 02

METHODOLOGY

2.1. Hardware Detail

The project is divided into parts, drive, and autonomous system. To get better understanding of details of the hardware, block diagram is created.

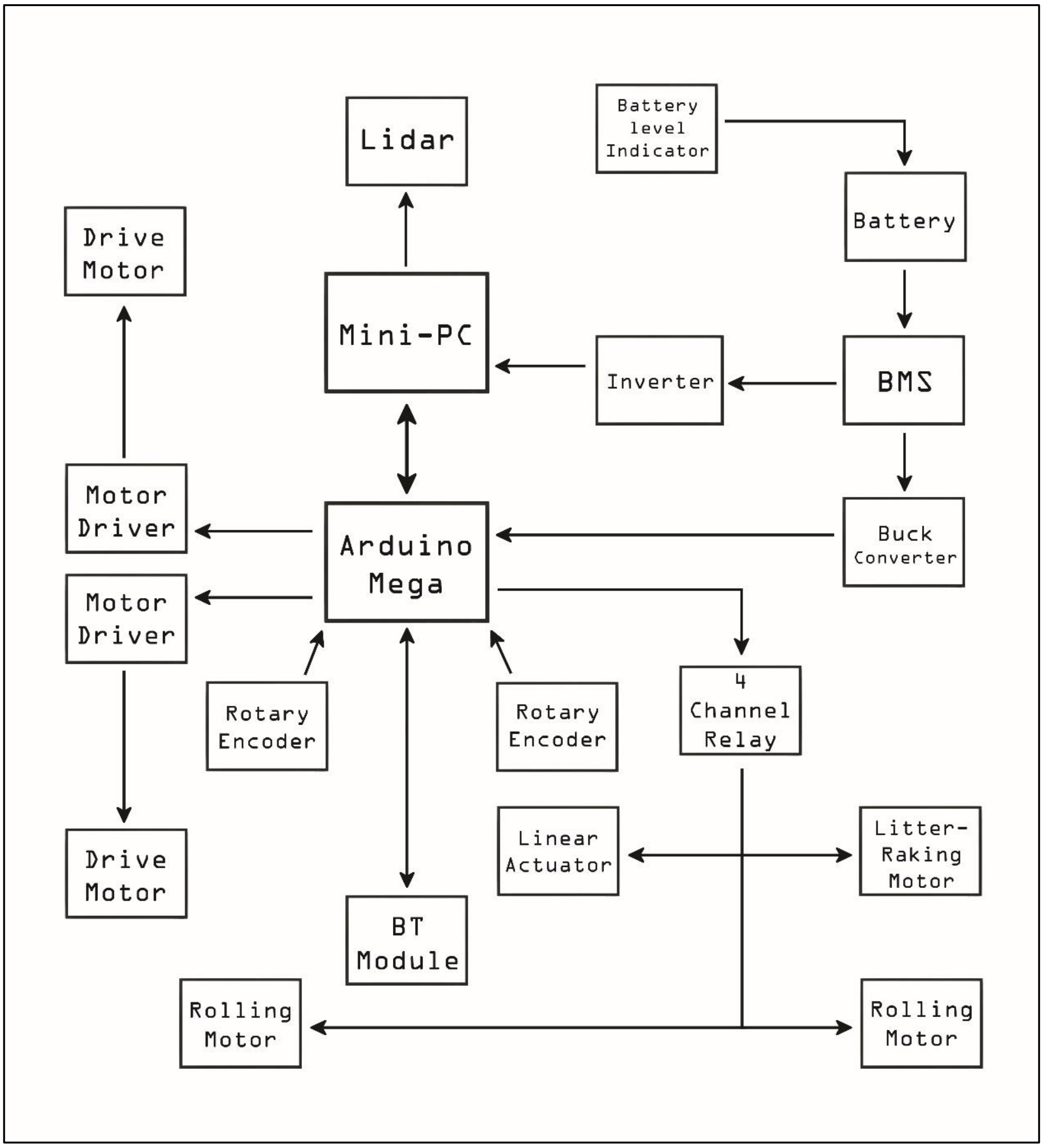

Figure 2.1 Block Diagram

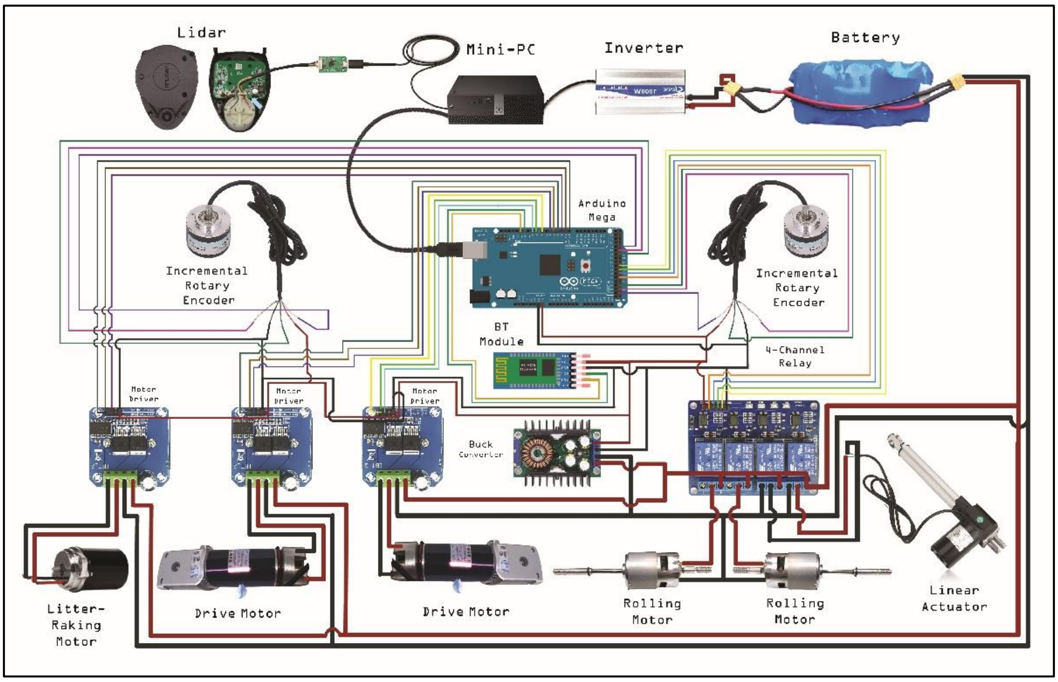

Figure 2.2 Wiring Diagram

The hardware used in this project is mentioned in detail as follows:

2.1.1. Arduino Mega 2560

The Arduino Mega Module serves as the microcontroller in the Poultry Bot, providing versatility and widespread use in the development process. Its adoption offers abundant I/O pins to connect sensors and actuators, ample processing power for complex algorithms, and a user-friendly development environment. The Arduino Mega's popularity stems from its strong community support, cost effectiveness, expandability through shields, and compatibility with diverse components, making it a reliable choice for robotic projects. Its robustness and reliability further contribute to seamless and efficient operation in the drive system of the poultry bot.

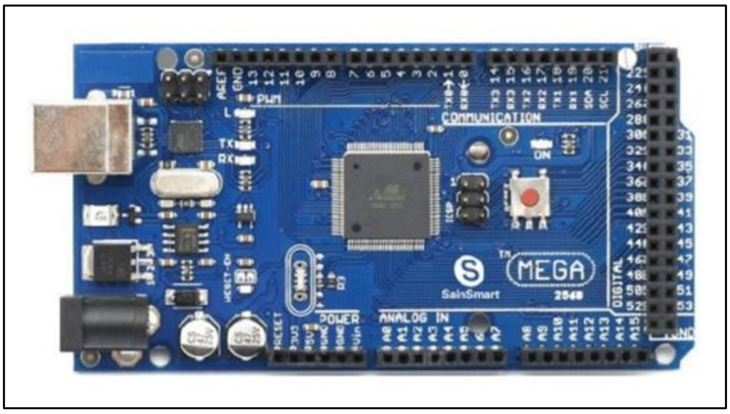

Figure 2.3 Arduino Mega

2.1.2. 12V Battery Pack

The Li-ion 3S4P 12V battery pack features Murata VTC6A 21700 lithium-ion cells, where three of these high-performance cells are connected in series to achieve a nominal voltage of 11.1 volts based on the individual cell's capacity of approximately 3.7V. Additionally, three sets of these series-connected cells are arranged in parallel to enhance the total capacity, providing a combined capacity of, 12300mAh (or 12.3Ah) based on the individual cell's capacity of approximately 41000mAh. The Murata VTC6A 21700 cells offer excellent energy density and performance. The battery pack incorporates essential safety features such as overcharge protection, over-discharge protection, and short-circuit protection, ensuring secure and reliable operations. These safety features are ensured by the battery management system (BMS) and the battery level indicator.

Figure 2.4 Battery Pack

2.1.3. DC Geared Motors

The DC geared motors are DGO-7024SIA which are compact DC geared motors known for its powerful and precise motion control capabilities across diverse applications. The gearbox of this motor enhances the torque while reducing speed, it ensures reliable and accurate motion for the drive system.

Table 2.1: Specification of DC Geared Motors

Parameters	Values
RPM	268.9
Working Voltages	0 to 24v
No Load Current	1.5A
Gear Ratio	1/11.19
Model No	DGO-7204SIA
Country	KOREA

Manufacture	SPG
Direction	Reversible

Figure 2.5 DC Geared Motors

2.1.4. DC Motors

The "DC 12V 100W 775 High Speed Long Shaft Motor" is an electric motor designed to operate on a 12V DC power supply. With a power rating of 100 watts, this motor can deliver relatively high-power output. Additionally, the motor is equipped with a long shaft, providing extended reach and access, making it suitable for rubber rollers where the motor needs to drive components at a distance from the main body.

Table 2.2: Specification of DC Motors

Parameters	Values
Motor Type	775
Rated Voltages	DC 12v
Operating Voltages	12v
Idle Speed	3000 to 6000
Nominal Current	0.32A
Nominal Power	100W

Figure 2.6 DC Motors

2.1.5. Bluetooth Module (HC-05)

The Bluetooth module can transmit data according to the serial port communication (SPI, IIC) and the MCU control system. The Bluetooth module can be used as a server and a slave. The HC-05 Bluetooth module is perfect for transparent wireless serial communication due to its preconfigured slave mode and simple pairing process. It requires no specific user code in the microcontroller program and supports two work modes: Command and Data mode, easily switchable using the onboard push button. In Command mode, users can modify system parameters, and these changes are retained even after power is removed. Its flexibility and ease of configuration make it an excellent choice for wireless serial communication projects without complex coding requirements. This is the reason it is used for the wireless control of the drive system.

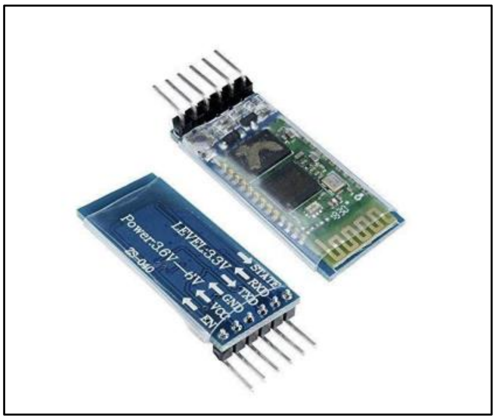

Figure 2.7 Bluetooth Module

2.1.6. Two Channel Relay Module

The two-channel relay module is designed to control high-voltage electrical devices through a low-voltage microcontroller or other control systems. It features a high-quality relay capable of handling up to a specified maximum current and voltage rating. The module typically operates at a specific input voltage, and its input control signal is triggered by either a low or high voltage, activating or deactivating the relay accordingly. This two-channel relay module is used to control the switching of the DC Motors responsible for rubber rollers.

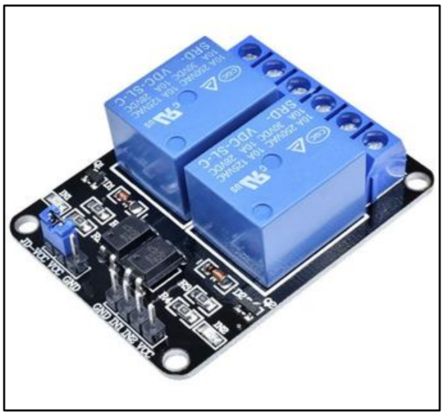

Figure 2.8 Two Channel Relay Module

2.1.7. Buck Converter

A buck converter is a type of DC-DC power converter that steps down voltage levels efficiently, providing a lower output voltage than the input by controlling the switch's on-off cycles. It's commonly used to power electronic devices with a stable, reduced voltage. The buck converter used in this project is XL4016.

Table 2.3: Specification of Buck Converter

Parameters	Values
Input Voltages	8v to 36v DC
Maximum Power Output	300W
Output Voltages	1.2v to 30v DC
Output Current	12A Rated, (8A Maximum with heat sink)
Adjustable Current	0.2 to 12A

Figure 2.9 Buck Converter

2.1.8. Motor Driver

A motor driver is an electronic interface used to control electric motors efficiently and safely. It enables precise control over the motor's direction, speed, and power supply, while also protecting the microcontroller from potential electrical noise and back EMF. The motor driver used is IBT2 H-Bridge motor driver module, which uses two BTS7960 chips, and it is an excellent choice for motor control due to its high current handling (up to 43A) and wide voltage range (6V to 27V). It is also easy to use with various microcontrollers like Arduino.

Table 2.4: Specification of Motor Driver

Parameters	Values
Input Voltages	6v – 27v
Maximum Current	43A
Input Level	3.3v – 5v

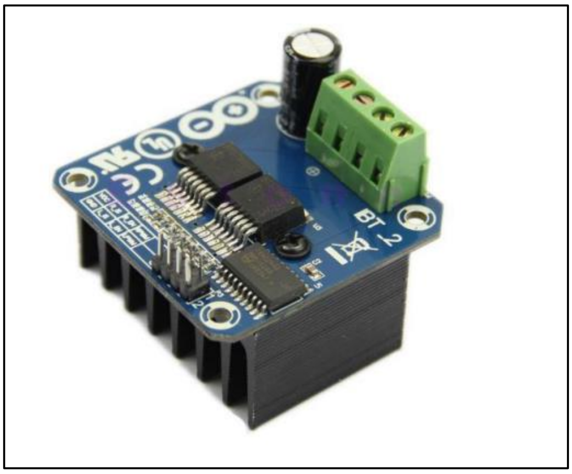

Figure 2.10 Motor Driver

2.1.9. Incremental Rotary Encoder

An incremental encoder is a type of encoder device that converts angular motion or position of a shaft into an analog or digital code to identify position or motion. Incremental encoders are one of the most used rotary encoders.

An incremental encoder provides excellent speed and distance feedback and since there are few sensors involved, the systems are both simple and inexpensive. An incremental encoder is limited by only providing change information, so the encoder requires a reference device to calculate motion. Therefore, the incremental rotary encoder is used to send the position of the motor shaft to the Arduino for the autonomous system.

Table 2.5: Specification of Incremental Rotary Encoders

Parameters	Values
Pulses	600 p/r
Power Sources	DC 5-24v
Shaft	6 x 13 mm/0.23 x 0.51 inches
Size	38 x 35.5 mm/1.49 x 1.39 inches
Output	Rectangular orthogonal
Maximum Mechanical Speed	5000 RPM
Responses Frequency	0-20kHz
Cable Length	1.5 meters

Figure 2.11 Incremental Rotary Encoder

2.1.10. Structure of Litter Racking

A poultry farm litter raking blade is a specialized tool used in poultry farming to manage and maintain the litter inside chicken houses or coops. The raking blade is typically attached to a tractor or a specially designed machine. It helps to evenly distribute and level the litter, which may consist of materials like straw, wood shavings, or sawdust. By raking the litter, the blade promotes better hygiene and reduces the buildup of manure and waste, ensuring a cleaner and healthier environment for the poultry. The process also helps to prevent the formation of ammonia, which can be harmful to the birds' respiratory health. Overall, the poultry farm litter raking blade aids in optimizing the litter quality and promoting the welfare and productivity of the poultry flock.

Figure 2.12 Litter Racking Structure

2.1.11. Mini PC

The Mini-PC in an autonomous Poultry Bot serves as its central processing unit, enabling essential functions such as processing sensor data, running decision-making algorithms, facilitating sensor data integration, achieving autonomy and adaptation, mapping, and localization through SLAM algorithms, and facilitating communication with external devices or operators. It acts as the brain of the robot, allowing it to function intelligently and independently in various tasks without requiring direct human intervention.

Table 2.6: Specification of Mini PC

Parameters	Values
Model	Dell Core i5 4th Generation
RAM	8 GB
ROM	256 GB SSD

Figure 2.13 Mini PC

2.1.12. Inverter

An inverter is a power conversion device that uses semiconductors. A device that converts direct current to alternating current is called a DC-AC inverter. In general, a circuit that converts a specified frequency and voltage by combining an AC-DC converter and a DC-AC inverter, is called an inverter circuit (inverter). The inverter used in this project is a 12V 1000W inverter which is powered by the 12V battery pack and is used to power the Mini-PC as it works on AC.

Figure 2.14 Inverter

2.1.13. Lidar

Lidar stands for Light Detection and Ranging, like sonar and radar with sound and radio waves respectively. Lidar technology uses beams of light to sense the range of an object. This can be very useful to a robot as it can sense the distance to a target or obstacle and create a local “map” of the world around it.

In the autonomous system, 2D lidar is chosen due to its effectiveness and affordability. The market offers a wide array of lidar models with diverse technologies, catering to different price points.

However, the decision to utilize 2D lidar is primarily driven by its ability to efficiently fulfill the robot's requirements while also being available at a relatively lower cost compared to other options

The LIDAR used in this project is RP Lidar A1M8 360 Degree Laser Scanner Development Kit and it is a low cost 2D LIDAR solution. It can scan a 360° environment within a 12-meter radius.

Table 2.7: Specification of Lidar

Parameters	Values
Measuring Range	From 0.15m to 12m
Measuring Resolution	<0.5 mm
Angular Resolution	≤ 1°
Sampling Speed	2000 Hz to 8000 Hz
Scanning Range	0° to 360°
Sampling time	0.5 ms
Scanning frequency Range	1 Hz to 10 Hz (typical 5.5 Hz)

Figure 2.15 Lidar

2.1. Software Detail

The software part is further divided into three parts, designing of the poultry bot (wiring diagram and structure design), code for the driving and autonomous system. The details of software implementation of these parts are given below:

2.2.1. Design Of The "Poultry Bot"

The designing part of the poultry bot consists of a wiring diagram and the structure design which is made using the software Adobe illustrator and AutoCAD respectively.

2.2.1.1 Adobe Illustrator

Adobe Illustrator is a powerful vector graphics editing software used for creating and editing illustrations, diagrams, and other graphic designs. It offers a wide range of tools and features for precise drawing and design work.

Adobe Illustrator is utilized to create wiring diagrams that involve components like IBT-2, buck converters, motors, inverters, LiDAR, and mini-PCs. These specific components may not be available in simulation apps like KiCad or Proteus. Therefore, custom software, such as Adobe Illustrator, is employed for designing detailed wiring diagrams involving these components in a visual and precise manner.

Figure 2.16 Adobe Illustrator

2.2.1.2 AutoCAD

AutoCAD is a computer-aided design (thus, the name "CAD") program. It was created by Autodesk, a company that primarily produces software and solutions for industries such as architecture, engineering, product design, manufacturing, construction, and more. AutoCAD lets designers create and edit designs and digital images in both 2D and 3D very efficiently. Instead of requiring them to edit images by hand, AutoCAD makes it much easier to manipulate designs.

Essentially, AutoCAD lets designers create geometric models on-screen, offering endless permutations for creating different types of objects and structures. This flexibility is what led AutoCAD to become an industry leader since it could be adopted for use in almost any industry or application.

Figure 2.17 AutoCAD

2.2.2. Code for the Driving System

The drive system is controlled by Arduino, and it is programmed via Arduino IDE.

2.2.2.1 Arduino Software

The Arduino Integrated Development Environment (IDE) is a user-friendly, cross-platform software tool used for programming and developing applications on Arduino microcontroller boards. It provides a simplified interface for writing, compiling, and uploading code to Arduino boards, making it accessible to both beginners and experienced developers. The IDE supports the C/C++ programming language and comes with a vast library of pre-written functions, simplifying the process of creating interactive projects with sensors, motors, and other hardware components. Additionally, it offers a Serial Monitor for debugging and monitoring data from the Arduino board, along with a range of useful tools for code analysis and project management. Therefore, the drive system is programmed using Arduino IDE.

Figure 2.18 Arduino Software

2.2.3. Code for the Autonomous System

The autonomous system is controlled by mini-pc and it is programmed via ROS and to run ROS other software are also used such as the operating system Linux, Gazebo and RViz.

2.2.3.1 Linux

Linux is an open-source operating system (OS). An operating system is the software that directly manages a system's hardware and resources, like CPU, memory, and storage. The OS sits between applications and hardware and makes the connections between all your software and the physical resources that do the work.

In the context of robotics, Linux is a popular choice for running robot operating systems, such as ROS, due to its support for hardware drivers, real-time capabilities, and ease of customization. Many robots and robotic applications run on Linux-based systems, and the community provides extensive support for integrating robotics hardware and software components with Linux distributions.

Figure 2.19 Linux

2.2.3.2 ROS

ROS (Robot Operating System) is an open-source framework for developing software for robots. It promotes modularity and reusability through a distributed architecture, enabling seamless communication between different software modules called "nodes" using a publish-subscribe messaging system. Key functionalities include message passing, service calls, parameter management, facilitating data exchange between robot components. Developers can use various programming languages like C++ and Python, enhancing accessibility and flexibility.

ROS is a vital tool in the robotics community, providing a collaborative platform for creating complex robotic systems. Its open-source nature fosters knowledge-sharing among developers worldwide. Due to this ROS is used to make the robot work autonomously.

Figure 2.20 ROS

2.2.3.3 Gazebo

Gazebo is an open-source physics-based simulator used for testing and evaluating robots and robotic systems in a simulated environment. It can simulate various aspects of robots, including sensors, actuators, and physical interactions between objects. Gazebo supports both indoor and outdoor environments, offering realistic physics and sensor models.

ROS and Gazebo are frequently used together to develop and test robotic applications. The "gazebo_ros" package facilitates integration, enabling ROS nodes to interact with simulated robots and their environment. Gazebo's physics simulation provides realistic feedback to ROS nodes, allowing developers to validate and refine algorithms before deploying them on real robots. In summary, ROS provides a software framework, while Gazebo offers a physics-based simulator, allowing developers to develop, test, and improve robotic applications in a simulated environment before real-world deployment.

Figure 2.21 Gazebo

2.2.3.4 RViz

RViz is a 3D visualization tool in the ROS framework that allows users to display and interact with various data from ROS-based robots. It provides a graphical user interface for visualizing sensor data, robot models, trajectories, and TF transforms, facilitating debugging and analysis. With interactive markers and customizable layouts, users can interact with the robot and environment, setting goals and adjusting positions.

Overall, RViz is an essential tool for roboticists and developers working with ROS, as it provides valuable insights into the robot's perception, behavior, and interaction with the environment. It aids in debugging, testing, and refining robot applications, thereby accelerating the development and deployment of the poultry bot.

Figure 2.22 RViz

CHAPTER # 03

PROJECT IMPLEMENTAION

3.1. Details of Hardware Implementation

The project is divided into parts, drive, and autonomous system. To get a better understanding of the project implementation, a flowchart and design of robot structure is given below.

3.1.1. Drive System

This section consists of Arduino Mega, 12V battery pack, DC-geared motors for driving the robot, DC motors for the rubber rollers, Bluetooth Module, 2 channel relay module, buck converter, motor drivers and incremental rotary encoder. Arduino here is used for controlling the motor drivers and the relay module and the Bluetooth module is used for the wireless control of the robot.

3.1.2. Autonomous System

This section consists of Mini-PC, Inverter, LIDAR for mapping and 12V battery pack. Mini-PC here is used to run ROS (Robot Operating System) for autonomous movement in a predefined map which is mapped using the LIDAR.

3.1.3. Working of the Drive and Autonomous System

The basic working of the drive and autonomous system together can be represented by the following flow chart.

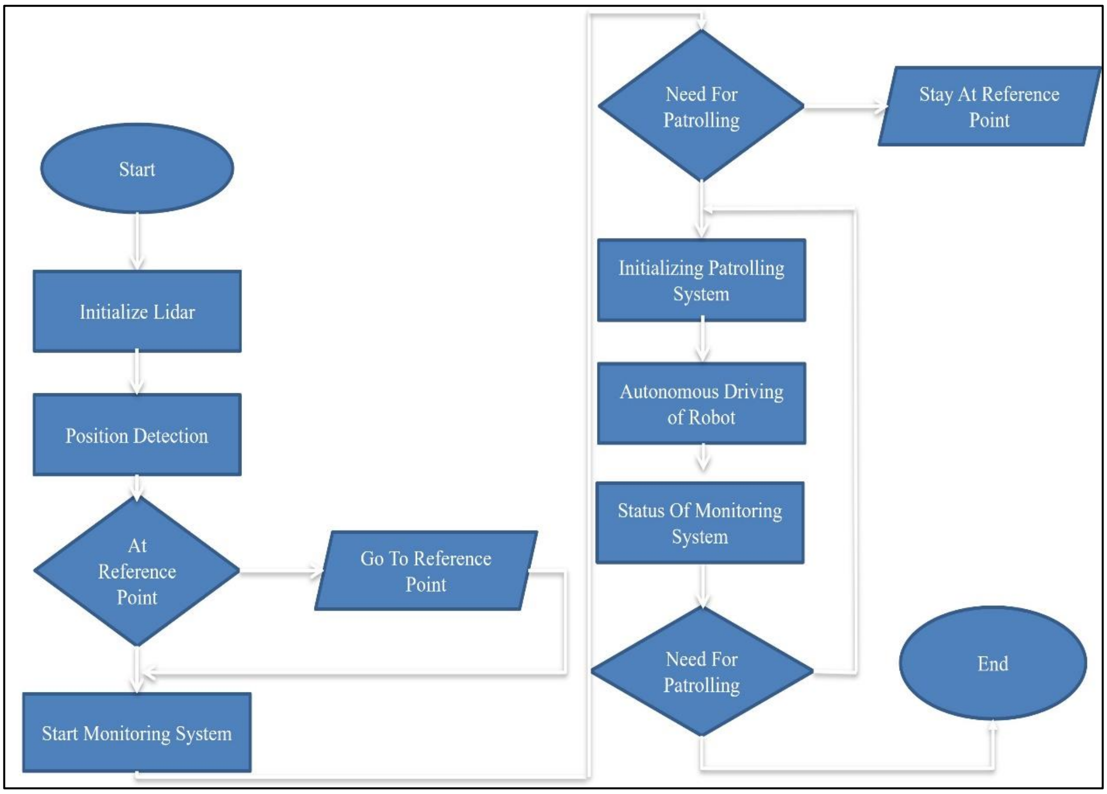

Figure 3.1 Flowchart

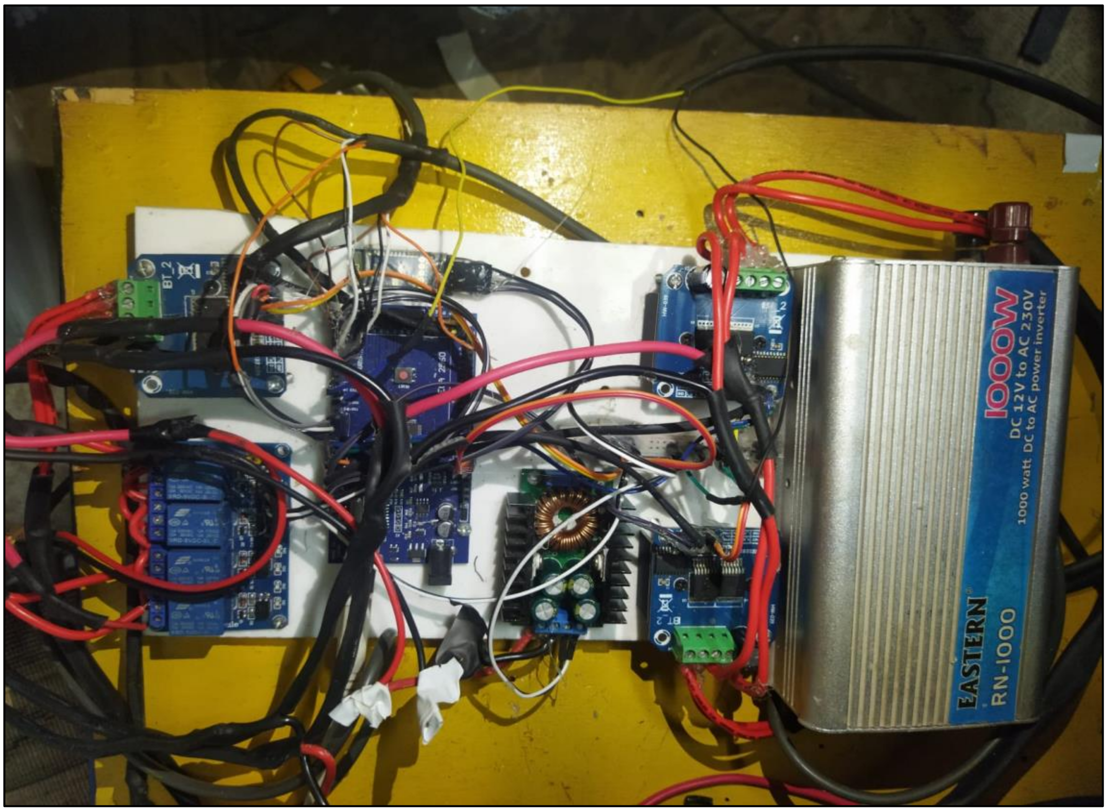

Figure 3.2 Circuit of Drive and Autonomous System

3.1.4. Structure of Poultry Bot Design and Dimensions

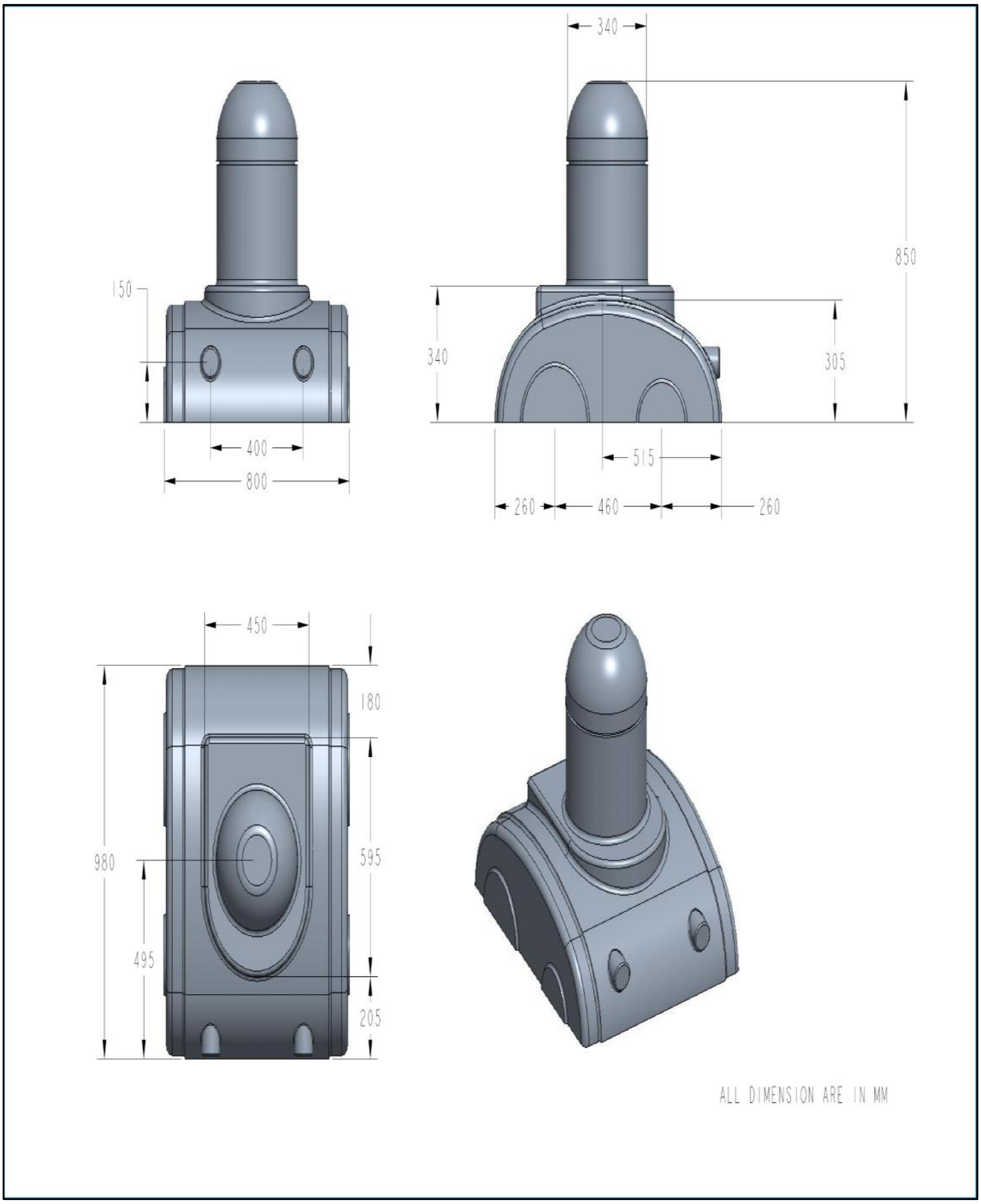

Figure 3.3 Structure of Poultry Bot Design and Dimensions

3.2. Details of Software Implementation

The main software implementation of this project is done using the navigation stack. The Navigation Stack is a system that enables autonomous

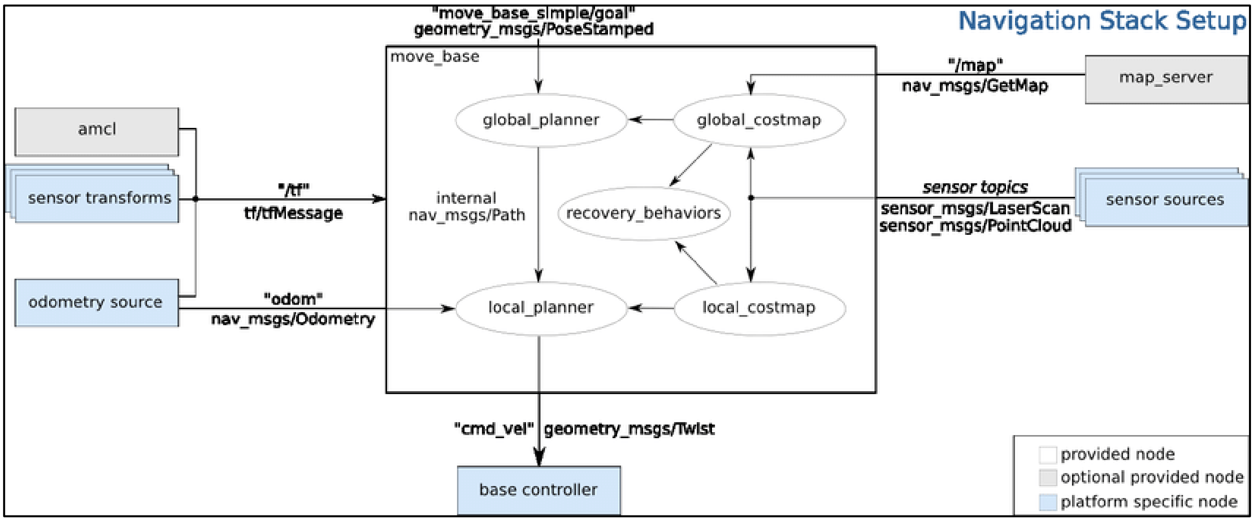

Figure 3.4 Navigation Stack Setup

robot navigation by taking in odometry and sensor data to generate velocity commands. However, setting it up on a specific robot requires running ROS, having a transform tree, and publishing sensor data correctly. Additionally, customization is needed to adapt the stack to the robot's physical attributes. The manual provided offers guidance on the setup and configuration process, making it easier for developers to implement the Navigation Stack effectively.

The navigation stack assumes that the robot is configured in a particular manner in order to run. The diagram above shows an overview of this configuration. The white components are required components that are already implemented, the gray components are optional components that are already implemented, and the blue components must be created for each robot platform. Navigation stack uses information from sensors to avoid obstacles in the world, it assumes that these sensors are publishing messages over ROS.

The navigation stack uses tf to determine the robot's location in the world and relate sensor data to a static map. However, tf does not provide any information about the velocity of the robot. Because of this, the navigation stack requires that any odometry source publish both a transform and a nav_msgs/Odometry message over ROS that contains velocity information.

3.2.1 RQT Graph

RQT graph is a graphical user interface (GUI) plugin in the RQT tool suite used to visualize the ROS graph of the POULTRY BOT. It provides a convenient way to view all the running nodes and their communication within the ROS network. The graph representation shows the nodes and topics organized by their namespaces, making it easier to understand the relationships and interactions between different components of the robot's software architecture. By using the RQT graph, users can gain valuable insights into the overall structure and communication flow of the POULTRY BOT's ROS-based system in a single window.

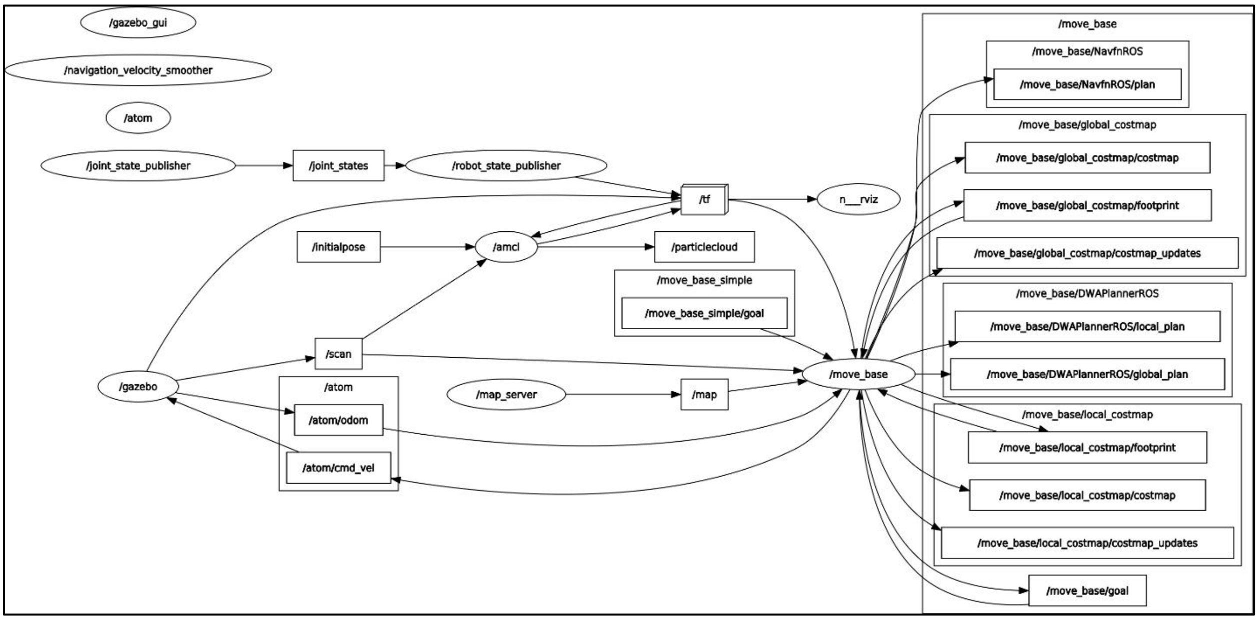

Figure 3.5 RQT Graph

The computation in ROS is done using a network of processes called ROS nodes. This computation network can be called the computation graph. The main concepts in the computation graph are ROS Nodes, Master, Parameter server, Messages, Topics, Services, and Bags. Each concept in the graph is contributed to this graph in different ways.

3.2.2 ROS Meter

ROS Master is much like a DNS server. When any node starts in the ROS system, it will start looking for ROS Master and register the name of the node in it. So, ROS Master has the details of all nodes currently running on the ROS system. When any details of the nodes change, it will generate a call-back and update with the latest details. These node details are useful for connecting with each node.

3.2.3 ROS Nodes

ROS nodes are a process that performs computation using ROS client libraries such as roscpp and rospy. One node can communicate with other nodes using ROS Topics, Services, and Parameters.

A robot contains many nodes, for example, one node processes Lidar maps, one node handles serial data from the robot, one node can be used to compute odometry, and so on. Using nodes can make the system fault tolerant. Even if a node crashes, an entire robot system can still work. Nodes also reduce complexity and increase debug-ability compared to monolithic codes because each node is handling only a single function.

3.2.4 ROS Messages

ROS nodes communicate with each other by publishing messages to a topic. As we discussed earlier, messages are a simple data structure containing field types. The ROS message supports standard primitive data types and arrays of primitive types.

Nodes can also exchange information using service calls. Services are also messages; the service message definitions are defined inside the srv file.

3.2.4.1 ROS Topics

ROS topics are named buses in which ROS nodes exchange messages. Topics can anonymously publish and subscribe, which means that the production of messages is decoupled from the consumption. The ROS nodes are not interested in knowing which node is publishing the topic or subscribing topics, it only looks for the topic name and whether the message types of publishers and subscribers match.

The communication using topics is unidirectional, if we want to implement request/response such as communication, we must switch to ROS services.

The ROS nodes communicate with topics using TCP/IP-based transport known as TCPROS. This method is the default transport method used in ROS. Another type of communication is UDPROS, which has low-latency, loose transport, and is only suited for teleoperation.

3.2.4.2 ROS Services

When we need a request/response kind of communication in ROS, we must use the ROS services. ROS topics can't do this kind of communication because it is unidirectional. ROS services are mainly used in a distribution system.

The ROS services are defined using a pair of messages. We have to define a request datatype and a response datatype in a srv file. The srv files are kept in a srv folder inside a package.

In ROS services, one node acts as a ROS server in which the service client can request the service from the server. If the server completes the service routine, it will send the results to the service client.

CHAPTER # 04

PROJECT CHARACTERIZATION

4.1. Result Obtained

In an autonomous robot the mapping and path planning is quite important and following are the results of the simulation while mapping and path planning using Gazebo and RViz.

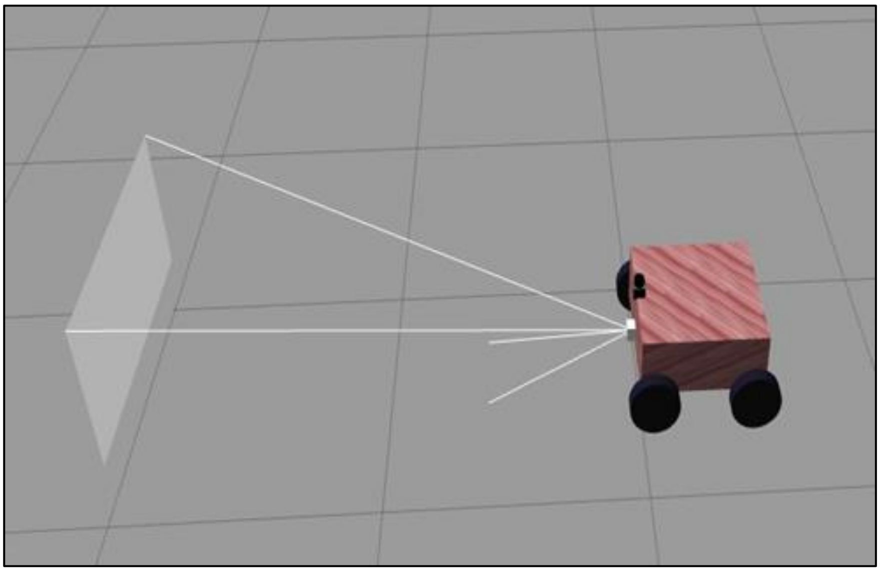

Figure 4.1 Gazebo Simulation of Mobile Robot

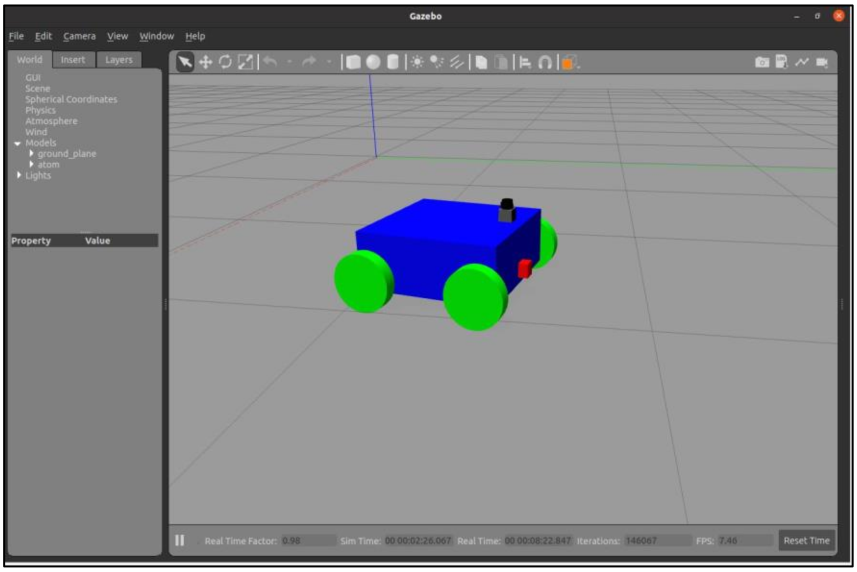

Figure 4.2 (Unified Robotics Description Format)
URDF of Mobile Robot

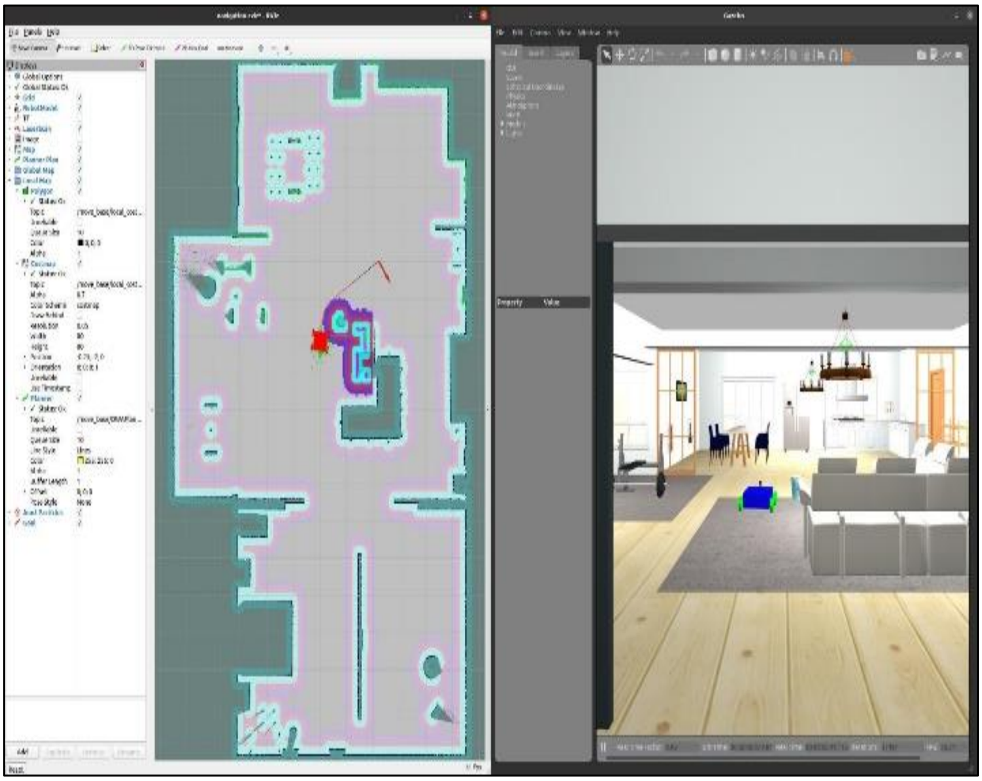

Figure 4.3 Gazebo Simulation As Well As RViz

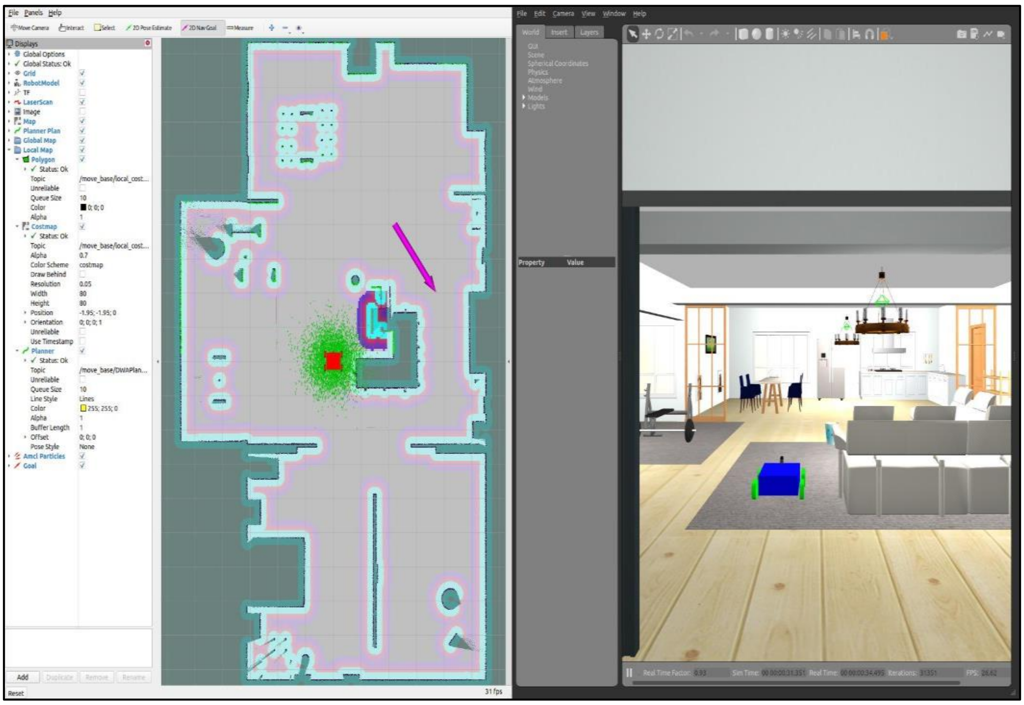

Figure 4.4 Moments of Autonomous Robot by Using Check Points

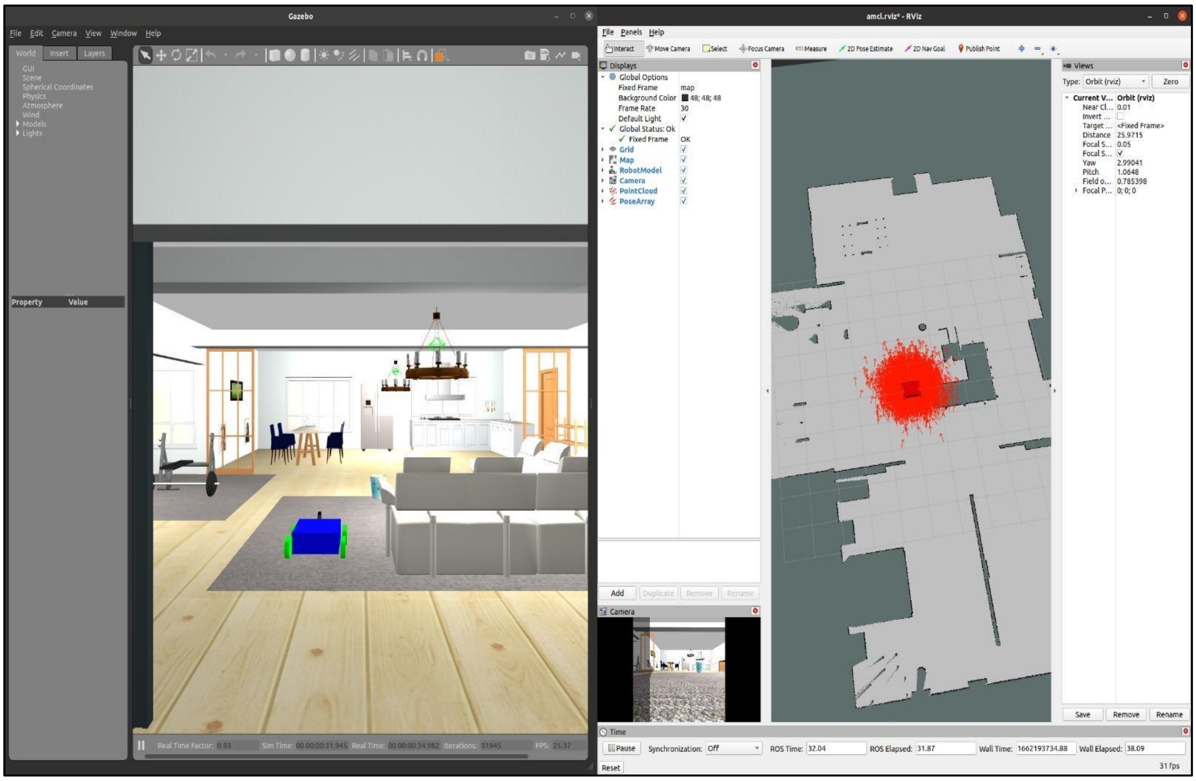

Figure 4.5 Robot Emulating Live Positioning on RViz

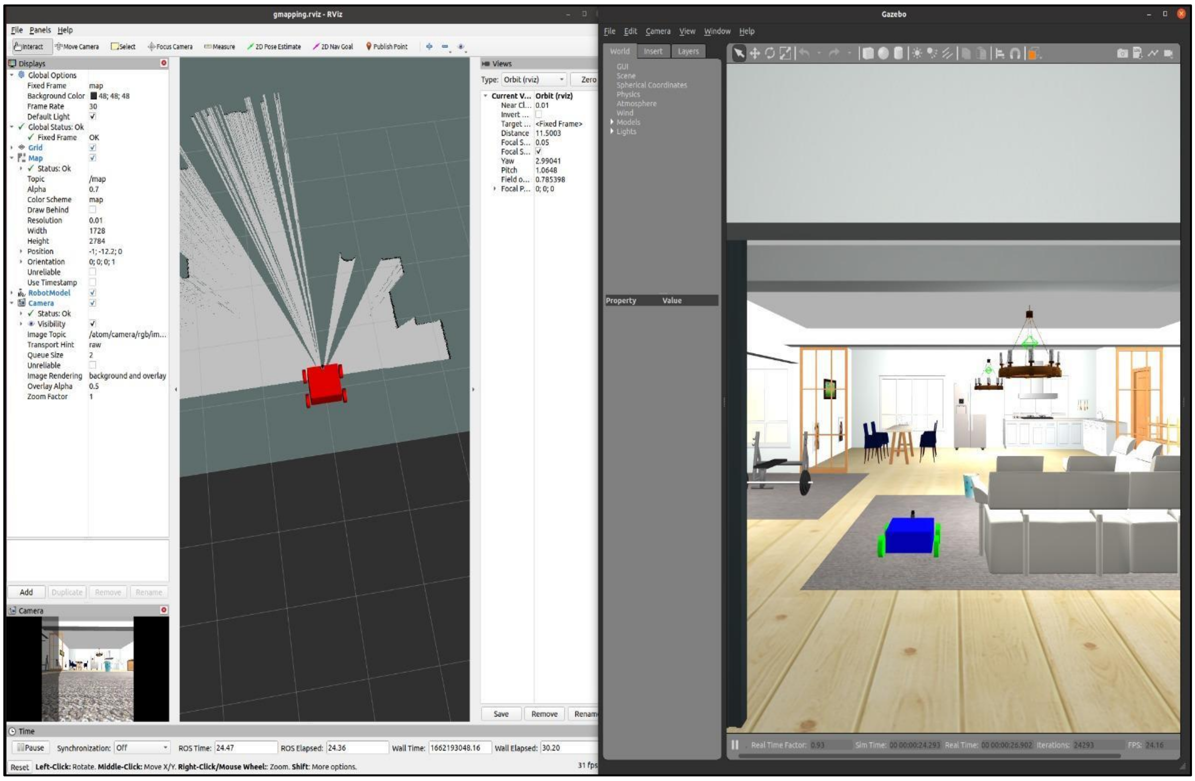

Figure 4.6 Mapping the Environment on Gazebo as Well as Showing on RViz

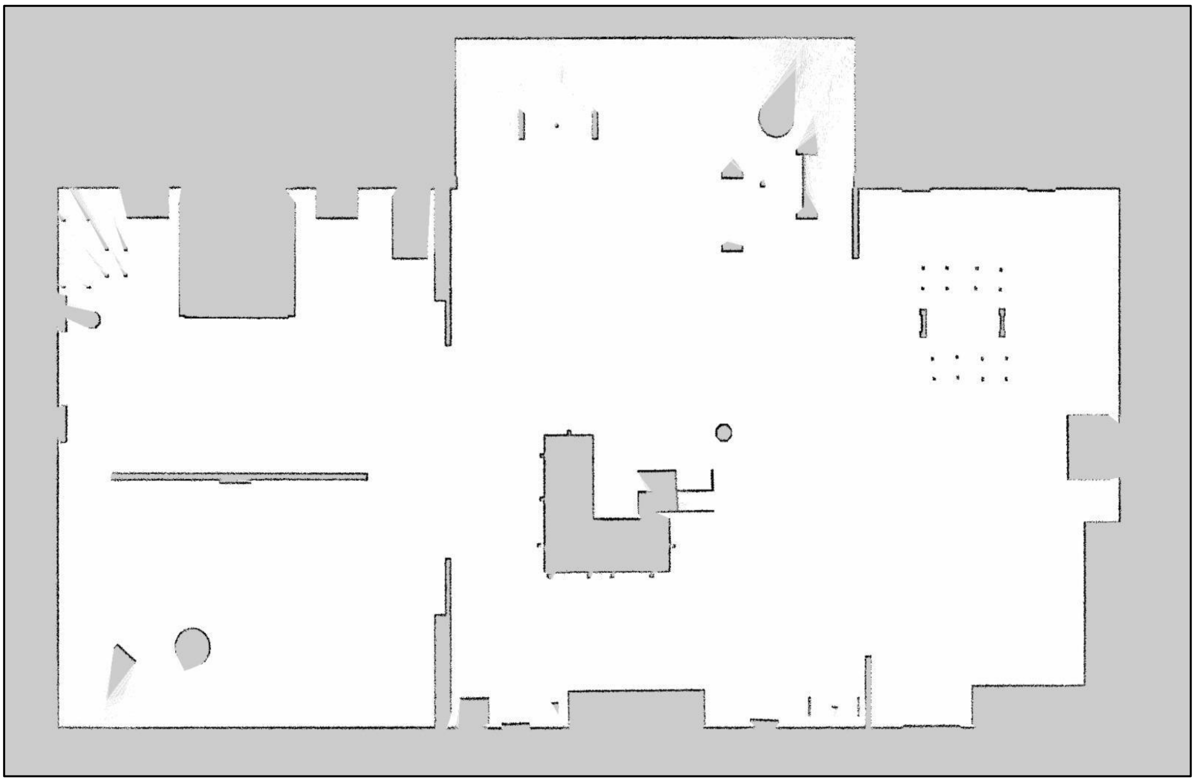

Figure 4.7 Final Map has been Generated Using G-Maps Packages

4.2. Analysis

By the results obtained it is evident that proper formation of maps is necessary for smooth autonomous movement. Furthermore, the communication between the autonomous and driving system must be efficient so the position of the robot could be transmitted and updated continuously to mini-pc.

4.3. Conclusion

A poultry bot performs an inspection in the shed, from litter racking to temperature monitoring, to assist the farmer in caring for their flock. Implementing this technology will improve the quality of poultry and aid in achieving better results. The self-driving and self-controlling robot will reduce reliance on humans, resulting in increased production.

4.4. Future recommendations

This project can be further improved by embracing AI and data-driven systems and enhancing disease control measures.

- Embrace AI and Data-Driven Systems: Emphasize the integration of highly adaptive artificial intelligence and data-driven systems in broiler and breeder production. These technologies can optimize operations, improve decision-making, and enhance overall efficiency.

- Enhance Disease Control Measures: Develop advanced disease detection and prevention strategies using AI-driven systems. Implement real-time monitoring and early warning systems to identify and control

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APPENDIX A: (Complex Engineering Problem)

Appendix A1: Range of resources

Table A1.1 Range of Resources

Human Resource			
S.No.	Discipline	Resource	Description
1	Mechanical	Welder	Helped in constructing the mechanical structure of the project.
2	Mechanical	Lathe Operator	Helped in coupling of motors and wheels.
3	Mechanical	Fiber glass manufacturer	Helped in the design and molding of the body of the robot.
Material/Equipment			
S.No.	Discipline	Resource	Description
1	Engineering Hardware	● E-Tech Saddar ● Sher Shah Market ● Step Electronics	To purchase the electrical components and wheels used in our project.
Reference Literature			
S.No.	Discipline	Resource	Description
1	Engineering	Articles / Books / Research Papers	Literature that provides sufficient information necessary to understand the working of human brain and emerging signals[6]–[10].

Appendix A2: Innovation

This project is an innovation as it automates the poultry farm industry and revolutionizes the way poultry farming is conducted. The poultry farm industry now is based on year old practices and due to this productivity and biosecurity welfare are affected. To overcome this issue, the poultry bot automates the general process of poultry farming and reduces human interaction. The process is automated by the autonomous patrolling of the robot which reduces human interaction. Furthermore, it provides IoT monitoring, automatic spray and litter raking systems which ensures the biosecurity in the poultry farm.

Appendix A3: Level of interaction

Being an electrical engineer, the problem occurred while creating a mechanical design for the structure as there were two major issues. The first issue was the balancing of the structure and the other issue was the wheel alignment. To overcome this issue wheels were changed, castor wheels were included and with the help of the welder balancing of the structure was ensured.

The other problem occurred during the use of an incremental rotary encoder which was used to determine the position of the robot but the issue faced was due to inaccurate readings of the encoder. This problem was solved by calibrating the readings of the encoder.

Appendix A4: Consequences to society and the environment

This project is built as an environment friendly project obeying the SDG goals of the UN (8,9 and 12). The sole purpose of this project is to improve the biosecurity and production of the poultry farm. By this project the human interaction and effort is reduced which is beneficial for the environment.

Appendix A5: Familiarity

The courses that we studied helped us significantly throughout the entire project.

The study of microprocessor-based systems helped us to initiate our project toward the Arduino Mega. Theories learned from the course electrical machines helped in selecting motors and successfully performing their operations. The concepts of embedded systems assist us in IoT, that heavily relies on embedded systems to function effectively. The Concept of Engineering Drawing Design 3D Structure in AutoCAD.

Finally, the skills learned from workshop practice helped us in proper wiring, soldering, and mainly fabricating PCB.

APPENDIX B: PLAGIARISM REPORT

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