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Quackbot Automated Robot Duck Egg Collector Based on Artificial Intelligence (AI) and Internet of Things (IoT)

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Abstract

Quackbot is a smart robot developed by IPB University vocational school students IoT System Project to collect duck eggs automatically using Artificial Intelligence (AI) and Internet of Things (IoT) technology. Based on the test results, Quackbot was able to detect the presence of duck eggs with a camera, then pick them up and store them accurately in the robot's body. IoT integration in Quackbot allows the robot to communicate with a website to record the number of eggs collected each day and correlate the robot's active status in real-time. It is hoped that the use of Quackbot can help students and employees of Duck Cage Technology and Livestock Management in collecting duck eggs more efficiently and reducing the possibility of incidents. In addition, data recorded in real-time on the website provides higher validity for the Livestock Technology and Management study program. The conclusion of the final report shows that Quackbot succeeded in carrying out all its functions well, had a positive impact on the management of the duck house, and was an effective solution in automating egg collection. Implementation of this technology not only increases efficiency but also ensures accuracy and transparency in recording bad data.

Keywords: Quackbot; Automated Duck Egg Collection; AI Egg Detection; IoT Duck Farming; Real-time Egg Managemen;

INTRODUCTION

The duck farming industry plays an important role in the agricultural and food sectors, especially in the production of duck eggs which have high nutritional value and stable market demand. Food from livestock is needed for the health, health and intelligence of the Indonesian people (Diwyanto, 2005). Laying ducks also have potential advantages when compared to other laying poultry such as purebred chickens and kampong chickens. Duck eggs have a higher content of protein, calories and fat compared to chicken eggs (Kriswanto & Wulansarie, 2023). Livestock products that have a big role in overcoming nutritional problems in the community are eggs, especially duck eggs which are indeed rich in nutrients when compared to domestic chicken eggs. Duck eggs show higher levels of nutrition than free-range chicken eggs and country chicken eggs (Bustan Jusmawi, Rosita, Maretha Fetty, Rini, 2016). The reproductive period in duck eggs can only produce 2-3 eggs per three days and has a hatching time of 27-30 days (Wirajaya et al., 2020).

The Agribusiness Technology and Management Study Program (TNK) has a duck cage with a large number of ducks. However, one of the problems faced is the egg collection process which is still done manually. This often faces various types of challenges, such as time efficiency, large labor needs, and also the most serious problem, namely fraud that occurs in officers. Thus, an automatic robot solution for duck egg collection is urgently needed to overcome this problem and improve the efficiency and operational effectiveness in the duck cage of the TNK study program.

The Automatic Robot for collecting duck eggs was then named Quackbot, which stands for Quack which means the same as the sound of a duck kwek kwek, and the Bot is a Robot. The Quackbot Robot is an Automated Smart Robot for Duck Egg Collection Based on Artificial Intelligence (AI) and IoT (Internet of Things). Artificial Intelligence is intelligence added to a system that can be regulated in a scientific context or can also be called Artificial Intelligence or simply abbreviated as AI, defined as the intelligence of scientific entities (Siahaan et al., 2020). Then the definition of the Internet of Things is, a system that is able to monitor hardware and be able to move the device without the need for direct action with the device and the device can be controlled using internet communication information technology (Anggiat, 2021)

In an era of increasingly advanced technology, the use of Artificial Intelligence (AI) and Internet of Things (IoT) technologies offers great potential to overcome these challenges. By utilizing AI and IoT, automated robots can be developed to collect duck eggs efficiently and effectively, reducing human intervention and increasing productivity. An IoT-based egg collection robot with AI settings in it has sensors to detect the presence of eggs (Sayekti et al., 2023). Then the IoT integration on the robot works directly with bluetooth & the internet as a channel between the two machines themselves (Anang Sucipto & Bagus Prakoso, 2022). In Industry 4.0, the Internet of Things (IoT) is a general technology concept that promotes the connectivity of objects. The Internet of Things (IoT) is a system that connects devices directly or indirectly to the internet (Siskandar et al., 2020).

Figure 1Raspberry Pi

In the robot, there are several important components in it that are integrated with Artificial Intelligence (AI), namely the Raspberry Pi. As shown in figure 1, the Raspberry Pi is open hardware, except for the main chip on the Raspberry Pi, which is the Broadcomm SoC (System on Chip) which runs many of the main components of the board - CPU, graphics, memory, USB controller, and others (Lesmana et al., 2019). The device uses an SD card for long-term boot and storage. Sub Transmission Network (Clinton & Sengkey, 2019). Raspberry Pi (minicomputer) and OpenCV are used as image processors so that robots can distinguish objects based on differences in color space values and know the position of objects by looking for their centroid values (Pramudyo et al., 2015). The Raspberry Pi Quackbot Robot is used as the brain of an automated robot, controlling all aspects of its operations. This includes motor propulsion, navigation, and physical egg collection.

The Raspberry Pi on the Quackbot Robot is also used as the basis of Artificial Intelligence to run image processing and machine learning algorithms that help in the recognition and identification of duck eggs. To detect the duck eggs, an additional component is used, namely a webcam. A webcam or web camera is a digital camera that is connected to a computer. By using this technology, the camera on the computer will provide the information, namely in the form of an image that appears through a web page (Ismai, 2021). An intraoral webcam or USB when connected on a Raspberry Pi to take pictures is then sent and stored in the server's database. The process of sending the image takes 5 seconds for the image to be received in the server database (Pi, 2014).

In order for the webcam to take an image of the egg and identify it, the YoloV8 algorithm is needed. You Only Look Once (YOLO) is an algorithm specifically designed to perform real-time object detection (Kukuh Isnaen & Stefanie, 2023). YOLO is an object detection approach in real-time using a convolutional neural network (Hayati et al., 2023).). This algorithm uses an object detection approach based on the Convolutional Neural Network (CNN) which can learn patterns and features from image data (Ibrahim & Latifa, 2024). The Quackbot Robot uses YoloV8 because there are several advantages, including high performance, and accurate object detection capabilities, so that YoloV8 is a very popular object detection model and is widely used to simplify the object detection process and ensure accurate and precise things (Yanto et al., 2023).

After the Robot can detect the type of egg, the Robot will then send a signal to the driver's motor to retrieve the egg. L298N motor driver is used to regulate the direction of rotation and speed of the motor (Qirom & Niam, 2020). Furthermore, Dinamo DC controls the movement of the robot chain to move towards the egg. A DC dynamo is a device that converts electrical energy into kinetic energy or motion (Adisty Maulina Putri et al., 2021). This DC dynamo also moves the robot's arm when the AI has detected the presence of duck eggs. In order for the robot to run perfectly without hitting obstacles in front of it, an ultrasonic sensor is also added. Ultrasonic sensors are sensors that work based on the principle of sound wave reflection and are used to detect the presence of a certain object or object in front of the working frequency in the area above the sound waves from 20 kHz to 2 MHz (Devi Pratama et al., 2024).

Figure 2 ESP32

Furthermore, to be integrated into the IoT Quackbot Robot uses the ESP32 component as shown in Figure 2. ESP32 can be used as a replacement circuit on Arduino, ESP32 has the ability to support connecting to WI-FI directly (Wagyana, 2019). Furthermore, ESP32, which has IoT capabilities, sends data to the website system and Telegram at the same time. The data sent includes detailed information such as the date, time, and proof of the picture when the eggs were taken. The website system allows users to monitor robot activity in real-time, including the robot's active or inactive status as well as historical data regarding egg collection.

To be able to run the robot, use a battery or battery as the main power source to operate all robot components. A battery or storage battery is a cell or secondary element and is a direct source of electric current that can convert chemical energy into electrical energy (Primary, 2021). Then to regulate and distribute electricity from the battery to various robot components using Power Supply. Basically, this power supply or power supply requires an electrical energy source which then converts it into electrical energy needed by other electronic devices (Cholish et al., 2017). The robot also uses a voltmeter to monitor the voltage provided by the battery and ensure that it is within safe and operational limits (Manurung & Sinambela, 2018).

From these problems and descriptions, a study was made on the Quakbot Automatic Robot as a Duck Egg Collector Based on Artificial Intelligence (AI) and IoT (Internet of Things) which aims to develop an automatic robot that is able to collect duck eggs using AI and IoT technology. Then the main purpose of the development of this robot is to improve the efficiency and effectiveness of the egg collection process, as well as to avoid any cheating that occurs by officers. In addition, this study also aims to monitor egg collection by monitoring environmental conditions in real-time.

This study covers various technical aspects using HDLC (Hardware Development Life Cycle) development. This method involves robot planning, needs analysis, device design, implementation, and maintenance. The research also involves the design of robot development, AI algorithms for egg recognition and collection, and IoT systems for monitoring environmental conditions and the status of Robots. Tests will be carried out in the duck farm environment to ensure the robot can operate effectively under real conditions.

This article is different from previous research. This study strongly supports previous research and is indeed carried out through a literature review that can involve an analysis and understanding of several studies. Previous research is an effort to research, explore, and study previous works that are very relevant to this research topic. Through a review of the existing literature, it was found that various previous research results that were still active with this research theme could be identified and integrated (Rifai & Fitriyadi, 2023)

- This research was previously conducted by (Santoso et al., 2021) about the development of a duck egg counting system using a webcam and the Raspberry Pi-based Haar Cascade Classifier method. The system can detect and count eggs automatically. The study is almost similar to our research, which is to discuss problems in duck cages and use Raspberry Pi as a system to detect the presence of eggs. However, in our research, further development was carried out, namely we determined the research of an automatic egg collection robot and used the YoloV8 Algorithm as an egg detection method. Then we also apply the IoT system to the robot as a communication medium for the robot with the monitoring system. By using IoT technology technology, robots can transmit data in real-time through available websites and telegrams.

Previous research has provided a deeper understanding of using the Haar Cascade Classifier method in the case of detecting eggs automatically. By analyzing and comparing the research, this research is expected to improve the accuracy of data collection and become a further development that can be the latest innovation from previous research.

METHOD

Time and Location

This research was conducted from January to June. The location of this research is in the Duck Cage of the Livestock Technology and Management Study Program, IPB Vocational School. This is because in our research on the Automatic Duck Egg Collection Robot implemented at the location as a solution to the problem in the Duck Cage of the Livestock Technology and Management Study Program, namely the collection of duck eggs which is still done manually and it is feared that there is fraud in the officers when collecting the duck eggs.

Data Collection Techniques

The data collection technique used in the project we created is a combined quantitative and qualitative research method approach. In general, the quantitative method is a method that is systematically arranged against the parts and to find the causality of the relationship. The quantitative method is a type of research whose specifications are systematic, planned, and clearly structured from the beginning to the creation of the research design. (Amalia Yunia Rahmawati, 2020). While qualitative methods are methods that are considered as ways, strategies to understand reality, systematic steps to solve the next series of cause and effect. The 8 data analysis technique in this study consists of several stages, namely first the researcher collects data in the field, then sorts and classifies the data, and then the researcher studies the keywords and analyzes the data, and finally the researcher concludes the results of the research. (Chief et al., n.d.)

So it is important to mix quantitative and qualitative research methods to gain an understanding of the impact of the technology. Quantitative can provide concrete numbers, while qualitative can help understand the context and nuances of the user experience and gain an in-depth view from an individual perspective. There are several steps of the combined quantitative and qualitative research method, namely:

1. **Case Study (Qualitative Method)**

   Before deciding what Robot to make, our group conducted a case study to determine the partner to be selected to be the IoT (Internet of Things) Final Project. The partner must also be related to the Agriculture and Animal Husbandry sector. We are looking for suitable partners to make solutions to these partners' problems that we can implement to be used as robots that are integrated into IoT (Internet of Things). So we set a Duck Cage which is within the scope of the IPB Vocational School in the Technology and Management and Animal Husbandry Study Program to make an innovation from the problems contained in the Study Program.

2. **Survey (Quantitative Method)**

   After our group learned about the Robot that we will make. We came to the Duck Cage of the Management and Animal Husbandry Technology Study Program to conduct a survey as a place to implement the Robot as an Automatic Duck Egg Collection Robot

3. **Interview (Qualitative Method)**

   In the survey we conducted, we also conducted an interview with Mr. Danang as a Lecturer in Management and Animal Husbandry Technology as well as the manager of the Duck Cage to ask what problems occurred in the Study Program, especially in the Duck Cage that we can implement in our projects related to Robotics and integrated into IoT (Internet of Things).

4. **Experiment (Quantitative Method)**

   From the interviews and surveys that have been carried out, our group decided to create an Automatic Egg Collection Robot. In the robot, we use AI (Artificial Intteligence) to detect the eggs in the cage, so that the robot can automatically run to pick up the eggs and then also integrate into IoT (Internet of Things) which can monitor the number of eggs produced every day.

DATA ANALYSIS

Data analysis, according to Noeng Muhadjir (1998: 104), states the definition of data analysis as "an effort to systematically search and organize the records of observations, interviews, and others to improve the researcher's understanding of the case being studied and present it as a finding for others. Meanwhile, to improve this understanding, the analysis needs to be continued by trying to find meaning." (Rijali, 2019). Based on the above data collection techniques, data analysis will be carried out from the projects we made, namely:

1. **Testing of Quackbot Robot in Automatic Egg Collection**

   The Quackbot robot has 2 modes, namely Manual Mode and Automatic Mode. In manual mode, the robot is moved using a remote to direct the robot to walk according to directions until it takes duck eggs. In the manual mode, there is an arduino car remote application that can be connected to a cellphone using ESP32 bluetooth. Then for automatic mode, the robot will run if the switch on has been turned on, the robot will walk around the duck cage until the camera detects an egg, then the camera will provide information through the Telegram API in the form of documentation of the results of the image recorded when the robot successfully gets the egg and if the robot arm picks up the egg, the telegram bot will also provide a notification that the egg has been obtained along with the number of eggs that have been taken on the day. In automatic mode, the robot will circle the cage for 60 minutes until it gets 10 eggs. After 60 minutes the robot will automatically stop. The robot is also equipped with an additional light that will be connected to a USB. The additional lights are used when the robot is in poor lighting conditions, so the camera can function properly.

2. **Analysis of the Use of Raspberry PI 5 as Artificial Intelligence (AI) and Machine Learning**

   The working process of the Quackbot Robot which uses the Raspebrry PI 5 as Artificial Intelligence (AI) and Machine Learning begins with a sensing system supported by a camera mounted on the Quackbot. This camera sends a direct image feed to the Raspberry PI, which acts as the robot's computing brain. The Raspberry PI is equipped with YOLOv8 software which is one of the best deep learning models for detecting objects in real-time. Once the image is received, YOLOv8 processes the image to detect and identify the egg. The YOLOv8 algorithm based on a convolutional neural network (CNN) analyzes the image very quickly, determining the location and number of eggs in each captured frame. YOLOv8 is trained with an egg image dataset to ensure a high level of accuracy in detection. Once the egg is identified, information regarding the location of the egg is passed to the Quackbot drive module. The Raspberry PI instructs the actuators and motors on the Quackbot to move towards the detected location.

3. **Analysis of the use of ESP 32 as the Internet of Things (IoT)**

The automated egg collection Quackbot robot uses ESP32 as the Internet of Things (IoT), combining robotics, AI, and IoT technologies. The working process starts with the camera on the Quackbot sending an image feed to the ESP32. ESP32, as the main controller, is connected with a driver motor that controls the DC motor for the egg-pulling mechanism. The camera detects the eggs using the YOLOv8 algorithm, then the ESP32 sends commands to the driver motor to activate the DC motor that drives the robotic arm to carefully pick up the eggs. Once the eggs are collected, the ESP32 sends a confirmation signal.

The IoT-enabled ESP32 sends data to websites and Telegram, including detailed information such as dates, hours, and image evidence. The website allows users to monitor the robot's activity in real-time and view historical data on egg collection. Integration with Telegram provides instant notifications regarding each egg collected, complete with time and images.

The IoT implementation on Quackbot allows remote monitoring and control of robots. The dashboard on the website shows the robot's movements, operational status, and daily performance reports. Telegram notifications ensure users are always informed without having to check the website. This system improves the efficiency and accuracy of egg collection and provides transparency and convenience in poultry farm management.

4. **Data Log**

To see the robot's activity logs such as when the robot is turned on and off, a website is created. From the website, employees or cage guards also have access to enter the website to monitor the robot, the eggs obtained such as the day and date the eggs were taken, the clock, and the images of the eggs obtained, as well as download the data. While the admin is responsible for ensuring that the website runs smoothly and as the website manager.

Research Procedure

The development method used in the manufacture of this "Egg Robot" tool is the Hardware Development Life Cycle (HDLC). This method was chosen because the cycle used in its creation or development aims to solve the problem effectively. In another sense, HDLC is a stage of work that aims to produce high-quality tools that are in accordance with the wishes of the customer or the purpose for which the system was made. In Figure 3 is the flow of the HDLC method:

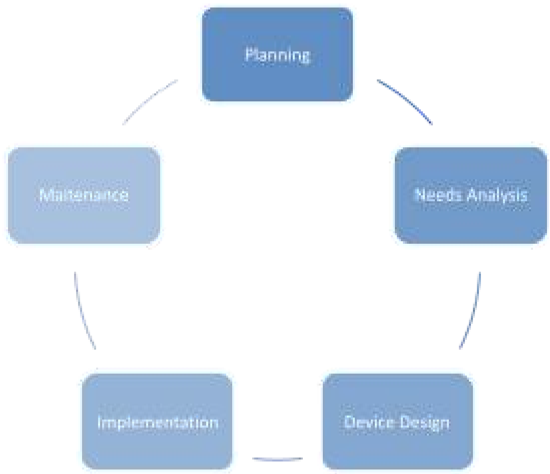


Figure 3 System Development Methodology

1. **Planning**

The planning stage includes the design of a Mini PC that can detect eggs from cameras, and send the point of presence of eggs to a microcontroller who then regulates the robot's movements to approach the eggs. This stage also includes the process of integrating the robot with the InfluxDB database, so that the robot can send egg data to the database.

2. **Needs Analysis**

At this stage, the process of identifying problems that occurred in the process of taking duck eggs carried out by partners was carried out. This analysis produces solutions to the problems experienced by partners. The solution includes the profits generated by the egg collection robots we create

3. **Device Design**

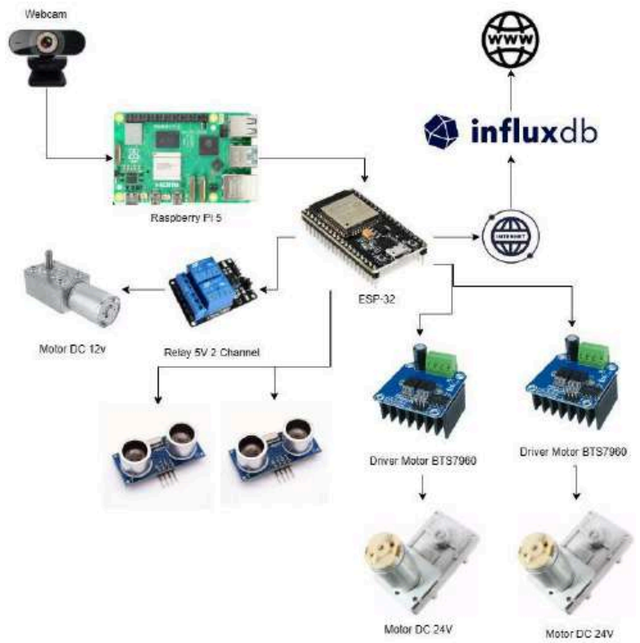


Figure 4 Device Design

The stage in figure 4 is the stage of identifying the devices needed after going through the needs analysis process. This stage will describe the needs of the device, as well as the integration scheme between the components in an easy-to-understand form. This design includes hardware and software design as shown in the figure below.

4. **Implementation**

After going through each system design process, the implementation stage is the stage where all the designs that have been prepared are executed. Each component is connected into a single unit, The process also includes case making and coding.

5. **Maintenance**

The maintenance stage is the process of working on the time that arises both from the device and from the system itself. Each device needs calibration or maintenance, of course, after entering the period of use. Because there are many factors that affect the occurrence of errors, for example, from the terrain to be passed, unexpected field conditions and so on. Internet of Things devices in the current era are getting easier in terms of maintenance because existing systems and various resources have begun to be scattered in open sources. So that if there is a request for changes or obstacles to the system and tools that we develop, it will be relatively easy and fast to resolve.

Results and Discussion

1. Data Analysis

1.1 Problem Analysis

Problem analysis is the first step in developing a research. The process of analyzing this problem was carried out through an interview with Mr. Danang as a Lecturer in Livestock Technology and Management. The problem obtained was about the problem found in the duck cage, namely the collection of duck eggs which was still done manually. Not only that, from manual egg collection, it can also cause concerns about fraud that occurs during egg collection. For this reason, Mr. Danang gave an idea to the students of the Computer Engineering Technology Study Program, especially our group, to make a new innovation regarding the Automatic Duck Egg Collection Robot. Furthermore, from this idea, the robot was developed again so that it can be integrated with Artificial Intelligence (AI) and the Internet of Things (IoT).

1.2 Needs Analysis

In the process of creating IoT-based systems, hardware and software play a very important role. Each component has a specific function that supports the entire process from concept, to the physical realization of the tool.

Table 1. Software Requirements

It	Software Name	Information
1.	Arduino IDE	Creating Arduino Coding and uploading to ESP 32
2.	Visual Studio Code	Create a Web for data export
3.	Fusion 360	Creating a 3D Design Robot
4.	Eagle 7	Making PCB Design
5.	Fritzing	Creating a Network Schematic Design

Table 2. Hardware Requirements

It	Hardware Name	Information
1.	ESP32	Integrated SoC (System on Chip) microcontroller with WiFi 802.11 b/g/n, Bluetooth version 4.2, and various peripherals.
2.	Mini PC (Raspberry)	The Raspberry Pi is open hardware, except for the main chip on the Raspberry Pi which is the Broadcomm SoC (System on Chip) which runs many of the main components of the board - CPU, graphics, memory, USB controller, etc.
3.	L298N	The L298N motor driver is a DC motor driver module. IC L298 is an H-bridge type IC that is able to control inductive loads such as relays, solenoids, DC motors and stepper motors.

4.	L2596	Used to regulate the input/output of incoming current on the arduino.
5.	Camera	A webcam or web camera is a digital camera that is connected to a computer and connected to a web page.

It	Hardware Name	Information
1.	12V DC Dynamo	A DC dynamo is a device that converts electrical energy into kinetic energy or motion motion.
2.	Optocoupler 4 Channel	electronic components that connect and isolate one circuit to another optically (beam)
3.	Ultrasonic Sensor	to detect the existence of a particular object or object
4.	PSU	A power supply that can provide electrical energy for electrical devices or other electronics.
5.	XH-M604	as a direct current regulator that is charged to the battery battery.
6.	Voltmeter	electrical voltage measuring instruments.
7.	Heatsink	materials that can absorb and dissipate heat
8.	Step Down DC	transformers that reduce the output voltage.

2. Design Results

2.1 Hardware Design

1. Block Diagram

Diagram blocks are a part of the principles and performance of a system in making a tool design. The overall working of a tool to be made lies in the system diagram block as shown in figure 5 (Wahyudi et al. 2017).

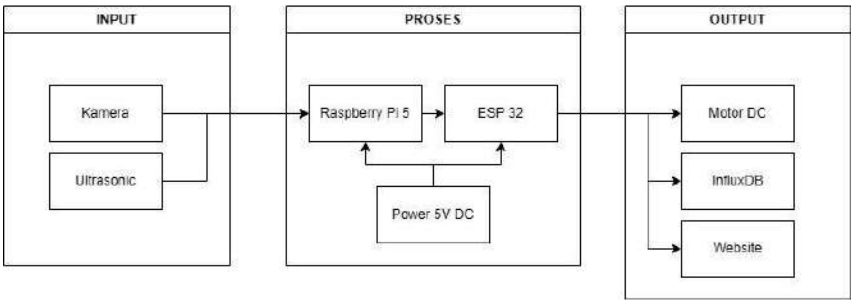


Figure 5 Block Diagram

In our tool there are 3 main blocks, namely: Input, Process, and Output. The component contained in the input block is a camera that functions to detect the presence of ducks. In the process block, there is a Raspberry Pi 5 that functions to process images from the camera using the OpenCV machine learning model. Then the existence of the processed eggs will be sent to ESP 32 which functions to move the DC motor to approach the eggs.

2. Flowchart

Flowchart or often called a flowchart is a type of diagram that represents an algorithm or sequential instruction steps in a system (Rosaly & Prasetyo, 2019). Flowcharts also describe the logical sequence of a logical problem-solving procedure (Khesya, 2021).
From this description, we can look for the steps of a procedure in the Quackbot Robot so that it can be made into a general flowchart as shown in figure 6.

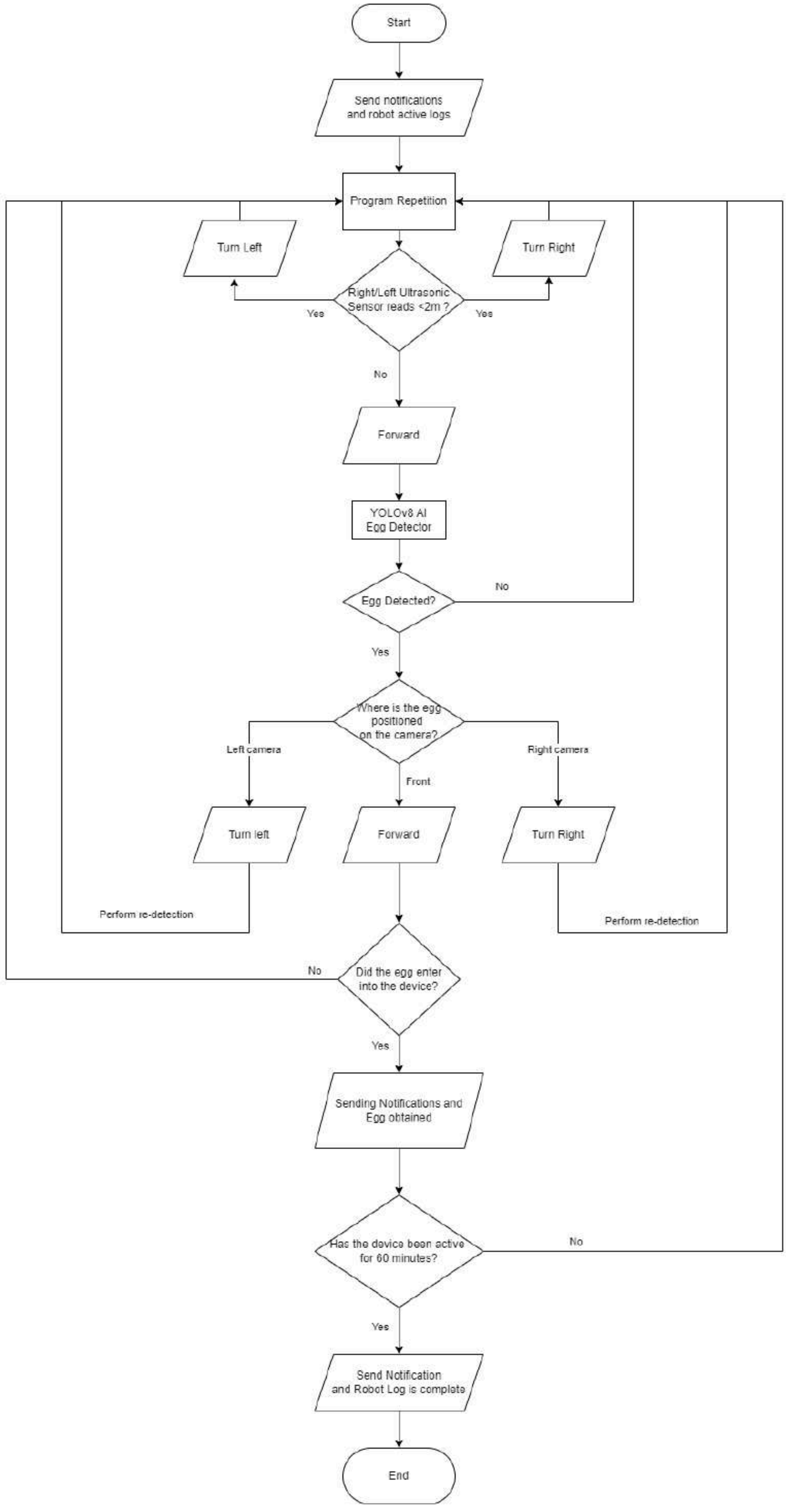


Figure 6 Flowchart

3. Mechanical Design and Results

Figure 7 is a 3D image of the Quackbot Robot Object.

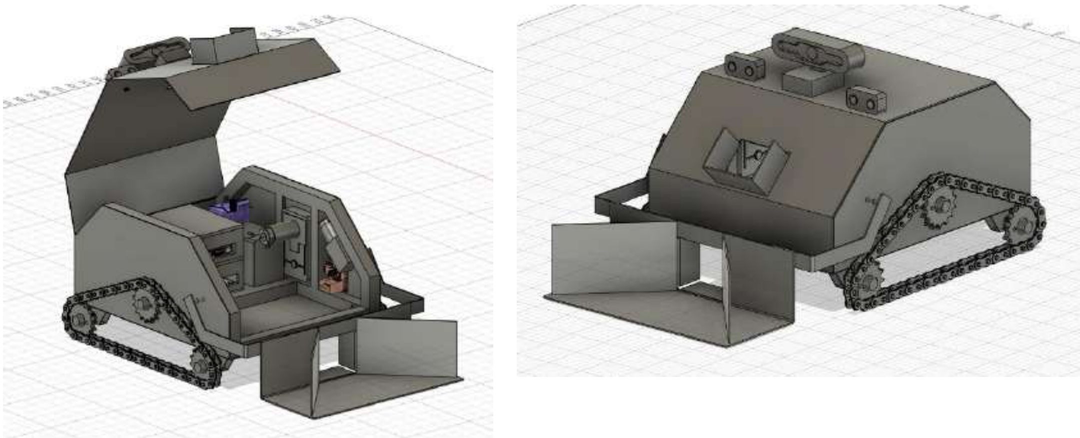


Figure 7 Mechanical Design

The robot frame uses a 1mm hollow iron base material which is then coated with a 1mm aluminum plate to form the robot's body. Then the robot arm used on the robot is made using a 1mm aluminum plate and the robot's driving wheels are made using a chain. The robot's body is coated with foam inside so that when the robot's arm inserts the egg inside, the egg does not break.

4. Schematic Networks

The design of the electronics circuit in the image above was made using fritzing software. In designing an electronic circuit (hardware), three components are needed, namely: input components, process components and output components. The electronics circuit of this intelligent system is designed as shown in figure 8.

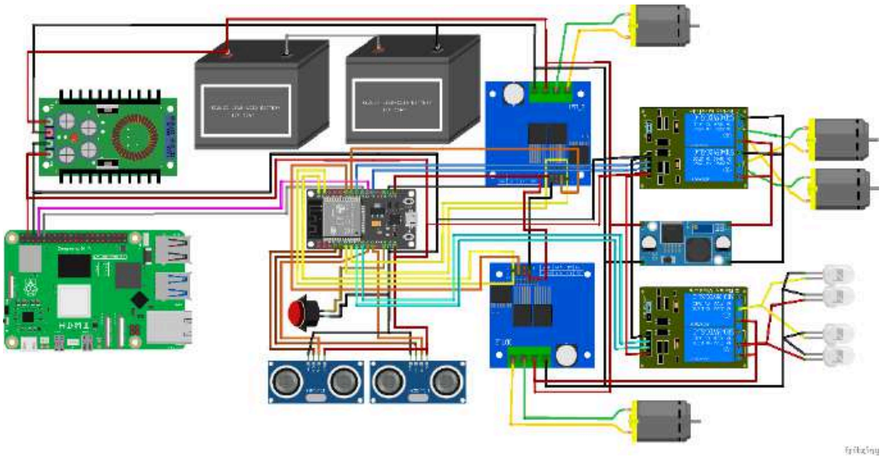


Figure 8 Schematic Networks

The DC-DC XL4016 stepdown module functions to reduce the voltage of the Lead Acid Battery from 24V DC to 5V DC required by the ESP32 and Raspberry Pi 5 microcontrollers, ESP32 and Raspberry Pi 5 are connected via a TXRX Serial cable for communication to read the sensor obtained by the ESP32 and Send motor commands to the ESP32, There is one cable that will be connected to turn on the light on the WB600 Webcam which is attached to the robot, The HC-SR04 ultrasonic sensor works to make the robot can detect whether there is an obstacle in front of the robot or not, then the DC Dynamo connected to the Motor Driver BTS7960 will determine where the wheel is turning. After the robot finished carrying out its task.

3. Software Design
    1. Use Case

This Usecase diagram describes the functional rights between employees and technicians regarding the system to be designed or built. A use case diagram is a highly functional model in a system that uses actors and use cases. Use case diagrams illustrate the effects of functionality that the system has expected (Ninuk & Syadid, 2017). The employee in this usecase is a farmer employee and the technician here is the person responsible for making the robot and maintenance. The website creation process is based on the usecase diagram in figure 9.

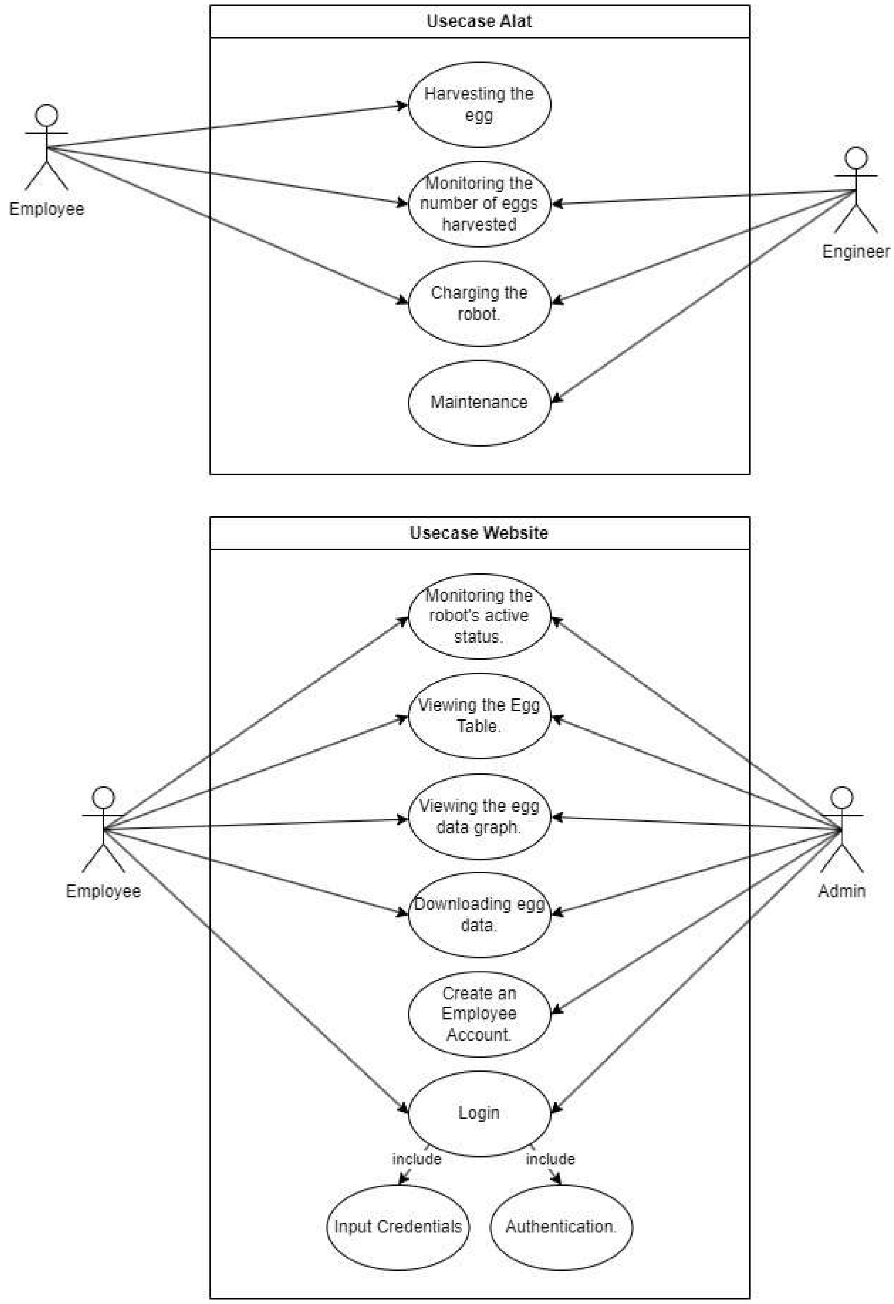


Figure 9 Usecase Diagram

a. Tool Usecase

There are 2 actors involved in the system, namely employees and technicians. Employees are farm employees who are in charge of picking up eggs after being collected by robots. Meanwhile, technicians are the people responsible for making robots and maintaining robots. The Use Cases that each actor can do:

Official:

- Taking the egg harvest
- Monitoring the number of egg harvests
- Charging the robot

Technician:

- Monitoring the number of egg harvests
- Charging the robot
- Maintenance

b. Usecase Website

The actors involved in the system are Employees and Admins. Employees are employees who have access to the website to monitor robots, eggs obtained, and download data. Meanwhile, admins, are the people responsible for ensuring that websites run smoothly, safely, and efficiently. The Use Cases that each actor can do:

Official:

- Monitor the robot's active status
- View egg table
- View egg data graphs
- Downloading egg data
- Login that includes Credential input and authentication

Admin:

- Monitor the robot's active status
- View egg table
- View egg data graphs
- Downloading egg data
- Create an employee account
- Login that includes Credential input and authentication

4. Implementation Results

1. Implementation Software

The login process uses an account that has been previously registered by the admin. This aims to minimize irresponsible people can register accounts and abuse authorship.

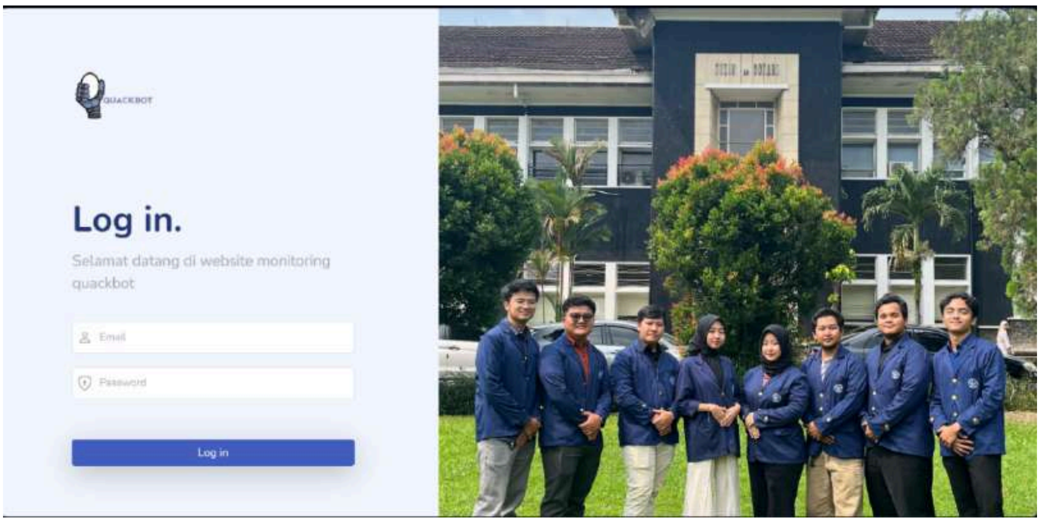


Figure 10 Quackbot Website Login Display

In Figure 10, the quackbot monitoring website has 2 roles in access, namely admin and employee. Admins here can see all features including user management and also robot capture data. Meanwhile, employees can only see the robot's capture data, they cannot create an account.

Figure 11 Website Display on Quackbot Static Page

Figure 11 is an overview of our Quackbot website, there is some information displayed on this page such as a graph of egg receipts in the last 12 months, the last active of the robot and the status of the robot whether it is on or off.

Figure 12 Website Display on Quackbot Data Page

Figure 12 is the result of the egg data that has been collected. This data can be exported into excel for reporting needs. These data are retrieved from the Mysql database. The data is sent via API and then stored in the database.

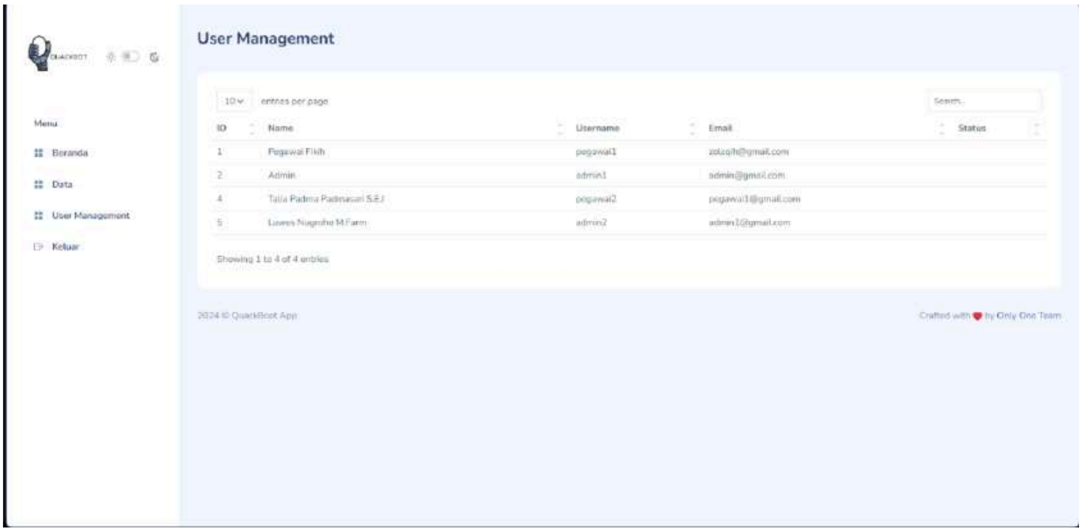


Figure 13 Website Display on User Management Page

Figure 13 shows the user accounts that have access to our website and are already registered. In this feature, only admins can access, employee accounts cannot access. Admins can perform CRUD account creation.

2. Source Code Implementation

This section contains an explanation of coding on the ESP32 which can control a robot and lift eggs using commands received via Bluetooth or the Raspberru Pi series. Here are the parts of the coding and its explanation.

a. Libraries and Variable Definitions

```
// Library apa saja yang digunakan
#include <NewPing.h>
#include <BluetoothSerial.h>

// Melakukan link agar library mudah di panggil
BluetoothSerial SerialBT;
```

Figure 14 Source Code Library and Variable Definition

The 'NewPing' library in figure 14 is used to control the ultrasonic sensor, while the 'BluetoothSerial' is used for Bluetooth communication.

b. Pin Definition and Motor Settings

```
// Pin yang digunakan untuk menghubungkan RaspberryPi
#define RXD2 16
#define TXD2 17
```

```
// Pengaturan untuk motor driver
#define KecepatanNormal 220
#define EN1 19
#define EN2 18
#define IN1 33
#define IN2 32
#define IN3 22
#define IN4 23

// Relay yang jadi motor driver
#define IN5 5
#define IN6 4

// Pin untuk pengaturan mode
#define MODE1 13

// Pin untuk menyalakan lampu
#define LAMPU1 25
#define LAMPU2 26
```

```
// Pengaturan untuk sensor ultrasonik
#define TRIG1 14
#define ECHO1 35
#define TRIG2 27
#define ECHO2 34
#define MAX_DISTANCE 200
NewPing sonar1(TRIG1, ECHO1, MAX_DISTANCE);
NewPing sonar2(TRIG2, ECHO2, MAX_DISTANCE);
```

Figure 15 Source Code Pin Definition and Motor Regulator

Pin definitions in figure 15 for serial connection, driver motor, operating mode, webcam light, and ultrasonic sensor. 'NewPing' is used to initialize ultrasonic sensors.

c. Setup

```
void setup()
{
  // Mengaktifkan Serial untuk berkomunikasi antara perangkat
  SerialBT.begin("QuackBot");
  Serial.begin(115200);
  Serial2.begin(115200, SERIAL_8N1, RXD2, TXD2);

  // pengaturan mode
  pinMode(MODE1, INPUT_PULLUP);

  // Penyesuaian pin untuk tangan dan membuat relay tangan menjadi high karena relay low trigger
  pinMode(IN5, OUTPUT);
  pinMode(IN6, OUTPUT);
  digitalWrite(IN5, HIGH);
  digitalWrite(IN6, HIGH);

  // Penyesuaian pin untuk lampu dan membuat relay lampu menjadi high karena relay low trigger
  pinMode(LAMPU1, OUTPUT);
  pinMode(LAMPU2, OUTPUT);
  digitalWrite(LAMPU1, HIGH);
  digitalWrite(LAMPU2, HIGH);

  // penyesuaian pin motor driver sesuai kebutuhan
  pinMode(EN1, OUTPUT);
  pinMode(EN2, OUTPUT);
  pinMode(IN1, OUTPUT);
  pinMode(IN2, OUTPUT);
  pinMode(IN3, OUTPUT);
  pinMode(IN4, OUTPUT);
```

```
    // penyesuaian pin sensor ultrasonik sesuai kebutuhan
    pinMode(TRIG1, OUTPUT);
    pinMode(ECHO1, INPUT);
    pinMode(TRIG2, OUTPUT);
    pinMode(ECHO2, INPUT);
}
```

Figure 16 Source Code Setup

Figure 16 shows the initialization of Bluetooth, Serial, and pin settings. 'SerialBT' for Bluetooth, 'Serial' and 'Serial2' for serial communication with Raspberry Pi. Set the output pin mode for hand relays and lights, and set the driver motor pins as well as ultrasonic sensors.

d. Control Function

- **Function to turn on the light**

```
// fungsi untuk menyalakan lampu
void lampu(int StatusLamp)
{
  if (StatusLamp == 1) {
    Serial.println("menyalakan lampu dekat");
    digitalWrite(LAMPU1, LOW);
    digitalWrite(LAMPU2, HIGH);
  } else if (StatusLamp == 2) {
    Serial.println("menyalakan lampu jauh");
    digitalWrite(LAMPU1, HIGH);
    digitalWrite(LAMPU2, LOW);
  } else if (StatusLamp == 3) {
    Serial.println("menyalakan jauhdekat");
    digitalWrite(LAMPU1, LOW);
    digitalWrite(LAMPU2, LOW);
  } else {
    Serial.println("mematikan lampu");
    digitalWrite(LAMPU1, HIGH);
    digitalWrite(LAMPU2, HIGH);
  }
}
```

Figure 17 Function to turn on the light

- **Function To Lift Eggs Inside**

```
// fungsi untuk angkat telur ke dalam
void angkat()
{
  Serial.println("angkat telur");
  digitalWrite(IN5, LOW);
  digitalWrite(IN6, HIGH);
  delay(600);
  digitalWrite(IN5, HIGH);
  digitalWrite(IN6, HIGH);
  delay(1200);
  digitalWrite(IN5, HIGH);
  digitalWrite(IN6, LOW);
  delay(300);
  digitalWrite(IN5, HIGH);
  digitalWrite(IN6, HIGH);
}
```

Figure 18 Function To Lift Eggs Inside

- **Function To Turn the Wheel Forward**

```
// fungsi untuk memutar roda ke depan
void maju(int kecepatan)
{
  Serial.println("maju");
  digitalWrite(IN1, HIGH);
  digitalWrite(IN2, LOW);
  digitalWrite(IN3, HIGH);
  digitalWrite(IN4, LOW);
  analogWrite(EN1, kecepatan);
  analogWrite(EN2, kecepatan);
}
```

Figure 19 Function To Turn the Wheel Forward

- **Function To Turn the Wheel Backward**

```
// fungsi untuk memutar roda ke belakang
void mundur(int kecepatan)
{
  Serial.println("mundur");
  digitalWrite(IN1, LOW);
  digitalWrite(IN2, HIGH);
  digitalWrite(IN3, LOW);
  digitalWrite(IN4, HIGH);
  analogWrite(EN1, kecepatan);
  analogWrite(EN2, kecepatan);
}
```

Figure 20 Function To Turn the Wheel Backward

- **Function to stop wheel rotation**

```
// fungsi untuk menghentikan perputaran roda
void berhenti()
{
  Serial.println("berhenti");
  digitalWrite(IN1, LOW);
  digitalWrite(IN2, LOW);
  digitalWrite(IN3, LOW);
  digitalWrite(IN4, LOW);
  analogWrite(EN1, 0);
  analogWrite(EN2, 0);
}
```

Figure 21 Function to stop wheel rotation

- **Function To Turn the Wheel to the Right**

```
// fungsi untuk memutar roda ke kanan
void kanan(int kecepatan)
{
  Serial.println("belok kanan");
  digitalWrite(IN1, LOW);
  digitalWrite(IN2, HIGH);
  digitalWrite(IN3, HIGH);
  digitalWrite(IN4, LOW);
  analogWrite(EN1, kecepatan);
  analogWrite(EN2, kecepatan);
}
```

Figure 22 Function To Turn the Wheel to the Right

- **Function To Turn the Wheel to the Left**

```
// fungsi untuk memutar roda ke kiri
void kiri(int kecepatan)
{
  Serial.println("belok kiri");
  digitalWrite(IN1, HIGH);
  digitalWrite(IN2, LOW);
  digitalWrite(IN3, LOW);
  digitalWrite(IN4, HIGH);
  analogWrite(EN1, kecepatan);
  analogWrite(EN2, kecepatan);
}
```

Figure 23 Function To Turn the Wheel to the Left

e. Distance Measurement

```
// fungsi untuk mengukur jarak dari kedua sensor ultrasonik
void jarak()
{
  delay(50);
  unsigned int distanceCm1 = sonar1.ping_cm();
  Serial.print("jarak1 (cm): ");
  Serial.println(distanceCm1);

  delay(50);
  unsigned int distanceCm2 = sonar2.ping_cm();
  Serial.print("jarak2 (cm): ");
  Serial.println(distanceCm2);

  delay(100);
}
```

Figure 24 Distance Measurement

Function to measure distance using ultrasonic sensor as shown in figure 24. Measure the distance and print the results to the serial monitor.

f. Main Loop

```
void loop()
{
  // Memanggil fungsi untuk membaca jarak alat dengan halangan seperti tembok
  //jarak();

  // Apabila Mode diaktifkan, hanya menerima perintah manual melalui bluetooth
  if (MODE1 == 1)
  {
    Serial.print("Mode Bluetooth Only");
    // Ketika Perangkat bluetooth terhubung, Baca perintah yang dikirim
    if (SerialBT.available()) {
      // Membaca perintah apabila sesuai panggil fungsi
      char command = SerialBT.read();
      switch (command) {
        case 'X':
          angkat();
          break;
        case 'W':
          lampu(1);
          break;
        case 'w':
          lampu(0);
          break;
        case 'U':
          lampu(2);
          break;
        case 'u':
          lampu(0);
          break;
        case 'V':
          lampu(3);
          break;
        case 'v':
          lampu(0);
```

```
          break;
        case 's':
          maju(80);
          break;
        case 'S':
          berhenti();
          break;
        case 'F':
          maju(KecepatanNormal);
          break;
        case 'B':
          mundur(KecepatanNormal);
          break;
        case 'R':
          kanan(KecepatanNormal);
          break;
        case 'L':
          kiri(KecepatanNormal);
          break;
      }
    }
  }
  // Apabila Mode normal, alat menerima perintah dari RaspberryPi dan Bluetooth
  else
  {
    // Baca peintah yang dikirim melalui kabel Serial yang terhubung dengan RaspberryPi
    if (Serial2.available()) {
      // Membaca perintah apabila sesuai panggil fungsi
      char command = Serial2.read();
      switch (command) {
        case 'X':
          angkat();
          break;
        case 'W':
```

```
lampu(1);
  break;
case 'W':
  lampu(0);
  break;
case 'U':
  lampu(2);
  break;
case 'u':
  lampu(0);
  break;
case 'V':
  lampu(3);
  break;
case 'v':
  lampu(0);
  break;
case 's':
  maju(80);
  break;
case 'S':
  berhenti();
  break;
case 'F':
  maju(KecepatanNormal);
  break;
case 'B':
  mundur(KecepatanNormal);
  break;
case 'R':
  kanan(KecepatanNormal);
  break;
case 'L':
```

```
      kiri(KecepatanNormal);
      break;
    }
  }
  // Ketika ESP32 sudah tidak menerima perintah melalui Serial
  // ESP32 tetap bisa di hubungkan melalui Bluetooth untuk mengarahkan
  // Alat ke tepi tanpa perlu di angkat

  // Ketika Perangkat bluetooth terhubung, Baca perintah yang dikirim
  if (SerialBT.available()) {
    // Membaca perintah apabila sesuai panggil fungsi
    char command = SerialBT.read();
    switch (command) {
      case 'X':
        angkat();
        break;
      case 'W':
        lampu(1);
        break;
      case 'w':
        lampu(0);
        break;
      case 'U':
        lampu(2);
        break;
      case 'u':
        lampu(0);
        break;
      case 'V':
        lampu(3);
        break;
      case 'v':
        lampu(0);
```

```
        break;
      case 's':
        maju(80);
        break;
      case 'S':
        berhenti();
        break;
      case 'F':
        maju(KecepatanNormal);
        break;
      case 'B':
        mundur(KecepatanNormal);
        break;
      case 'R':
        kanan(KecepatanNormal);
        break;
      case 'L':
        kiri(KecepatanNormal);
        break;
    }
  }
}

// Apabila jarak alat dari sensor kiri/kanan di bawah 10cm, berhenti dan menjauh
// if (distanceCm1 <= 10) {
//   berhenti();
//   delay(500);
//   kiri(255);
//   delay(1000);
//   maju(255);
// }
// if (distanceCm2 <= 10) {
//   berhenti();
```

Figure 25 Main Loop

The main loop function found in figure 25 runs continuously. Check the operation mode (manual or normal) and read commands from Bluetooth or serial. If Mode1 is active, it only accepts manual commands via Bluetooth. Perform actions based on the commands received (drive the motor, turn on the lights, lift the eggs). Then in normal mode it receives commands from the Raspberry Pi via serial and Bluetooth.

5. Artificial Intelligence (AI) and IoT (Internet of Things) Testing

1. IoT System Testing on Quackbot Robot

In the IoT System test on the Quackbot Robot is carried out when the Robot is active. It can be seen in figure 26 is the appearance of the Quackbot Static website.

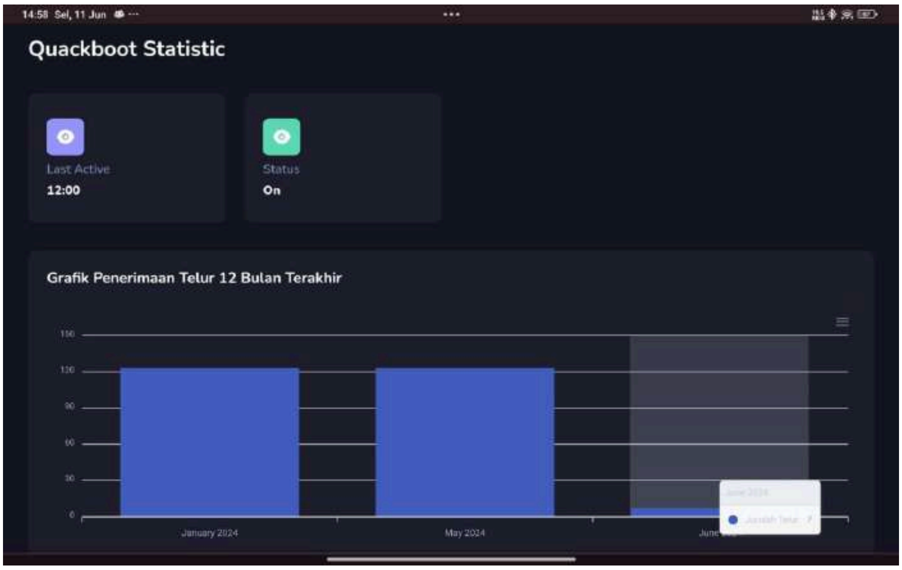
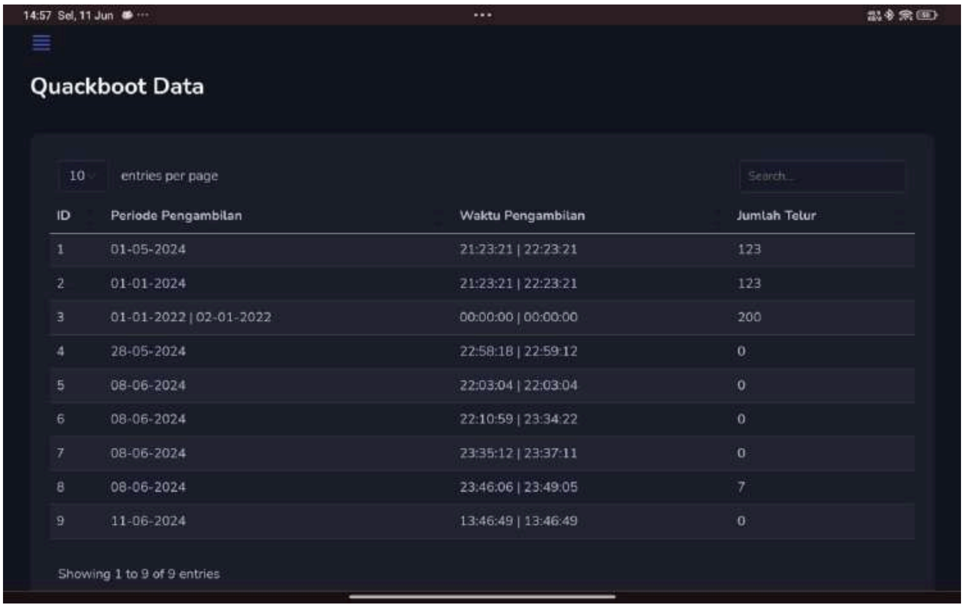


Figure 26 Quackbot Static

On the Quackbot Static website page displays the last active and status. At the time the test was carried out, it was at 12.00. Therefore, the website automatically reads the last active and on status. Furthermore, there is also a Graph of Egg Recipients in the Last 12 Months. It can be seen in figure 22 in June, when the test took place, only a total of 7 eggs were obtained.



ID	Periode Pengambilan	Waktu Pengambilan	Jumlah Telur
1	01-05-2024	21:23:21 | 22:23:21	123
2	01-01-2024	21:23:21 | 22:23:21	123
3	01-01-2022 | 02-01-2022	00:00:00 | 00:00:00	200
4	28-05-2024	22:58:18 | 22:59:12	0
5	08-06-2024	22:03:04 | 22:03:04	0
6	08-06-2024	22:10:59 | 23:34:22	0
7	08-06-2024	23:35:12 | 23:37:11	0
8	08-06-2024	23:46:06 | 23:49:05	7
9	11-06-2024	13:46:49 | 13:46:49	0

Figure 27 Quackbot Data

Next on the Quackbot website page contained in figure 27. Data is a page that displays the retriever period, namely date, month, and year. The test was carried out on June 11, 2024. Then there are 2 times of retrieval on the left side is the time when the robot is activated and on the right is the time when the robot is inactive. Next, there is the number of eggs produced. In the picture when the test does not obtain eggs or 0.

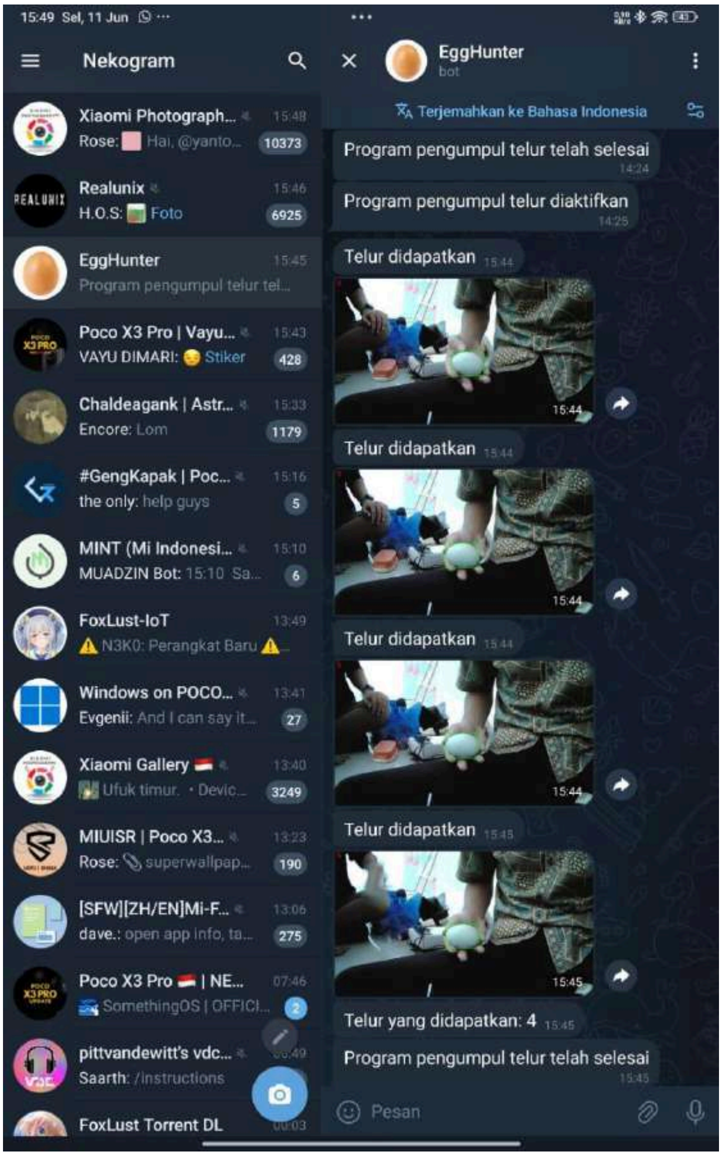


Figure 28 Bot Telegram EggHunter

The Quackbot robot is not only integrated on the Website but can also be integrated through the Telegram Bot as shown in figure 28. This can make it easier for users to monitor the Robot in real-time. The Telegram Bot provides information such as active and inactive Robots, and Robots also send notifications directly when the Robot detects and picks up an egg, as well as notifications of the number of eggs that have been obtained when the Robot is operating.

2. Testing Artificial Intelligence (AI) Systems on Quackbot Robots

1. Duck Egg Dataset

   Dataset collection can be done by inputting a photo of a duck egg as a sample of the duck egg dataset.

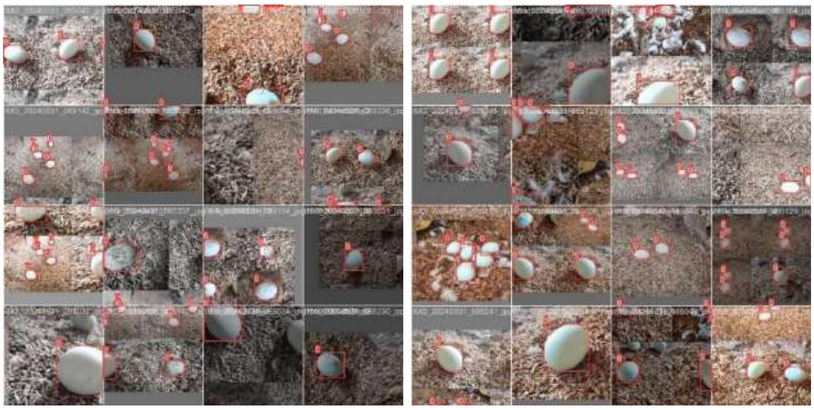


Figure 29 Duck Egg Dataset

Figure 29 is a dataset of eggs that have been labeled. This dataset was obtained through direct data collection carried out in the duck cage of the IPB Vocational School. This dataset will be used to train Machine Learning models to recognize eggs.

2. Graph and Confusion Matrix Training Results

After the model was trained, the F1 Convidence graph was obtained as follows:

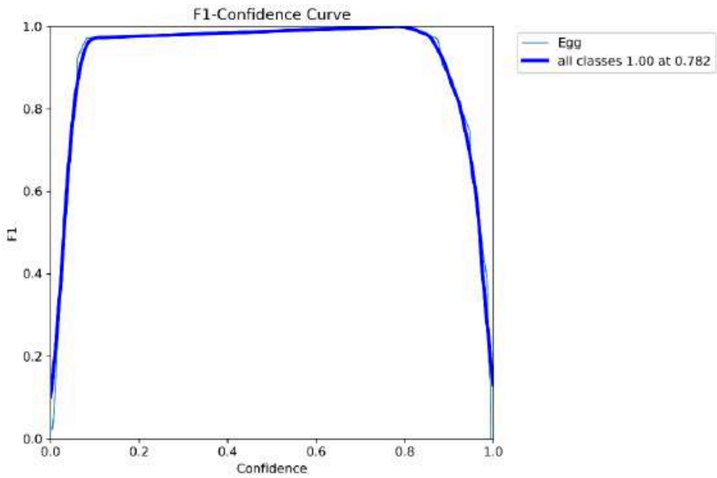


Figure 30 F1-Confidence Curve

Figure 30 shows the F1 Convidence which shows the relationship between the F1 Score and the confidence threshold value in the object detection model. This value indicates how confident the model is in the predictions it produces, resulting in the best balance between Precision and Recall. In the graph of the training results, the highest F1 score of 1.00 was obtained at Confidence 0.782. This indicates that the curve maintains a high F1 score across various confidence levels, indicating the model performs well and is resistant to various thresholds.

The confusion matrix from the results of this training is also as follows:

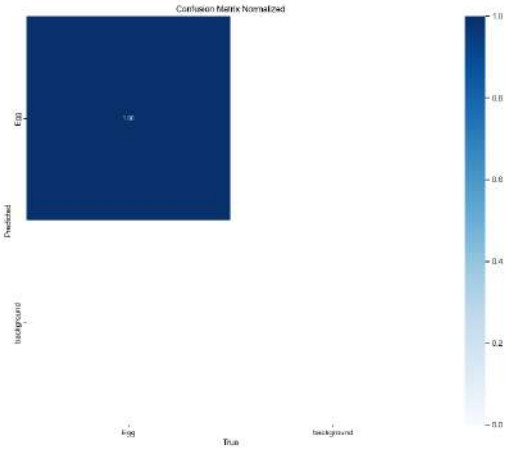


Figure 31 Confusion Matrix Normalized

From the confusion matrix in figure 31, it can be seen that as many as 100% of eggs are detected as eggs. Meanwhile, no eggs were detected as a background. This means that this model has a lot of promising True Positives.

At the validation stage, it also shows positive things. All eggs in the validation dataset were detected well.

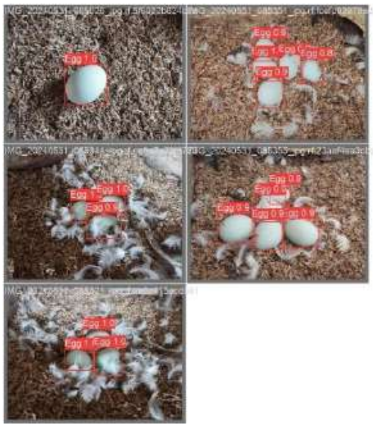


Figure 32 Validation test

In figure 32 it can be seen that all eggs are detected well, with a fairly high confidence score, between 90% - 100%.

3. Results of Machine Learning Model Experiments
   After testing data collection, the results of the experiment were obtained as shown in figure 33.

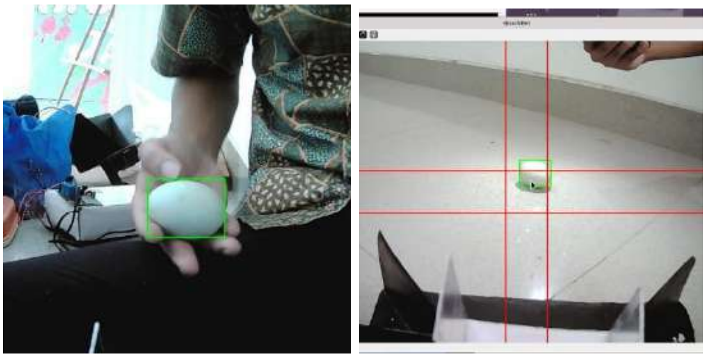


Figure 33 Duck Egg Detection Experiment

From the results of the experiment on the machine learning model that was made, the robot can detect eggs quite well. However, to be able to detect eggs properly, the robot needs enough lighting so that the camera can get a clear image so that it can be detected by the robot.

CONCLUSION

In making the IoT System Final Project Report based on the test results, it can be concluded as follows:

1. Group 1 of the IoT System Project succeeded in creating and developing a Robot with the name "Quackbot". The robot is a smart robot that collects duck eggs automatically based on Artificial Intelligence (AI) and the Internet of Things (IoT).
2. The robot successfully tested an Artificial Intelligence-based robot to automatically pick up duck eggs equipped with a camera to detect the presence of an egg. After the camera detects the duck egg, the Robot manages to do its job of picking up an egg until it enters the Robot's body perfectly.
3. The integration of the Internet of Things in the Quackbot Robot was also successfully tested. When the camera has detected an egg, the role of IoT, namely the robot, successfully communicates with the website to record the number of eggs every day along with when the robot is active and inactive will be recorded on the website in real-time.
4. The Quackbot robot can be used by students and employees of the Duck Cage Technology and Livestock Management to make it easier to take duck eggs automatically, and there is also valid data contained on the website, so that there is no more cheating, and also has a positive impact on the Livestock Technology and Management Study Program.

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