

Egg Saver

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Abstract

Eggs left on the ground for extended periods are prone to contamination due to environmental factors and poor ergonomics. This project presents Egg Saver, an egg collecting machine that facilitate in collecting the floor eggs in poultry farming. The Egg Saver, powered by an ESP32 microcontroller Arduino system, uses a 12V motor to perform all movements and a gripping mechanism to transfer eggs to a designated storage area, improving operational efficiency. It is controllable via the Blynk app, enhancing user convenience. Capable of travelling at 0.1 m/s to 0.3 m/s on flat surfaces, the system can collect eggs within approximately one minute. With some improvement in the future, the Egg Saver demonstrates significant capability in helping Malaysia's poultry farming sector.

1. Introduction

Floor eggs, defined as eggs laid outside the nest by hens, present a significant challenge in cage-free systems. Eggs left on the ground are vulnerable to predation by rodents, insects, and other egg-eating animals. Over time, environmental factors such as moisture, temperature, and microbial activity contribute to egg decomposition, while soil-borne pathogens like bacteria and fungi can accelerate deterioration. Fluctuations in environmental conditions, including temperature, rainfall, or soil composition, further affect egg survival [1].

Manual collection of floor eggs is labor-intensive, time-consuming, and inefficient. These eggs are prone to breakage and must be collected daily, with the frequency depending on farm size and production goals. As a result, farmers face increased workload and operational challenges. To address these issues, egg collecting machines have emerged as a promising alternative. Automated systems can reduce labor, improve efficiency, and maintain egg quality. Over the past decade, research has focused on integrating robotics, machine vision, and sensing technologies to optimize egg collection processes.

Earlier work by Vroegindeweij et al. [2] introduced mechanical spring-based egg collectors adaptable to various floor types. This study laid the foundation for combining practical collection mechanisms with navigation algorithms. In a related study, Vroegindeweij et al. [3] developed the NURAC path-planning algorithm for autonomous robots. The algorithm optimizes movement to minimize travel distance, navigate littered floors, and avoid obstacles. Experiments demonstrated significant reductions in collection time compared to human patterns and showed that robots could adapt to variable floor conditions. These studies highlighted the potential for integrating autonomous navigation with egg collection tasks, reducing labor, and improving operational efficiency.

Building on this foundation, Vroegindeweij et al. [4] evaluated PoultryBot, an autonomous mobile platform intended for deployment in poultry houses. The study assessed navigation accuracy, egg detection, and retrieval

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performance under realistic farm conditions. While PoultryBot successfully located and retrieved eggs autonomously, the overall retrieval rate remained below 50%, highlighting limitations in perception and manipulation capabilities. The findings emphasized the need for continued refinement in robotic handling and object recognition for commercial viability.

Chang et al. [5] developed a precision-based automatic egg collector for real-time operation in poultry houses. The robot consists of a mobile chassis, conveyor-based egg collection mechanism, storage tanks, and sorting units. It integrates IoT-enabled control, allowing remote monitoring and operation. Soft grippers and carefully controlled collection speeds minimize egg damage. The combination of mechanical optimization and remote automation significantly reduces labor while maintaining high egg integrity. IoT integration also enables data collection on egg locations, collection efficiency, and system performance, providing actionable insights for farm management.

Chou et al. [6] proposed a smart poultry robot optimized for free-range farms. The system integrates image-processing algorithms to detect egg positions accurately and employs semi-autonomous operation to reduce disturbance to hens. Adaptable visual detection accommodates varying lighting conditions and egg appearances, highlighting the value of AI-driven perception. The study also emphasizes practical considerations such as cost-efficiency, scalability, and ease of integration with existing farm infrastructure.

Owusu et al. [7] developed an automated egg collecting and sorting system to address the inefficiencies of manual collection. The system integrates a conveyor-based mechanism with sensors and servo motors to sort eggs by weight into large, medium, and small categories following FAO standards. A Human-Machine Interface (HMI) provides local control, while an Android mobile application allows remote monitoring and performance tracking. The system improves collection efficiency, reduces labor requirements, minimizes breakage, and maintains egg quality. Its portability and cost-effectiveness make it suitable for small to medium-sized operations, while automated sorting ensures consistent categorization for processing or market purposes. Integration of HMI and mobile monitoring offers real-time insights, enabling farmers to optimize workflow and reduce human error.

Collectively, these studies illustrate the progression from mechanical solutions to integrated systems leveraging robotics, sensing, and artificial intelligence. Despite advancements, challenges remain in combining robust mechanical handling with advanced perception, ensuring adaptability across diverse poultry house conditions, and managing costs for smaller farms. Nonetheless, autonomous egg collection demonstrates significant potential to enhance efficiency, reduce labor, improve egg quality, and support animal welfare. Continued research integrating robotics, machine vision, and smart data management is critical for scalable and commercially viable poultry farm automation.

In this study, the focus was on developing an egg-collecting machine as a preliminary step toward a semi-automatic system to reduce human labor in collecting floor eggs. By integrating mechanical components such as a conveyor belt and soft gripper, the system guides eggs toward a collection storage area. Additionally, IoT integration allows for remote control, enhancing operational flexibility.

2. Material and Method

The Egg Saver system is composed of several subsystems and key components, as shown in Fig. 1. The main subsystems include the body, suction mechanism, motor system, and control programming, which ensures the various components operate synchronously and efficiently.

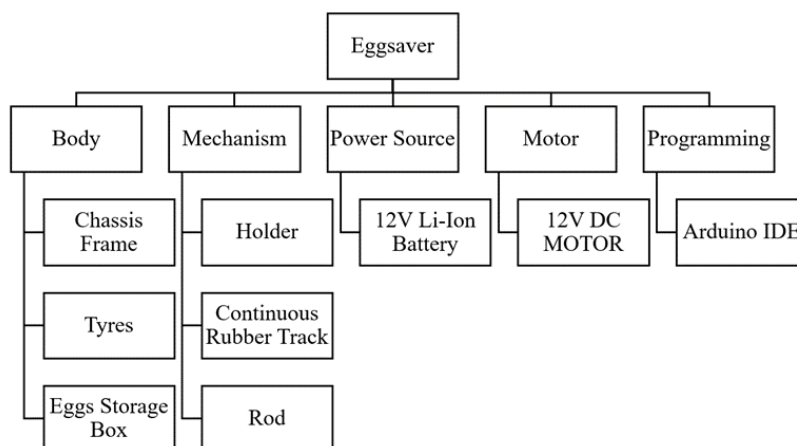


Fig. 1 Main components in EggSaver system

2.1 Egg Saver Design

The Egg Saver consists of several main components: the body, the scoop/collection mechanism, the motor system, and the Arduino board, as illustrated in Fig. 2. The body includes a chassis frame, wheels or tyres, and an egg storage box. The chassis provides the main structural support and is built from lightweight, durable materials such as stainless steel or polymer. It is equipped with wheels or tyres to allow smooth movement across various surfaces, while the storage box is designed to hold eggs securely after collection.

The collection mechanism comprises a holder, a rubber continuous track that moves the holder, and a guiding rod to direct the eggs into the storage box. Power transmission is achieved through a system of gears that transfer energy from the motor to the moving components. The motor system uses a 12V DC motor to provide the required power for both mobility and egg collection. The machine is controlled through Arduino IDE programming, which ensures that the components work in synchrony and operate efficiently.

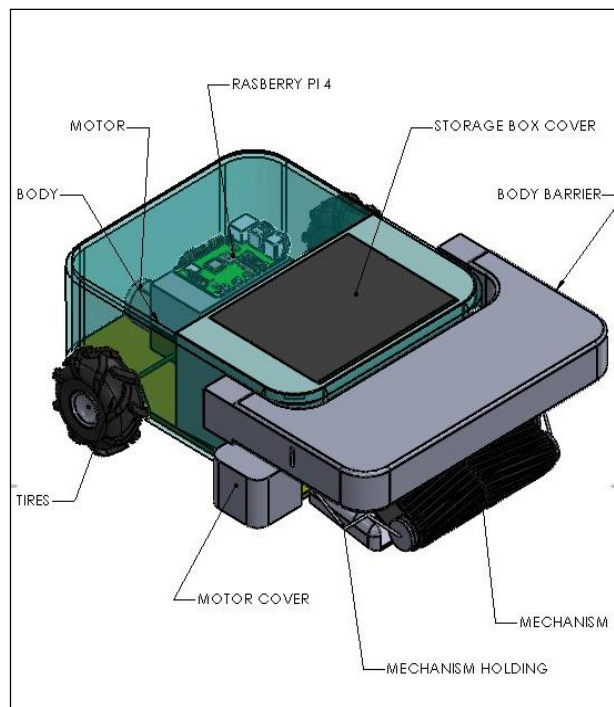


Fig. 2 The initial design of Egg Saver

To operate, the Egg Saver is placed inside a chicken coop constructed to match the project's specifications. Once powered on, the motors connected to the two rear wheels and the collection system are activated. The machine collects chicken eggs using a rubber mechanism designed with appropriate grip strength and radial dimensions to accommodate average egg sizes. Collected eggs are then guided through the front section of the machine and deposited into the storage box. A barrier above the collection mechanism prevents chickens from encountering it, ensuring safe operation. Additionally, a motor is installed on each rear wheel, allowing the machine to turn by activating one wheel at a time, according to command from the Raspberry Pi 4 control board.

2.2 Circuit Connection

The Egg Saver is operated via the Blynk smartphone application, which provides a user interface with buttons for forward, backward, left, and right movement, as well as a control for the collection mechanism motor. Power is supplied by a dry cell to the ESP32 Dev1 microcontroller, which then transmits signals to the L298N dual motor driver. The driver distributes power to the motors in accordance with programmed commands. The motors drive the rear wheels, while two additional front wheels are included for stability, ensuring efficient operation within the poultry house environment as shown in Fig. 3.

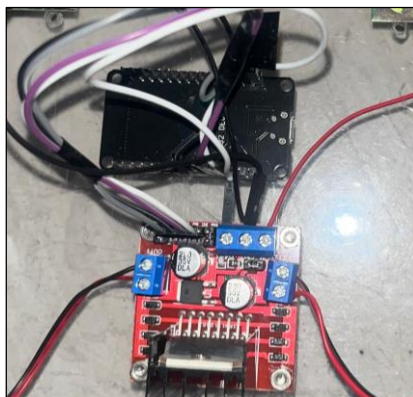


Fig. 3 Circuit connection

2.3 Programming

Programming involves writing specific code to define the actions of the Egg Saver. The program used in this project enables manual control of the machine's movements. The Egg Saver is capable of four types of movement: forward, backward, left, and right, all of which operate according to the desired user inputs. Fig. 4 illustrates the programming code for the Egg Saver machine.

```

EggSaver_coding_program.ino
1  #define BLYNK_TEMPLATE_ID "TMPL65i2xXkEp"
2  #define BLYNK_TEMPLATE_NAME "Eggsaver"
3  #define BLYNK_AUTH_TOKEN "cFFBhu9XqbKgy4k0u0iujbE3ghvwEFXa"
4
5
6  #define BLYNK_PRINT Serial
7
8  #include <WiFi.h>
9  #include <WiFiClient.h>
10 #include <BlynkSimpleEsp32.h>
11
12 char auth[] = BLYNK_AUTH_TOKEN;
13
14 char ssid[] = "helo";
15 char pass[] = "123456789";
16
17
18 int IN1 = 2;
19 int IN2 = 4;
20 int IN3 = 5;
21 int IN4 = 13;
22
23 void setup()
24 {
25
26   Serial.begin(115200);
27
28   pinMode(IN1, OUTPUT);
29   pinMode(IN2, OUTPUT);
30   pinMode(IN3, OUTPUT);
31   pinMode(IN4, OUTPUT);
32
33
34   Blynk.begin(auth, ssid, pass, "blynk.cloud", 8080);
35
36

```

Fig. 4 Egg Saver coding

2.5 Material Selection

The Egg Saver incorporates materials with unique properties, allowing multi-directional movement that can be manually controlled via a smartphone. Strong electromechanical coupling is evident in the Egg Saver, effectively converting electrical energy into mechanical energy and vice versa. The primary material used for the body is stainless steel. Originally, aluminium was intended; however, stainless steel was chosen due to its flexibility, making it easier to shape for this project. It is also a suitable material because of its high strength and good bending properties, while being more cost-effective and durable than aluminium. Stainless steel is additionally rust-resistant, ensuring longevity.

The chassis is constructed from lightweight yet strong materials such as stainless steel. It supports all components and withstands the demanding conditions of a farm environment. Stainless steel is widely used in construction due to its durability and excellent resistance to corrosion. The robot features a four-wheel configuration with differential drive, enabling precise movement and the ability to turn on the spot. Its compact

dimensions allow it to navigate under perches and through narrow aisles typical of poultry farms. The egg collection mechanism is designed for gentle handling. Egg collection channels are angled appropriately to accommodate the surface of the chicken coop, allowing eggs to be raised easily and safely. The grippers are made from materials such as rubber and adhesive tape, which securely hold the eggs. Control of the grippers is achieved using precision servo motors and pneumatic actuators, ensuring smooth and accurate operation.

3. Result and Discussion

The Egg Saver has undergone performance testing, and observations regarding challenges encountered during the project are also included. Based on the outcomes of these tests, the advantages and limitations of the project are discussed, along with a summary of potential solutions.

3.1 The Prototype of Egg Saver Machine

Fig. 5(a) shows the prototype of the Egg Saver. Within the body of the Egg Saver, there are two 12V DC gear motors that provide the primary function of moving the machine as shown in Fig. 5(b). Additionally, an ESP32 module serves as a Wi-Fi and Bluetooth provider, connecting the machine to the user's phone or controller to manage its movement according to the environment. The system also includes a motor driver, which amplifies electrical signals to control the motors, enables precise speed regulation, and provides robust protection features such as over-current protection (OCP) and over-temperature protection (OTP). A storage box capable of holding 16 chicken eggs is incorporated, along with a barrier to reinforce the position of the storage box (Fig. 5(c)).

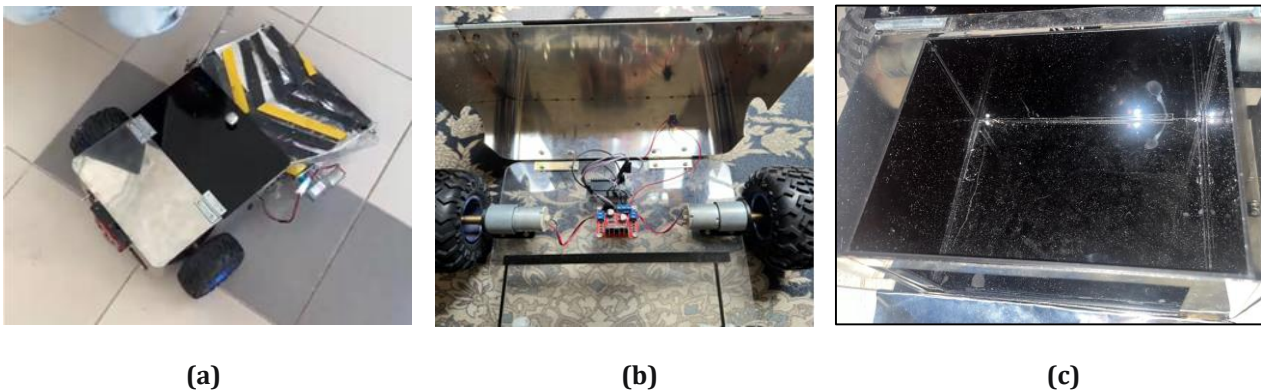


Fig. 5 Egg Saver Machine (a) The Prototype of the Egg Saver (b) 12V DC Gear Motors (c) Storage Box

Fig. 6 shows the mechanism used to collect eggs and transfer them into the storage box. The scoop mechanism is designed to operate at an appropriate angle, allowing eggs to be lifted smoothly and safely. It controls the movement of the eggs and grips their surfaces to ensure they are collected properly and efficiently. This mechanism is powered by a dual shaft 3V motor, which provides kinetic energy to the conveyor, enabling the bending action of the conveyor to function effectively.

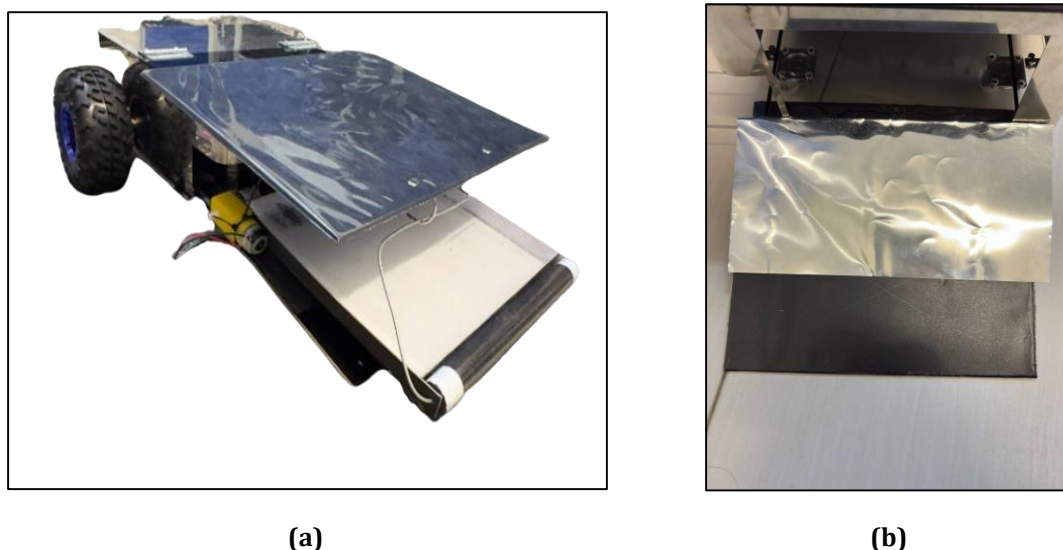


Fig. 6 (a) Scoop mechanism from (a) Side view (b) Scoop mechanism from top view

3.2 Performance Test

This prototype has been tested in terms of movement and control via the controller, as well as the functionality of the scoop mechanism and egg collection time. The Egg Saver was analysed in terms of force, torque, power requirements, material selection, programming, and circuit connections. Torque calculations for the machine's movement indicated the torque required at each wheel to overcome rolling resistance. Power consumption, including that of the conveyor belt motor and movement motors, was evaluated while accounting for system efficiency. The programming incorporated efficient movement control algorithms to optimise the machine's motion. During actual testing, the programming and controller performed well, enabling forward, backward, left, and right movements. The system can travel at speeds of 0.1 to 0.3 m/s on flat surfaces.

Table 1 Test results

No. of Test	Time taken for egg entering the storage box (seconds, s)					Average time (s)
T1	8.26	8.43	8.87	8.21	9.06	8.566
T2	8.54	7.94	7.89	8.41	9.04	8.364
T3	8.67	8.56	8.94	9.21	8.71	8.818
T4	8.43	9.37	9.23	8.87	8.64	8.908
T5	9.54	9.36	8.46	8.23	8.68	8.854
Average Time Taken						8.702

The Egg Saver system was also tested for its egg collection efficiency and the time required to transfer eggs into the storage box. Table 1 presents the results of these tests. On average, the machine takes 8.7 seconds to place eggs into the storage box, compared to approximately 2 seconds when collected manually. This demonstrates that this machine is currently less efficient than manual collection.

4. Conclusion

This prototype has been tested in terms of movement and control via the controller, as well as the functionality of the scoop mechanism and the egg collection process. During practical testing, the programming and controller performed effectively, enabling forward, backward, left, and right movements. The system can travel at speeds of 0.1 to 0.3 m/s on flat surfaces. The Egg Saver system was also assessed for its egg collection efficiency and the time required to transfer eggs into the storage box. On average, the machine takes 8.7 seconds to place eggs into the storage box, compared to approximately 2 seconds when collected manually. Although the machine is currently less efficient than manual collection, it can still reduce the physical effort required by humans. Future improvements are required to further enhance its performance. Besides improvements to the scooping system, the integration of obstacle-detection sensors within the coop allows the machine to navigate more efficiently towards the eggs.

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Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design:** Muhammad Danish Imran Mohd Yusof, Thaqif Aiman Khalid, Ammar Sufi Sulaini; **data collection:** Muhammad Danish Imran Mohd Yusof, Thaqif Aiman Khalid, Ammar Sufi Sulaini; **analysis and interpretation of results:** Muhammad Danish Imran Mohd Yusof, Thaqif Aiman Khalid, Ammar Sufi Sulaini; **draft manuscript preparation:** Siti Mariam Basharie.

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