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FINAL YEAR PROJECT REPORT

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POULTRY BOT: MONITORING SYSTEM

By

Ammar Bin Amir	19B-004-EE
Maaz Siddiqui	19B-008-EE
Osama Bin Khalid Raza	17B-051-EE
Muhammad Qasim Umer Qureshi	19B-062-CE

Supervised by

Dr. Abid Karim (Professor)

ST-13, Block 7, Gulshan-e-Iqbal, Abul Hasan Isphahani Road, Opposite Safari Park, P.O. Box 75300, Karachi, Pakistan. Phone: 34978274-5; 34994305; 34982476; http://www.uit.edu

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.

Student Name (Student ID):	Ammar Bin Amir (19B-004-EE)
Signature:	___________________________
Student Name (Student ID):	Maaz Siddiqui (19B-008-EE)
Signature:	___________________________
Student Name (Student ID):	Osama Bin Khalid Raza (17B-051-EE)
Signature:	___________________________
Student Name (Student ID):	Muhammad Qasim Umer Qureshi (19B-062-CE)
Signature:	___________________________
Date:	___________________________

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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 raking. As these tasks contain limited complexity and variation, they are fulfilled using motors and simple control logic. The properly running poultry shed still requires good stockmanship with intensive monitoring and awareness of animal behavior and interactions as well as proper management and conscientious 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 a 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 the technology of LIDAR which is adopted to make the bot move precisely in the field area. Disinfectant and anti-bacterial, which cannot be ignored when it comes to poultry care, are also integrated that will follow the user-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 Objectives

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 Raking 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-raking 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 a few units. To get a better understanding of the project block diagrams have been created.

Figure 2.1 General Block Diagram

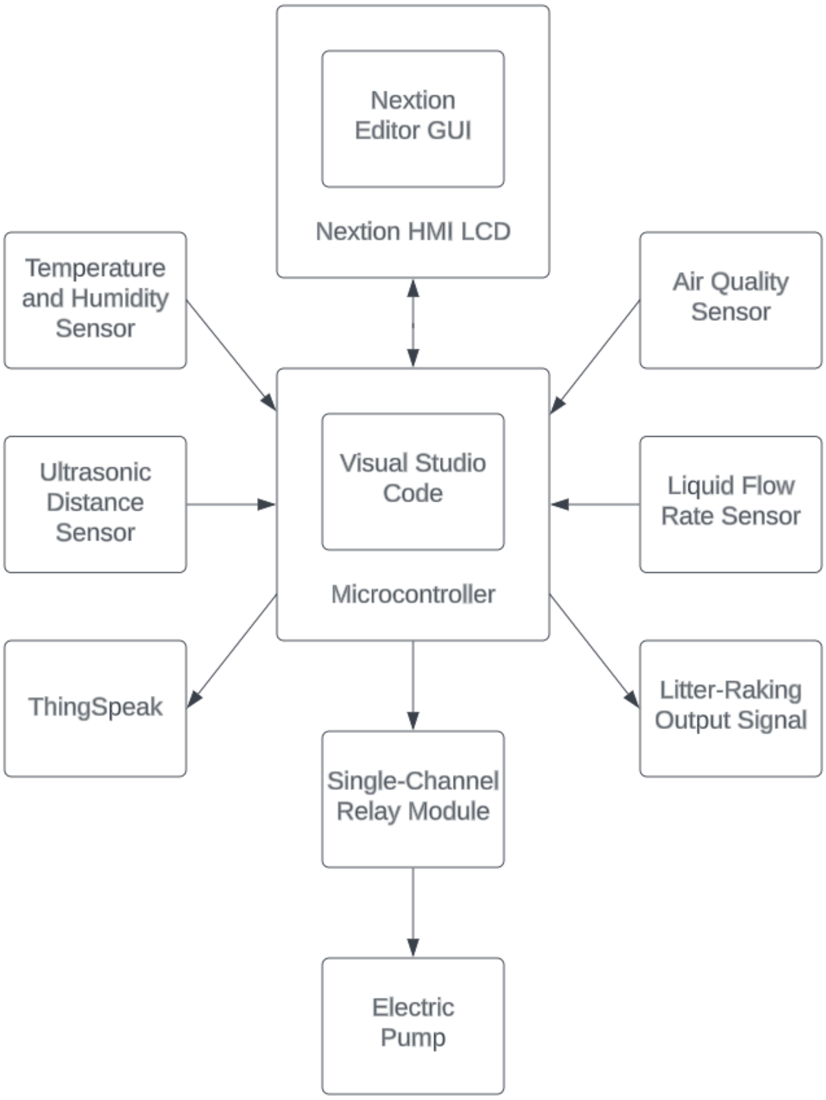

Figure 2.2 Block Diagram of Processing Unit

Figure 2.3 Block Diagram of Power Supply Unit

Figure 2.4 Block Diagram of Live-Streaming Unit

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

2.1.1. Microntroller

A microcontroller is a compact integrated circuit that contains a processor core, memory, and peripherals, designed for embedded systems and control applications. It serves as the brain of small-scale devices, managing their operations and executing tasks based on pre-programmed instructions. ESP32 DevKit Module is used as a microcontroller in this project.

The ESP32 DevKit module is a versatile and powerful development board based on the ESP32 microcontroller. It features a dual-core 32-bit processor running at up to 240 MHz, equipped with Wi-Fi and Bluetooth connectivity, making it ideal for Internet of Things (IoT) projects. The module offers a wide range of peripherals, including GPIO pins, UART, SPI, I2C, ADC, and PWM, providing flexibility for various applications. With ample memory resources and built-in security features, it enables the efficient development of connected devices and applications. Its compact form factor, cost-effectiveness, and extensive software support through the Espressif IoT

Development Framework (ESP-IDF) and Arduino IDE make the ESP32 DevKit a popular choice for IoT prototyping and development. The ESP32 DevKit module operates at a voltage range of typically 3.3V to 3.6V, making it compatible with various power supply sources. In terms of current specifications, the ESP32 DevKit module typically consumes around 80mA to 260mA during normal operation, depending on the tasks and functionalities enabled.

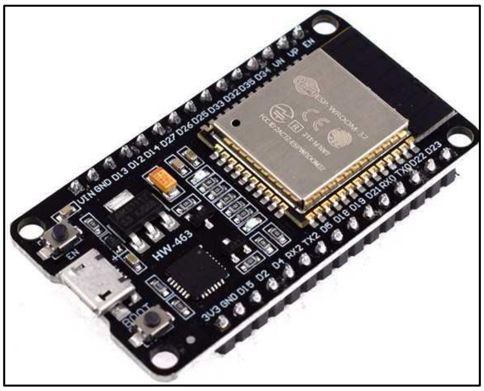

Figure 2.5 Microcontroller: ESP32 Devkit Module

2.1.2. Temperature and Humidity Sensor

Temperature is a measure of the average kinetic energy of the particles in a substance. It determines the hotness or coldness of an object and is measured using the Celsius, Fahrenheit, or Kelvin scale.

Humidity is a measure of the amount of water vapor present in the air. It indicates how saturated the air is with water vapor at a specific temperature.

The DHT22 is a digital temperature and humidity sensor designed to accurately measure ambient temperature and relative humidity in a wide range of applications. It features a single-wire communication interface, making it easy to integrate with microcontrollers and other devices. The sensor boasts a temperature measurement range of -40°C to 80°C with an accuracy of ±0.5°C and a humidity measurement range of 0% to 100% with an accuracy of ±2%. Its low power consumption and quick response time make it suitable for various projects such as weather monitoring systems, home automation, and industrial applications where reliable temperature and humidity data are essential. The DHT22 temperature and humidity sensor operates within a voltage range of 3.3V to 5.5V, making it compatible with most microcontrollers and embedded systems. When powered, the DHT22 consumes an average current of around 2.5mA during normal operation.

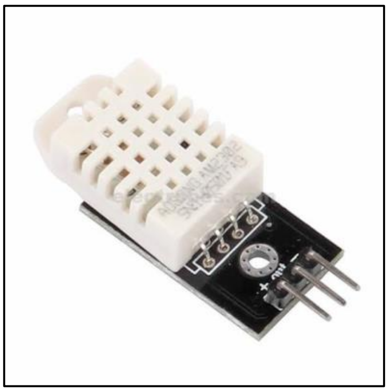

Figure 2.6 Temperature and Humidity Sensor: DHT22

2.1.3. Air Quality Sensor

Air quality refers to the cleanliness and healthiness of the air we breathe, determined by the concentration of pollutants and particulate matter in the atmosphere, which can impact human health and the environment. Factors such as emissions from vehicles, industrial activities, and natural sources contribute to air quality levels.

The MQ135 is a gas sensor module used to detect a wide range of harmful gases in the atmosphere, including ammonia, nitrogen oxides, benzene, and other volatile organic compounds. It operates on the principle of chemiresistance, where the resistance of the sensing material changes when it comes into contact with specific gases, thus allowing the sensor to measure gas concentrations. The MQ135 is commonly utilized in various applications, such as air quality monitoring devices, indoor air quality assessments, and gas leak detection systems, due to its sensitivity and cost-effectiveness, making it a popular choice for environmental monitoring and safety purposes. It typically operates at a voltage of 5V DC and consumes a low current, usually around 150mA, making it suitable for use with microcontrollers like Arduino and ESP32.

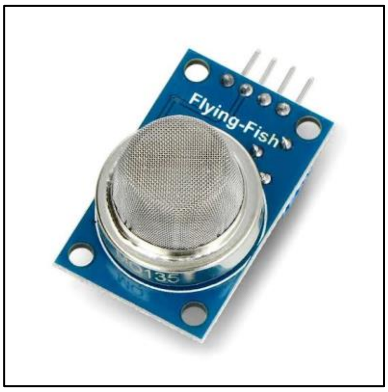

Figure 2.7 Air Quality Sensor: MQ135

2.1.4. Ultrasonic Distance Sensor

Ultrasonic distance refers to measuring the distance to an object by emitting high-frequency sound waves and calculating the time it takes for the waves to bounce back after hitting the object.

The HC-SR04 is an ultrasonic sensor module widely used for distance measurement in various applications. It operates by emitting ultrasonic sound waves and measuring the time it takes for the waves to bounce back after hitting an object. The module consists of two main components: a transmitter and a receiver. The transmitter sends out ultrasonic pulses, and the receiver detects the echoes. By calculating the time difference between sending and receiving signals and knowing the speed of sound in the air, the module can determine the distance to the object. It typically has a measurement range of 2cm to 400cm and features four pins: VCC for power supply (5V), GND for ground connection, TRIG for trigger signal input, and ECHO for echo signal output. This simple yet effective design makes the HC-SR04 popular for distance sensing in robotics, automation, and other projects. The HC-SR04 ultrasonic sensor operates at a voltage range of 5V DC, making it compatible with most microcontrollers and Arduino boards. The sensor's operating current typically ranges from 2mA to 15mA during active mode, depending on the duration and frequency of measurements.

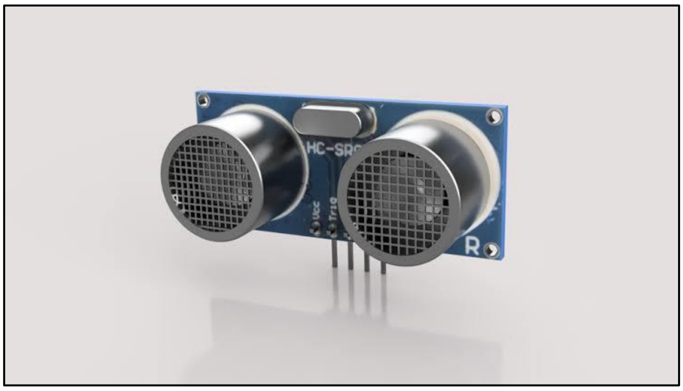

Figure 2.8 Ultrasonic Distance Sensor: HC-SR04

2.1.5. Liquid Flow Rate Sensor

Liquid flow rate refers to the volume of liquid passing through a point per unit of time, typically measured in liters per minute or gallons per hour.

The YF-S201 is a liquid flow sensor module widely used in various applications to measure the flow rate of liquids. Its specification includes a compact design, featuring a small and lightweight body for easy integration into different systems. The sensor utilizes a hall effect sensor to detect the flow of liquids, making it highly reliable and accurate. It operates within a wide flow rate range, typically from 0.3 to 6 liters per minute, and is compatible with various liquids, including water and other non-corrosive liquids. The YF-S201 is equipped with a pulse output that provides a frequency signal corresponding to the flow rate, making it convenient for interfacing with microcontrollers and other electronic devices. The voltage specifications for the YF-S201 typically range from 5V to 24V DC, making it compatible with various microcontrollers and systems. The YF-S201 water flow sensor has a low current consumption, typically in the range of a few milliamperes during operation, having a maximum working current of up to 15mA.

Figure 2.9 Liquid Flow Rate Sensor: YF-S201

2.1.6. Single-Channel Relay Module

A relay is an electrically operated switch that uses an electromagnet to control the flow of current in a circuit. It allows low-power signals to control higher power loads, making it essential in various electronic and electrical applications.

The single-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. It is equipped with screw terminals for easy connection of external devices and has an LED indicator to show the relay's status. This versatile and compact module is commonly used in various automation, robotics, and home automation projects where the control of high-power devices is required. The relay module typically operates with a coil voltage of 5V or 12V, depending on the specific variant. The maximum switching voltage can range from 110V to 250V AC or up to 30V DC, and the maximum switching current varies between 10A to 30A.

Figure 2.10 Single-Channel Relay Module: HW-307B

2.1.7. Electric Pump

An electric pump is a device that uses electrical energy to create mechanical motion, enabling the transfer of fluids such as water or air. It operates by converting electrical power into kinetic energy, generating flow or pressure within the fluid system.

The device operates at a voltage of 12 volts with a nominal range of 9 to 14 volts, indicating that it can handle fluctuations within this range. The device draws a current of 3.5 amps, which represents the amount of electrical charge passing through it per unit of time. Additionally, the device has a flow rate of 5.0 liters per minute (LPM), which refers to the volume of fluid it can handle or transfer in a minute. Moreover, it can generate a pressure of 125 pounds per square inch (PSI) or 7.0 bar, signifying its ability to maintain or sustain a specific pressure level.

Figure 2.11 12V DC Electric Pump

2.1.8. Structure of Spraying Unit

Spraying unit is basically the complete system where all the monitoring and controlling is done related to liquid. It contains 19L water bottle, 8-hole agricultural nozzle and 1 inch HDPE (High Density Polyethylene) water pipes along with ultrasonic distance sensor and liquid flow rate sensor.

2.1.8.1. Liquid Storage Tank

A 19-liter spraying unit is a portable piece of equipment used for spraying liquids in various applications. It consists of a 19-liter capacity tank that can hold liquids such as water, pesticides, herbicides, or fertilizers.

Figure 2.12 Liquid Storage Tank: 19 Liter Water Bottle

2.1.8.2. Water Pipe

A 1-inch HDPE water pipe is a durable and versatile pipe used for transporting potable water in various applications. HDPE stands for high-density polyethylene, a thermoplastic material known for its excellent strength, flexibility, and resistance to corrosion and chemicals. HDPE water pipes are lightweight, easy to handle, and can withstand harsh environmental conditions, making them a reliable choice for long-term water distribution systems.

Figure 2.13 Water Pipe: 1 Inch HDPE Pipe

2.1.8.3. Spray Nozzle

An 8-hole agriculture spray nozzle is a specialized component used in agricultural irrigation systems for the controlled dispersion of water or fertilizers onto crops. This nozzle features eight small holes or orifices through which the liquid is released in the form of fine droplets. The multi-hole design ensures uniform coverage across the crop area, promoting even distribution of water and nutrients. By creating a mist-like spray pattern, minimizes water wastage and optimizes the efficiency of irrigation.

Figure 2.14 Spray Nozzle: 8-Hole Agricultural Spray Nozzle

2.1.9. Nextion HMI LCD

HMI LCD stands for Human-Machine Interface Liquid Crystal Display. It is a type of display technology used to visually interact with and control machines or systems through a user-friendly interface.

The HMI LCD NX4832T035 is a human-machine interface (HMI) display module designed for industrial applications. It features a 3.5-inch TFT LCD screen with a resolution of 480x320 pixels, providing clear and vibrant visual output. The module is equipped with a resistive touchscreen for intuitive user interaction, enabling precise input and control. The HMI supports multiple communication protocols, facilitating seamless integration with various industrial devices and systems. With a robust design and wide operating temperature range, it ensures reliable performance in harsh environments. The

NX4832T035 is an efficient and user-friendly HMI solution, ideal for enhancing human-machine interaction in industrial automation and control processes. The module operates at a voltage range of 4.5V to 7V and consumes a low current of up to 145mA and 15mA when in sleep mode.

Figure 2.15 Nextion HMI LCD: NX4832T035

2.1.10. Camera Module

A camera module is a compact imaging device integrated into electronic devices, capturing visual information by converting light into electronic signals for storage or display purposes.

The ESP32-CAM is a versatile and compact development module featuring the ESP32-S chip, designed for implementing various Internet of Things (IoT) and camera applications. It comes equipped with a high-performance 32-bit dual-core processor running at up to 240MHz, integrated Wi-Fi, and Bluetooth connectivity, which allows seamless communication with other devices and the internet. The module incorporates an OV2640 camera sensor capable of capturing images up to 2 megapixels and streaming video at resolutions up to 1600x1200. Additionally, it supports various communication interfaces like UART, I2C, SPI, and PWM, offering flexibility for connecting external sensors and peripherals. The ESP32-CAM can be programmed and configured using Arduino IDE and its GPIO pins allow for easy integration into different projects, making it an ideal choice for IoT applications, home automation, surveillance systems, and more. It operates with a recommended voltage supply of 5V and can handle a typical current consumption of around 800mA during peak operations, such as capturing images or streaming video.

Figure 2.16 Camera Module: ESP32-CAM

2.1.11. Printed Circuit Board (PCB)

PCB stands for "Printed Circuit Board," it is a flat board made of insulating material with printed copper traces that connect electronic components, enabling the assembly and functioning of electronic circuits.

A Printed Circuit Board (PCB) is a crucial component in modern electronics, serving as a physical platform to support and connect various electronic components. The PCB's specifications encompass several essential aspects: its dimensions, number of layers, material composition (typically fiberglass-reinforced epoxy), copper thickness, and trace width. Additionally, the specification details the layout of components, vias, and interconnects, ensuring proper signal flow and electrical integrity. The PCB's design may include specific features such as surface mount technology (SMT) pads or through-hole connections, depending on the application's requirements. The overall aim is to create an optimized, reliable, and efficient electrical pathway that enables the seamless functioning of the electronic device it's integrated into.

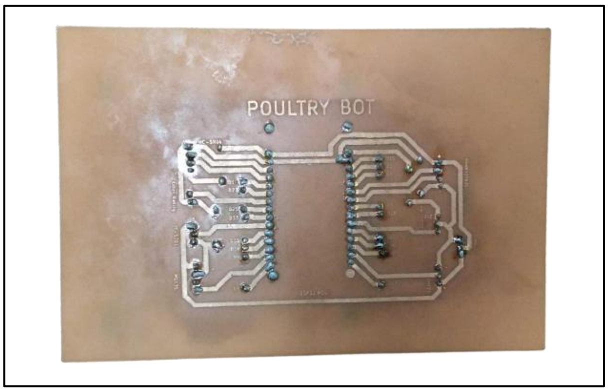

Figure 2.17 Printed Circuit Board (PCB)

2.1.12. Battery Pack

A battery pack is a collection of individual batteries connected to store electrical energy efficiently and provide a portable power source for various devices and applications. It allows for convenient recharging and discharging of stored energy as needed.

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, four sets of these series-connected cells are arranged in parallel to enhance the total capacity, providing a combined capacity of, 16400mAh (or 16.4Ah) 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 operation for various applications.

Figure 2.18 Battery Pack: Li-Ion 12V 3S4P

2.1.13. Battery Management System (BMS)

BMS stands for "Battery Management System." It is an electronic control unit that monitors and optimizes the performance of rechargeable batteries, ensuring their safe and efficient operation in various applications like electric vehicles and renewable energy systems.

The HX-3S-FL25A-A is a lithium battery protection board designed for 3-series (3S) Li-ion battery packs. It provides essential protection features to ensure the safe and efficient operation of the battery pack. The board supports a maximum continuous discharge current of 25A, making it suitable for various applications requiring high-power output. Equipped with overcharge, over-discharge, overcurrent, and short-circuit protection, the HX-3S-FL25A-A safeguards the battery cells against potential risks, extending their lifespan and enhancing safety. Its compact design and easy integration make it an ideal choice for DIY projects, robotics, electric vehicles, and other battery-powered devices.

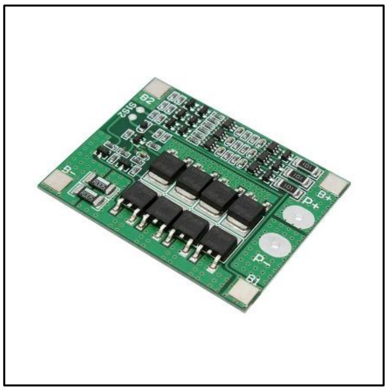

Figure 2.19 Battery Management System (BMS): HX-3S-FL25A-A

2.1.14. 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.

XL-4016 is a high-performance step-down buck converter integrated circuit (IC) designed to efficiently regulate voltage levels in power supply applications. Operating with a wide input voltage range, typically from 4V to 40V, it can deliver a continuous output current of up to 8A. The IC utilizes pulse width modulation (PWM) technology to achieve a high conversion efficiency, minimizing power losses and maximizing power conversion. Its output voltage can be easily adjusted through an external resistor, making it versatile for various electronic devices and projects. The XL-4016 features built-in protection mechanisms such as overcurrent, over-temperature, and short-circuit protection, ensuring safe and reliable operation in diverse applications, including battery chargers, LED drivers, and embedded systems.

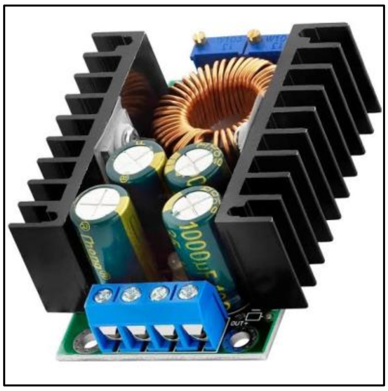

Figure 2.20 Buck Converter: XL4016

2.1.15. Battery Level Indicator

A battery level indicator shows the remaining charge of a battery, typically displayed as a percentage or a visual representation of bars.

The MH-DL 18S battery level indicator is a device used to monitor and display the charge status of a battery. The specification includes a compact and user-friendly design, featuring a digital LED display that shows the battery's remaining capacity in percentage or voltage units. It is equipped with intuitive controls for easy operation and can be easily attached to the battery pack with a secure mounting mechanism. Additionally, the MHDL 18s indicator offers multiple levels of accuracy, providing precise and reliable information about the battery's power level, helping users efficiently manage their power resources, and ensure uninterrupted operation in various applications and environments.

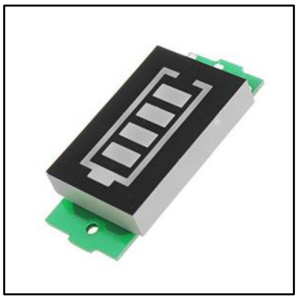

Figure 2.21 Battery Level Indicator: MH-DL 18S

2.2. Software Detail

The software used in this project are as follows:

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. Overall, the Arduino IDE serves as an essential and versatile platform for unleashing creativity and innovation in the world of electronics and embedded systems.

Figure 2.22 Arduino IDE (Integrated Development Environment) Software

2.2.2. ThingSpeak

ThingSpeak is an internet of things (IoT) platform that enables users to collect, analyze, and visualize data from connected devices and sensors. It serves as a cloud-based data storage and processing system that allows developers and enthusiasts to easily capture real-time data, store it in channels, and access it through APIs. With its user-friendly interface, ThingSpeak offers various features such as data logging, data visualization, and the ability to trigger actions based on predefined conditions. Users can monitor and interact with their IoT devices remotely, making it an ideal solution for building smart applications and monitoring systems for a wide range of applications, including agriculture, home automation, industrial monitoring, and more.

Figure 2.23 ThingSpeak Software

2.2.3. Nextion Editor

The Nextion Editor is a powerful software tool used to design and develop graphical user interfaces (GUIs) for Nextion series intelligent display modules. It offers a user-friendly WYSIWYG (What You See Is What You Get) interface that allows designers and developers to create visually appealing touch-screen interfaces without the need for complex coding. The editor supports drag-and-drop functionality, making it easy to add buttons, text, images, and other interactive elements. With various pre-built components and customization options, designers can quickly prototype and implement their GUI designs. Additionally, the Nextion Editor enables seamless integration with microcontrollers, enabling efficient communication and control between the display and the external device. Overall, the Nextion

Editor streamlines the GUI development process, making it accessible for both beginners and experienced developers.

Figure 2.24 Nextion Editor Software

2.2.4. Visual Studio Code

Visual Studio Code (VS Code) is a highly popular, free, and lightweight integrated development environment (IDE) developed by Microsoft. It is designed to provide a versatile coding experience for developers across various platforms, including Windows, macOS, and Linux. With an extensive ecosystem of extensions, VS Code supports numerous programming languages and frameworks, making it adaptable to different development workflows. The editor offers an intuitive user interface, powerful code editing features like IntelliSense, code refactoring, and Git integration, facilitating seamless collaboration and version control. Its customizable layout, built-in terminal, and integrated debugging capabilities enhance productivity and streamline the development process. Combining performance, flexibility, and community-driven support, Visual Studio Code is an excellent choice for modern software development tasks.

Figure 2.25 Visual Studio Code Software

2.2.5. Ki-CAD

KiCad is an open-source Electronic Design Automation (EDA) software suite that facilitates the creation of schematics and printed circuit boards (PCBs). It offers a comprehensive set of tools, including schematic capture, PCB layout, and component footprint libraries, allowing engineers and hobbyists to design complex electronic circuits. KiCad supports various file formats, making it compatible with different industry standards, and it is available for Windows, macOS, and Linux operating systems. Its user-friendly interface, extensive community support, and continuous development make KiCad a popular choice for electronics enthusiasts seeking an accessible yet powerful solution for their PCB design needs.

Figure 2.26 Ki-CAD Software

2.2.6. MIT App Inventor

MIT App Inventor is a user-friendly and intuitive web-based platform developed by the Massachusetts Institute of Technology (MIT) that enables individuals, particularly those with little to no prior programming experience, to create mobile applications for Android devices. The platform utilizes a visual programming approach, allowing users to design apps by simply dragging and dropping components and blocks of code to define their functionality. It abstracts the complexities of traditional programming languages and empowers users to build interactive and functional apps through a simplified interface. By providing a vast array of pre-built components and integration with device sensors and functionalities, MIT App Inventor allows for rapid app development and fosters creativity among aspiring app creators, making it an excellent tool for educational and hobbyist purposes.

Figure 2.27 MIT App Inventor

CHAPTER # 03

PROJECT IMPLEMENTAION

3.1. Details of Hardware Implementation

The project is divided into a few units. To get a better understanding of the project implementation, a schematic has been given below.

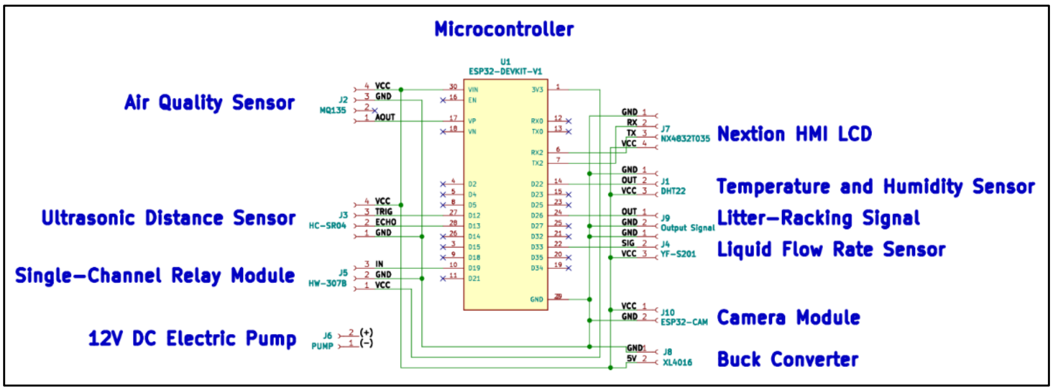

Figure 3.1 Circuit's Schematic Diagram

3.1.1. Processing Unit

The components used in the processing unit are ESP32 Devkit Module, DHT22, MQ135, HC-SR04, YF-S201, HW-307B, Electric Pump, and NX4832T035 in addition to an output pin for litter-raking.

3.1.1.1. Connections in Processing Unit

The DHT22 sensor has three pins; VCC, GND, and OUT pin (digital pin for communication). The VCC and GND pins are given 5V and GND from the power supply whereas the data pin is connected to the GPIO pin of ESP32 which is D22.

The MQ135 sensor has four pins; VCC, GND, AOUT (analog output), and DOUT (digital output). The VCC and GND are connected to the 5V and GND of the power supply, the AOUT pin is connected to the analog input pin of ESP32 which is ADC1_0 whereas the DOUT pin is not connected.

The HC-SR04 sensor also has four pins; VCC, GND, TRIG (trigger pin), and ECHO (echo pin). The VCC and GND are connected to the 5V and GND of the power supply, and TRIG and ECHO pins are connected to the GPIO pins of ESP32 which are D12 and D13, respectively.

The YF-S201 sensor typically has three pins; VCC, GND, and Signal pin (data output pin). The VCC and GND are given 5V and the GND of the power supply, where the signal pin is connected to the GPIO pin of ESP32 is D33.

The single-channel relay module consists of three pins; VCC, GND, and IN (signal input pin). Where the VCC and GND pins are provided 3.3V and GND of the ESP32 and the IN pin is connected to the GPIO pin of ESP32 which is D19.

The electric pump contains two wires that can be considered positive and negative with respect to a fixed clockwise direction. The pump and relay are interconnected. The positive end of the pump is connected to the (-) negative end of the 12V battery, the (+) positive end of the 12V battery is connected to the common (COM) terminal of the relay and the remaining negative end of the pump is connected to the normally open (NO) terminal of the relay.

There are two pins given in the circuit for the purpose to tell whether the litter-raking should be initiated or not. These pins are the output signal pin and GND pin that are connected to GPIO pin D26 of ESP32 and GND pin respectively.

Lastly, the NX4832T035 LCD contains four pins; VCC, GND, TX (transmitter pin), and RX (receiver pin). The VCC and GND pin are provided 5V and GND from the power supply. On the other hand, the remaining pins are connected to the ESP32 microcontroller through a UART (serial) communication interface namely TX2 and RX2 pins.

3.1.1.2. Working of Processing Unit

The DHT22 operates on capacitive humidity sensing and uses a thermistor for temperature measurement. Inside the sensor, a humidity-sensitive capacitor's dielectric properties change with varying humidity levels, leading to a variation in capacitance. The sensor also includes a temperature-sensitive resistor (thermistor) to measure the surrounding temperature. When exposed to the air, moisture is absorbed by the sensor's humidity-sensitive material, affecting the capacitance, while the thermistor's resistance changes with temperature. The sensor's internal microcontroller processes these analog signals, converting them into digital data representing humidity and temperature, which is then transmitted to ESP32.

The MQ135 sensor works on the principle of a chemiresistor, where its internal sensing material's electrical resistance changes when it comes into contact with the target gas. The presence of the gas leads to a variation in the resistance, and by measuring this change, the sensor can infer the concentration of the gas. The analog output of the sensor is directly proportional to the concentration of the detected gas, and calibration is essential to ensure accurate readings. This output is then sent to ESP32.

In the HC-SR04 sensor, the TRIG pin is an output from the ESP32 that sends a short pulse to trigger the sensor, and the ECHO pin is an input to the ESP32 that receives the echo signal back from the sensor. To measure the distance, the ESP32 sends a short pulse to the TRIG pin, which triggers the HC-SR04 to emit an ultrasonic sound wave. The sound wave travels through the air, hits the liquid present in the bottle, and bounces back. The ECHO pin then receives the reflected sound wave, and the ESP32 measures the time it took for the sound wave to travel back. Using the speed of sound and the time of flight, the ESP32 can calculate the distance to the object.

The YF-S201 flow sensor operates based on the Hall effect. Inside the sensor, there is a magnetic rotor that spins as water or fluid flows through the sensor. The rotor contains magnets, and as it spins, it generates pulses. The sensor has a Hall effect sensor to detect these pulses. The more pulses per unit of time, the higher the flow rate. By measuring the time between pulses, the flow rate of the liquid passing through the sensor can be calculated.

An HW-307B single-channel relay module is working as an electrically controlled switch that can be used to turn ON or OFF the electric pump using a low-power control signal. The relay consists of a coil and a switch. When a control signal from the ESP32 energizes the relay's coil, it creates a magnetic field, causing the switch to change position, and closing the circuit on its output terminals.

When the relay is activated (energized) through a control signal from a microcontroller or switch, it completes the circuit, allowing the pump to receive power and operate. A 12V DC electric pump is working by converting electrical energy from the 12V DC power supply into mechanical energy to pump fluids. The pump contains an impeller or diaphragm that creates a pressure difference, causing the fluid to be drawn into the pump and then expelled through the pump's outlet. The pump's operation is driven by an electric motor, which rotates the impeller or moves the diaphragm, depending on the pump's design.

The fluid is then transferred to both nozzles allowing them to spray the fluid in the form of mist or fog.

When the ammonia level reaches 25 ppm, the pin for litter-raking gets high indicating litter-raking should be enabled. The pin only gives two values that are high and low dependent on the ammonia level.

The ESP32 communicates with the Nextion display using serial communication, exchanging data and commands to control the display, update its content, and receive touch input. The ESP32 sends appropriate commands to the display to show text, images, buttons, and other graphical elements. When the user interacts with the touchscreen, the display sends touch data back to the ESP32, allowing the microcontroller to respond accordingly.

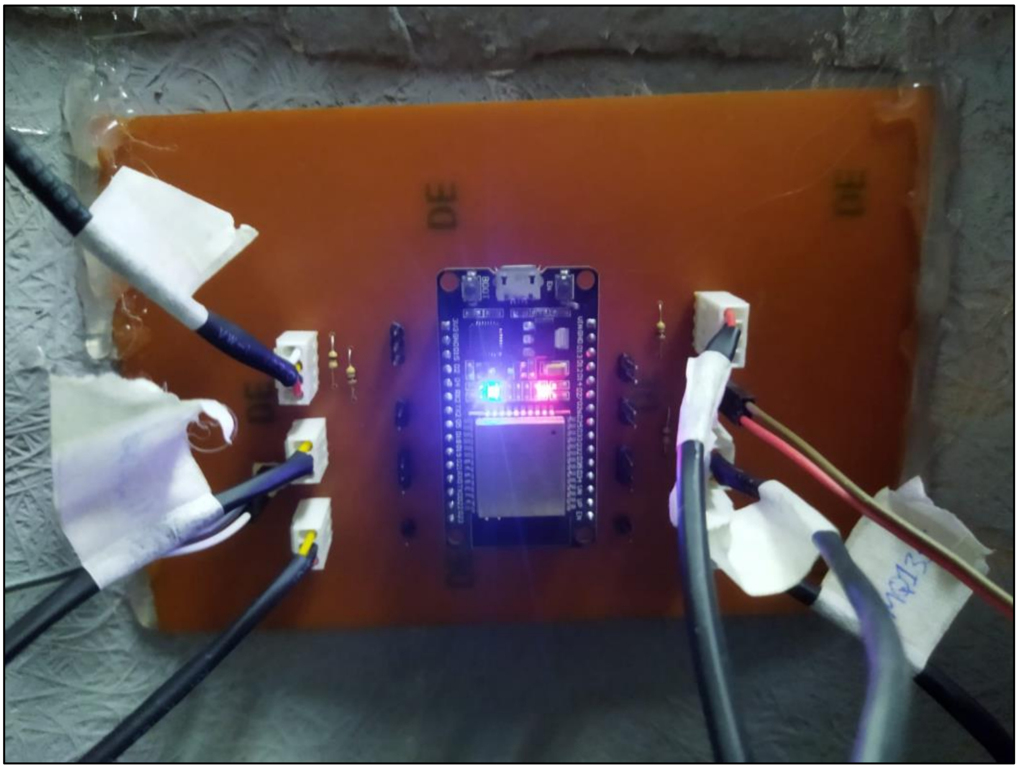

Figure 3.2 Complete Circuit of Processing Unit Integrated on the Fabricated PCB is Enabled

3.1.2. Power Supply Unit

The components used in the power supply unit are Li-Ion 3S4P Battery Pack, HX-3S-FL25A-A Protection Board, XL-4016 DC-DC Step-Down Converter, and 3S Battery Level Indicator.

3.1.2.1. Connections in Power Supply Unit

Li-ion 3S4P battery pack is created using 12 individual Murata VTC6A 21700 lithium-ion cells with matching capacities and voltage ratings. Three cells are connected in series to create 3S and for 4P, four groups of 3S are connected in parallel. All the cells are connected with nickel strips that are electrically welded on the terminals of cells. The entire battery pack is then balanced using a balanced charger that balanced each cell.

The HX-3S-FL25A-A protection board is connected to each cell in the battery pack to provide safety features and monitoring capabilities. It has six terminals; B-, B1, B2, B+, P+ and P-. The B- and B+ are battery negative and positive terminals that are connected to the 0V and 12V of the battery pack, respectively, where the B1 and B2 are the connection for each cell for 3S. The B1 is considered as 4V which is connected to the positive end of the cell whose negative end is connected to B- on the other hand, B2 is considered as 8V which is connected to the positive end of the cell whose negative end is connected to B1 making the B+ to be considered as 12V for the series connection of 3S battery pack. Only left with P+ and P- are power output connections as positive and negative terminals, respectively.

The XL4016, a high-performance step-down buck converter integrated circuit (IC), is connected to a Li-ion 3S4P battery pack by wiring the battery's positive terminal to the XL4016's input voltage pin and connecting the battery's negative terminal to the IC's ground pin. The buck converter's voltage is then stepped down to 5V using its potentiometer.

Lastly, the 3S battery level indicator is connected to a Li-ion 3S4P battery pack by tapping into the positive and negative terminals of the pack. Since it can connect batteries ranging from 1S to 8S therefore, the required 3S is enabled by shorting it with its own circuitry as provided.

3.1.2.2. Working of Power Supply Unit

The resulting battery pack delivers increased overall capacity and remains at a 12V output. When in use, the cells discharge in unison, and the parallel arrangement enhances the discharge current capability. In this configuration, the parallel connection increases the capacity, while the series connection boosts the voltage.

The protection board continuously monitors the voltage and current of each cell, cutting off the current flow in case of dangerous conditions, such as overcharging or discharging beyond safe limits, to prevent damage or thermal runaway. It ensures the safe and balanced operation of the Li-ion battery pack, enhancing its overall performance and lifespan.

The XL4016 regulates the input voltage (12V-5V) from the 3S Li-ion battery pack efficiently and delivers a continuous output current suitable for the connected load. By utilizing pulse width modulation (PWM) technology, the XL4016 achieves high conversion efficiency, minimizing power losses. The regulated voltage is then supplied to all the other components having 5V as the operating voltage.

The battery level indicator is designed to monitor the voltage of the entire 3S battery pack, as it is connected in parallel to the series-connected sets. By measuring the overall voltage, the indicator determines the charge level of the entire battery pack. It provides visual feedback, typically through LEDs, indicating the remaining charge and enabling users to assess the battery's status.

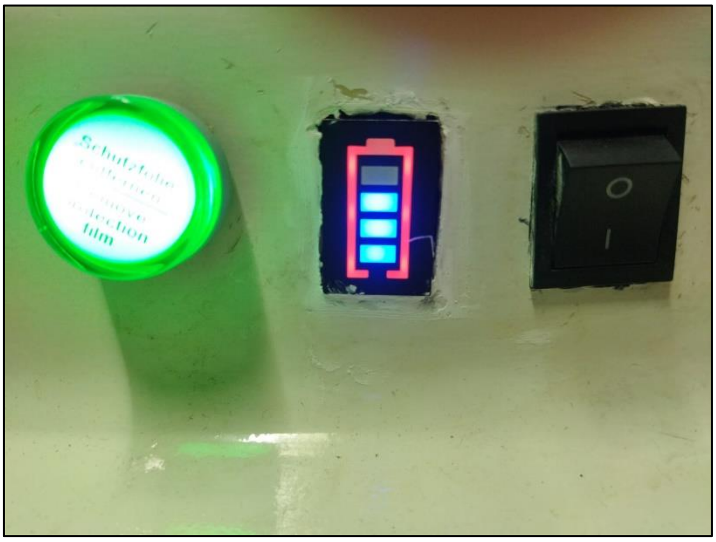

Figure 3.3 Indication of Power Supply Unit Controlled through Switch along with Battery Level Indicator Indicating 75% Charging Remaining

3.1.3. Live-Streaming Unit

The component used in the live-streaming unit is ESP32-CAM.

3.1.3.1. Connections in Live-Streaming Unit

The operating voltage of ESP32-CAM is 5V which is provided by the power supply.

3.1.3.2. Working in Live-Streaming Unit

The camera captures video frames and stores them in its memory. The ESP32 module, equipped with Wi-Fi capabilities, establishes a connection to a network, allowing users to access the camera remotely. The captured media is streamed to a web server or directly to a smartphone application, offering real-time surveillance or remote monitoring capabilities.

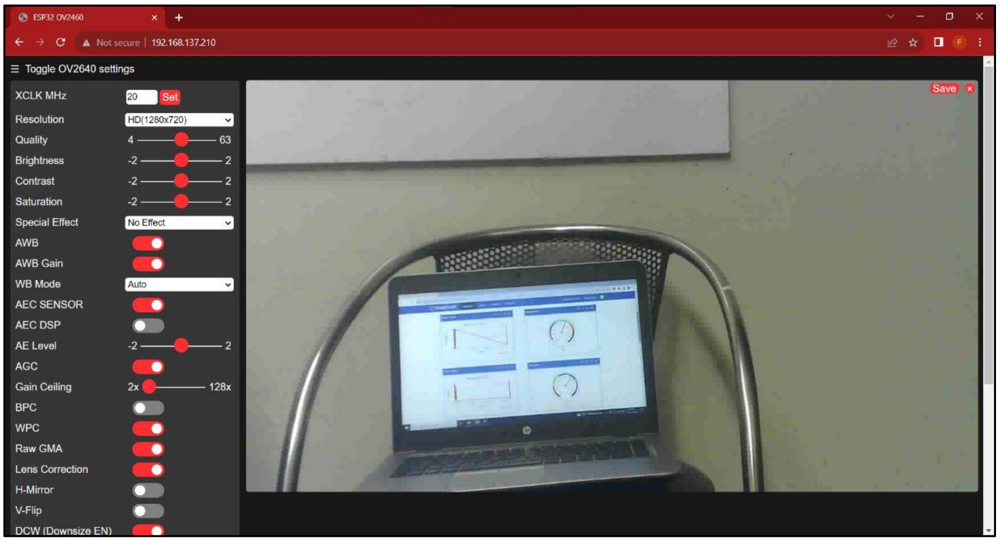

Figure 1 Live-Streaming Seen on the Local IP Address by ESP32-CAM

3.2. Details of Software Implementation

The software implementation details are as follows:

3.2.1. Arduino Software

Arduino IDE is used to upload respective codes in ESP32 to test all the components. In the respective library according to the sensor included, the pin(s) are defined, and code is created as per use. The code is then uploaded by selecting the ESP32 board, the baud rate and the port interconnected with the device and ESP32. The components tested are temperature and humidity sensor, air quality sensor, ultrasonic distance sensor, liquid flow rate sensor, nextion HMI LCD, single-channel relay module, and the camera module.

Figure 3.2 Wi-Fi Testing on Arduino IDE

3.2.2. ThingSpeak

A channel is created on ThingSpeak (IoT Cloud Platform) where a graphical user interface has been designed according to the parameters and available gadgets that helps in readibilty. The data of all four sensors that are DHT22 (Temperature and Humidity Sensor), MQ135 (Air Quality Sensor), HC-SR04 (Ultrasonic Distance Sensor), and YF-S201 (Liquid Flow Rate Sensor) are displayed on ThingSpeak (IoT Platform) with the help of read API provided by ThingSpeak. The values of all the parameters; temperature, humidity, ammonia level, liquid storage capacity, and liquid flow rate is updated according to the change.

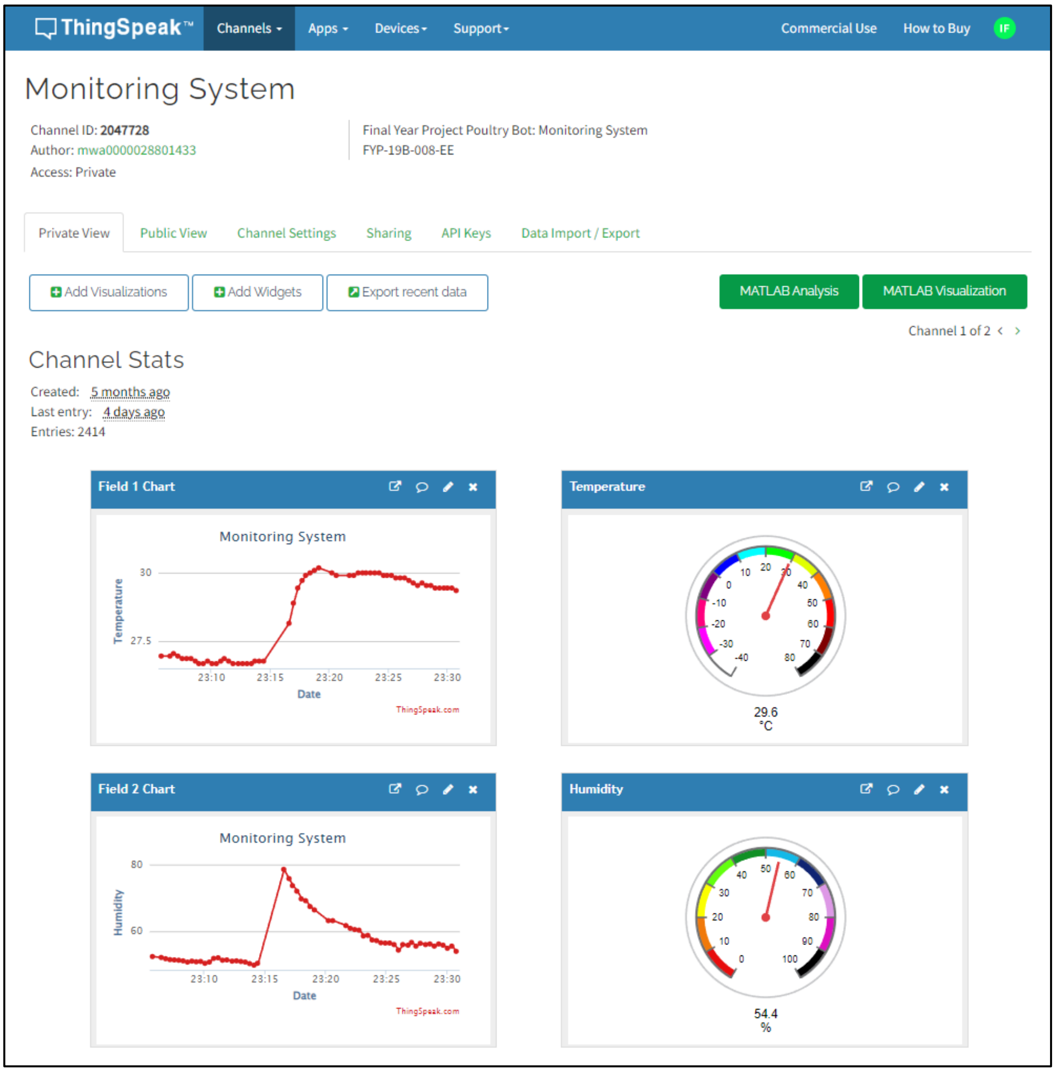

Figure 3.3 Temperature and Humidity Monitoring in ThingSpeak

3.2.3. Nextion Editor

A file Nextion Editor is created consisting of a number of pages along with a home page. Each page contains a visual representation of data sent by ESP32 taken from sensors. The graphics include background images, text, buttons, gauges, a progress bar, sliders, scrolling text, and variables. A few lines of code were written to switch pages and to update the values and graphics of the parameters. Once the GUI is designed, the Nextion Editor compiles the project into a binary file (".tft"), ready to be uploaded to the Nextion display via microSD card or serial communication. This file is then transferred to the LCD with the help of an SD card through an SD card port of the LCD, powered on so that the GUI can be transferred easily. Once the file is saved in the LCD the SD card was removed providing the GUI where the data can be received and the touch data can be transmitted via serial communication.

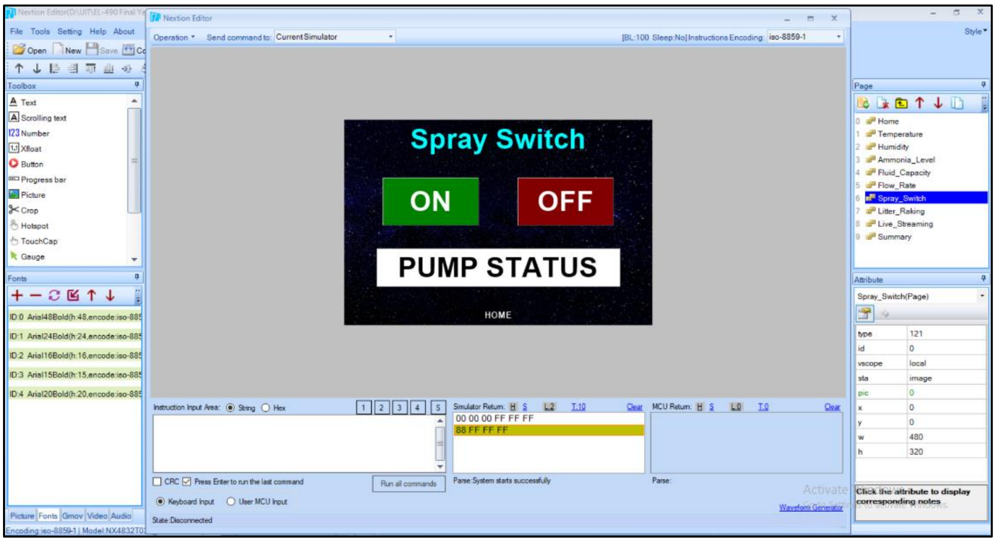

Figure 3.4 On Off Buttons Debugging in Nextion Editor

3.2.4. Visual Studio Code

The main code has been written on VS Code for ESP32 and IoT. It contains all the included libraries, the definition of all the pins, separate functions as per the required operations of each component, and some special functions such as time delays. A special extension “programio” has been included that helps the VS Code getting the arduino boards. For the IoT purpose, it also contains the user id and password of Wi-Fi to send data to ThingSpeak through the provided API. Furthermore, the code is also able to respond to the touch of the LCD where the pump is controlled from the LCD.

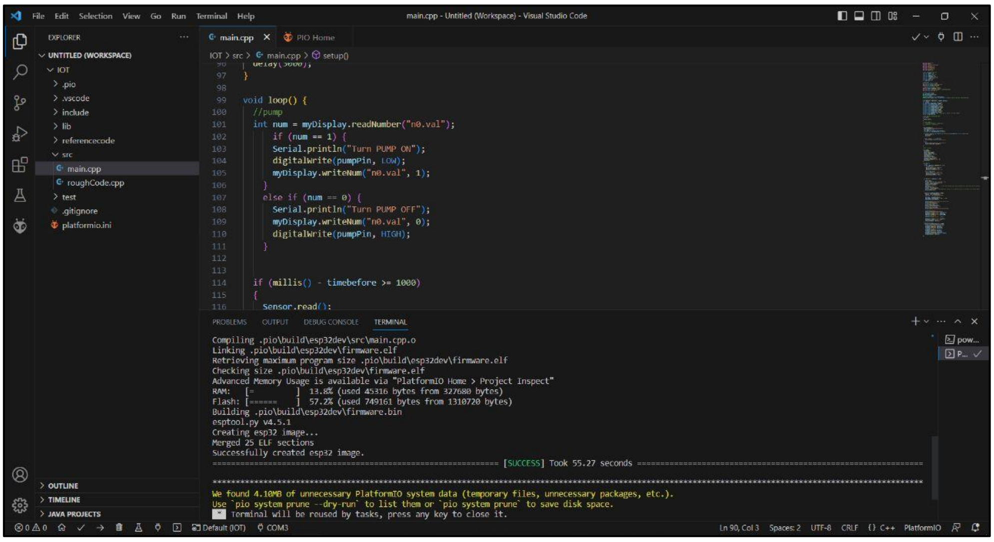

Figure 3.5 Code Compiling in VS Code

3.2.5. Ki-Cad

Ki-CAD software is used to design PCB layouts for the circuitry. First of all, a new Ki-CAD file is created that contains a schematic layout and PCB layout. Considering the schematic layout, a schematic diagram has been constructed by placing components from the library and connecting them with the help of wires. To convert the schematic to PCB layout, after the establishment of connection, the components are annotated for their identity and then the footprints of the components are assigned from the footprints library. Then a netlist file has been generated completing the task on schematic layout. Coming towards the PCB layout, the generated netlist file has now been imported that contains footprints of all the components and their connections. The components are then arranged according to the desired output, the traces have been created between the components on the copper layer, and finally, some text has been written on the silkscreen layer to make the PCB layout look good and unique. After the completion of the PCB layout, the Gerber files and drill files have been generated and imported so that the PCB of the circuit can be made physically.

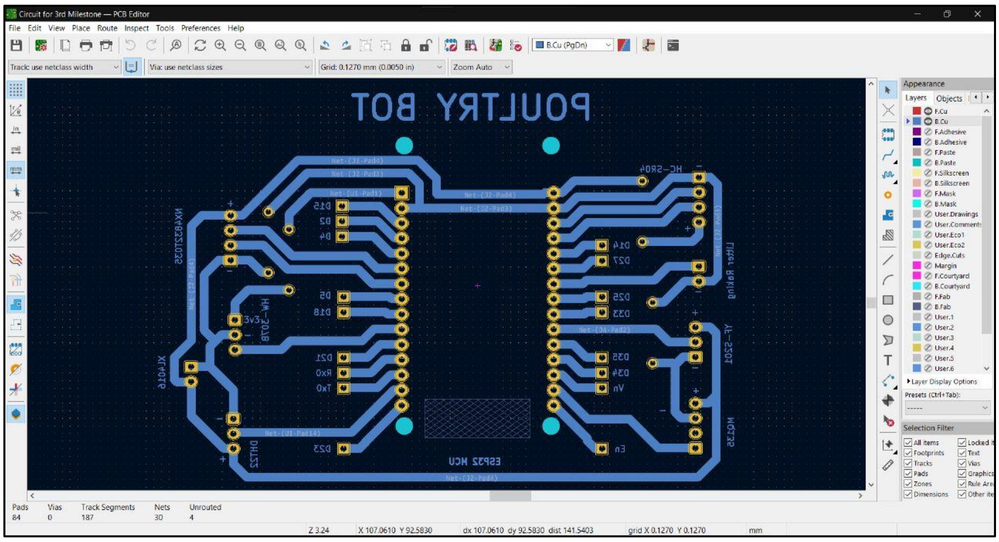

Figure 3.6 PCB Layout Designing in Ki-CAD

3.2.6. MIT App Inventor

MIT App Inventor is a specialized software from which a remote control app has been created. This app contains a GUI where controls of a remote and a small window for live streaming of ESP32-CAM can be seen taken from the numerous provided features of the app. The window is enabled by providing it the IP address of the local server generated by the ESP32-CAM. On the other hand, the controls that are forward, backward, left, and right are used to control the motion of the robot manually along with upward, downward and enabling switch for litter-raking. The app also provides simple drag-and-drop coding from which the buttons have been coded according to their operation. Since the remote control is connected with Bluetooth so, several lines of code are also written comprised of Bluetooth connection establishment along with Wi-Fi interfacing. After the GUI and code have been completed, the app has been downloaded easily in the (".apk") extension provided by the app which is compatible with Android. This file is then installed in the Android mobile for manual controlling of the robot through remote control.

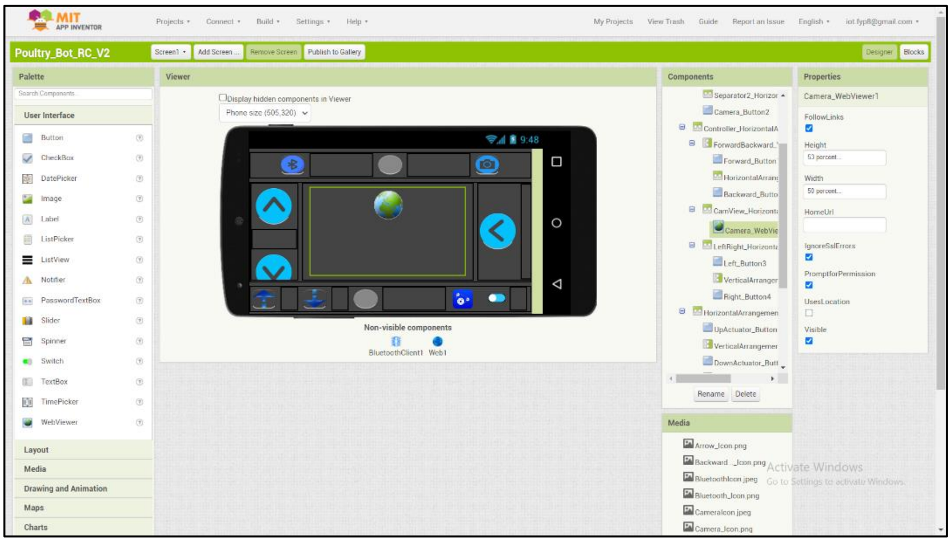

Figure 3.7 Remote Control Designing in MIT App Inventor

CHAPTER # 04

PROJECT CHARACTERIZATION

4.1. Results Obtained

The results obtained in the project are similar to what was expected. The monitoring of all the parameters; temperature, humidity, ammonia level, liquid storage capacity in the water bottle, and liquid flow rate through the electric pump has been monitored successfully by finely sending the data to the IoT cloud platform and HMI LCD simultaneously where the change in values can be observed. Furthermore, the electric pump has been controlled from the manual switch integrated into the HMI LCD. Last but not least, the live streaming has been seen victoriously on the remote control app that controls the poultry bot when tends to be controlled manually.

The images of the results obtained are following:

Figure 4.1 Image of Robot Structure Displaying Nextion HMI LCD, Camera Module, and Two Spray Nozzles (In Orange Color) on Left and Right

Figure 4.2 Image of Nextion HMI LCD (Bottom) and Camera Module (Top) Integrated in the Structure

4.2. Analysis

The monitoring parameters that are temperature, humidity, ammonia level, liquid storage capacity in the water bottle, and liquid flow rate through an electric pump were first to be displayed on Blynk IoT but due to difficulties in connection with ESP32 the IoT Cloud Platform was changed to ThingSpeak. Furthermore, the data readability on HMI LCD was not that easy including the integration of the control button. Coming towards the app, it was not an easy nut to crack, the design of GUI was not that drag and drop instead defining horizontal and vertical layout as per the requirements. Lastly, a few problems occurred while working on the software as these were new to us so learning and implementing was quite a great challenge.

4.3. Conclusion

In conclusion, the implementation of IoT monitoring is a very small example of Industrial Revolution 4.0 to make the industry automated and to be controlled remotely. The parameters which are monitored, include temperature, humidity, ammonia level, liquid capacity of the storage tank, and liquid flow rate through the electric pump. The purpose of temperature is to cross-check whether the temperature is maintained in the control shed or not on the other hand humidity helps to determine whether the moisture absorbers should be placed or not. The ammonia level is a very crucial parameter based on which litter-raking takes place as the increase in ammonia level is harmful to the health of birds. The remaining two parameters are situated in the spraying unit where the storage capacity defines the quantity of liquid and the liquid flow rate determines the area covered by the spray. Coming towards the live streaming feature, it can provide the user view of the entire poultry farm without any human interaction. Last, but not least, the remote control app is a wonderful feature that allows the user manually controlling of the robot along with integrated options of litter-raking control and live-streaming view.

4.4. Future Recommendations

In the future, a database can be created to have a record of all the monitoring parameters on an hourly, daily, weekly, or monthly basis. The electric pump which is manually controlled can be automated using machine learning where the liquid can be sprayed considering the daily routine that when the spraying is done. The Wi-Fi connection can be made strong with the integration of the LoRa (Long Range) module expanding the shed coverage. Lastly, for the camera module, AI (Artificial Intelligence) can be implemented to detect dead birds along with increasing the video quality by replacing it with a high quality camera. Furthermore, the multiple cameras could be used to have a 360 view of the robot as well as of the shed.

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APPENDIX A: (Complex Engineering Problem)

Appendix A1: Range of Resources

Table A1.1 Table of Range of Resources

Human Resource			
S.No.	Discipline	Resource	Description
1	Mechanical	Welder	Helped in constructing the mechanical structure of the litter-raking.
2	Mechanical	Lathe Operator	Helped in coupling of litter raking motor.
Material/Equipment			
S.No.	Discipline	Resource	Description
1	Engineering Hardware	• E-Tech Saddar • Sher Shah Market • Step Electronics	To purchase the electrical components and litter raking structure.
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 provides IoT monitoring, automatic spray, and litter raking systems that ensure biosecurity in the poultry farm. 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 automates the poultry farm industry and revolutionizes the way poultry farming is conducted.

Appendix A3: Level of Interaction

In this project, new challenges were faced that are using the software first time without any expertise so solving the occuring problems was a great issue. This issue was solved by taking help from search engines, open-source projects and community forums.

Appendix A4: Consequences to Society and the Environment

This project is built as an environment-friendly project obeying the SDG (Sustainable Development 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. Through this project, human interaction and effort are 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 ESP32 microcontroller. For the programming, the C++ language learned from the course programming fundamentals and its further implementation in the course data structure and algorithms helped in writing fantastic code. Theories learned from the course electrical machines helped in selecting motors and successfully performing their operations. The understanding of power electronics helped us in the manipulation of the DC voltage. Courses like linear circuit analysis, digital logic design, electronic circuit design, and integrated electronics play great role in circuit designing. The concepts of embedded systems assist us in IoT, which heavily relies on it to function effectively. Finally, the skills learned from workshop practice helped us in proper wiring, soldering, and mainly fabricating PCB.

APPENDIX B: PLAGIARISM REPORT

Submission date: 07-Aug-2023 09:05AM (UTC-0700)

Submission ID: 2142710111

File name: FYP-19B-008-EE_Report_Plague_Check.pdf (1.7M)

Word count: 8277

Character count: 44690

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