DESIGN & PERFORMANCE ANALYSIS OF AUTOMATED COCONUT SCRAPING MACHINE

A Project

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DECLARATION

We hereby declare that the undergraduate thesis work reported in this thesis has been performed by us under the supervision of Md. Faruque Hossain, Lecturer, Department of Mechanical Engineering, Sonargaon University (SU) and this report has not been submitted in part or full elsewhere for any other degree, reward or for any other purpose. we do solemnly and sincerely declare that all and every right in the copyright of this practicum report belong to the Department of Mechanical Engineering, Sonargaon University (SU). Any reproduction or use in any form or by any means whatsoever is prohibited without the written consent of Sonargaon University (SU).

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ABSTRACT

Coconut is extensively used in the food business, including both large-scale commercial processing plants and home kitchens. The process of harvesting coconuts is somewhat time-consuming, and the hand execution requires substantial physical effort, making it an inefficient method. An automated coconut scraping machine has been designed to address this difficulty as part of the project. To assess its efficacy, 3 coconuts were thoroughly scraped, and the necessary duration for each was precisely measured. The average time required to scrape a single coconut was found as 15 minutes. The electrical energy utilized in the coconut scraping process was accurately measured, indicating an average usage of 0.15 kWh per coconut. The operating expenditure for scraping one coconut, based on an electricity pricing of 7 taka per kWh, was determined to be a cost-effective 1 taka and 5 paisa. The machine efficiently produces finely grated coconut with the requisite consistency for various culinary uses, obviating the necessity for manual effort. This device possesses considerable potential for domestic integration, offering a decrease in human labor. The low power usage guarantees economical running expenses for a diverse array of customers.

CHAPTER 1
INTRODUCTION

1.1 Introduction

Coconut scraping is an essential yet labor-intensive task in households, restaurants, and food processing industries, particularly in regions where coconut is a staple ingredient. Traditionally, scraping coconut by hand using manual tools is time-consuming, physically demanding, and poses a risk of injury. To address these challenges, the Automated Coconut Scraping Machine project proposes a solution that is efficient, safe, and user-friendly.

The automated machine is designed to simplify the coconut scraping process by using an electric motor-driven mechanism that can quickly and uniformly extract coconut meat from the shell. The user simply places the halved coconut into the holder, and the machine takes care of the scraping process with minimal human effort [1].

By automating this repetitive task, the machine aims to save time, reduce physical strain, and enhance safety. It also ensures consistent quality and quantity of coconut scrapings, which is valuable for both domestic cooking and commercial food production. Overall, this project combines mechanical design, motor control, and safety features to deliver a practical tool that improves everyday life and productivity [2-3].

1.2 Scope & Objectives

The Automated Coconut Scraping Machine project focuses on designing a system that efficiently scrapes coconut meat with minimal human intervention. The machine is intended for use in households, restaurants, and small-scale industries where coconuts are frequently used. It aims to replace manual scraping methods with a safer, faster, and more consistent mechanical solution. The project covers the mechanical design, motor integration, safety mechanisms, and user interface development to ensure ease of operation and maintenance. Future expansions may include size adaptability for different coconut varieties and improvements in energy efficiency. Objectives of this projects are mentioned below:

1. To design an automatic coconut scraper machine.
2. To analyze the performance of produced automatic coconut scraper machine.

1.3 Use Of Home Work

The development of the Automated Coconut Scraping Machine required extensive background research and planning through homework activities. These included:

- Understanding Traditional Methods: Studying the manual process of coconut scraping to identify pain points such as time consumption, risk of injury, and inconsistency in output.
- Market Research: Investigating existing coconut scraping machines to understand their limitations, such as cost, complexity, or lack of automation, and finding opportunities for improvement.
- Design Planning: Sketching initial designs and creating layout diagrams to plan the mechanical structure and motor setup.
- Component Selection: Researching and selecting appropriate motors, blades, housings, and safety mechanisms suitable for scraping hard coconut shells effectively.
- Safety Studies: Analyzing safety requirements to ensure the machine would be user-friendly and accident-proof during operation.
- Technical Knowledge Building: Learning about motor control circuits, mechanical gearing, material strength, and ergonomics to apply correct engineering principles.
- Cost Estimation: Preparing a cost analysis to design a machine that is both effective and affordable for household and small-scale users.

1.4 Need For Home Work of Automated Coconut Scraping

Homework was essential in the development of the Automated Coconut Scraping Machine to ensure the project was well-planned, efficient, and successful. The major reasons for carrying out detailed homework were:

- Understanding User Requirements: To accurately identify the needs and expectations of users, such as safety, ease of use, speed, and low maintenance.

- Identifying Challenges: To study the difficulties involved in manual coconut scraping and find out the specific problems the machine should solve.
- Technical Preparation: To gather knowledge about mechanical components, motors, power requirements, blade materials, and control systems necessary for building a reliable machine.
- Design Optimization: To create an effective design by comparing different mechanisms, materials, and methods, leading to a machine that is efficient, durable, and cost-effective.
- Safety Considerations: To research potential risks and design safety features that prevent user injury during operation.
- Market Analysis: To understand existing products, spot their drawbacks, and plan how to offer a better, more competitive solution.
- Budget Planning: To estimate the cost of production and select affordable yet high-quality components, keeping the final product accessible to the target users.

1.5 Problem Statement

Coconut scraping is a common yet tedious and time-consuming task, especially in households, restaurants, and food industries where coconuts are regularly used. Traditional manual scraping methods involve significant physical effort, expose users to the risk of hand injuries, and often result in inconsistent quality and quantity of coconut scrapings.

There is a lack of affordable, compact, and user-friendly automated solutions specifically designed for efficient coconut scraping at home and small businesses. Therefore, there is a pressing need to develop an Automated Coconut Scraping Machine that minimizes manual labor, enhances safety, reduces processing time, and delivers consistent output, all while being cost-effective and easy to operate.

1.6 Project Management

Effective project management was crucial to successfully designing and developing the Automated Coconut Scraping Machine. The project was divided into clear phases, each

with specific tasks, timelines, and deliverables to ensure systematic progress and timely completion.

- Project Planning
- Resource Management
- Design and Development
- Fabrication and Assembly
- Testing and Quality Control
- Risk Management
- Documentation and Reporting
- Final Review and Presentation

CHAPTER 2
CONSTRUCTION

2.1 Introduction

Coconut is widely used in cooking, cosmetics, and various industries, but extracting coconut meat from the shell is a challenging and time-consuming task. Traditionally, coconut scraping is done manually using hand tools, which requires considerable effort and poses a risk of injuries such as cuts or hand strain. As the demand for convenience and safety in food preparation increases, there is a strong need for a more efficient solution [4].

The Automated Coconut Scraping Machine is designed to address these challenges by automating the scraping process. With a simple setup, the user can place the coconut half onto the machine, and the motor-driven scraper will extract the coconut meat quickly, uniformly, and safely. This project aims to reduce human effort, minimize the risk of injuries, and ensure consistency in scraping, making it ideal for household use, restaurants, and small-scale industries [5-6].

2.2 Methodology

The development of the Automated Coconut Scraping Machine followed a structured and systematic approach to ensure the design, functionality, and safety of the machine. The methodology can be divided into the following key phases:

2.2.1 Research and Planning

Problem Analysis: Analyzed the traditional coconut scraping methods and identified the key issues: time consumption, physical effort, and safety concerns.

Literature Review: Studied existing automated scraping machines and other related mechanical systems to identify feasible design approaches and technological requirements.

2.2.2 Design and Development

Conceptual Design: Developed initial concepts for the scraping mechanism, considering motor types, blade materials, and the safety features required.

Material Selection: Chose durable materials for the construction of the machine, such as stainless steel for the scraper blades and food-safe plastics for the housing.

Mechanical Design: Used CAD software to create detailed drawings of the machine's structure, including dimensions, motor placement, and blade assembly.

2.2.3 Prototype Development

Fabrication of Parts: Manufactured the mechanical parts using appropriate tools and machinery.

Assembly: Assembled the components, ensuring alignment of motor, blade, and control system to work seamlessly during operation.

2.2.4 Electrical and Control System Integration

Motor Selection: Chose a motor with sufficient torque and speed to scrape the coconut efficiently without overloading.

Control Circuit Design: Developed the electrical circuit, including switches, sensors, and power supply, ensuring smooth and safe operation.

Automation: Integrated a simple user interface that allows the machine to function at the press of a button, with sensors to detect the position of the coconut and automatically adjust the scraping mechanism.

2.2.5 Testing and Troubleshooting

Initial Testing: Ran tests to evaluate the scraping efficiency, speed, and consistency of the machine.

Safety Testing: Checked for any safety hazards, including motor overheating, blade exposure, and electrical short circuits.

Performance Improvements: Based on feedback and observations, adjustments were made to enhance performance, such as modifying the blade design or adjusting motor speeds.

2.2.6 Final Refinements and Packaging

Ergonomic Enhancements: Refined the machine's design to ensure it is easy to operate and maintain, with added safety features like a protective cover for the blades.

User Manual: Created a simple user manual with instructions for assembly, operation, and maintenance of the machine.

2.3 Block Diagram

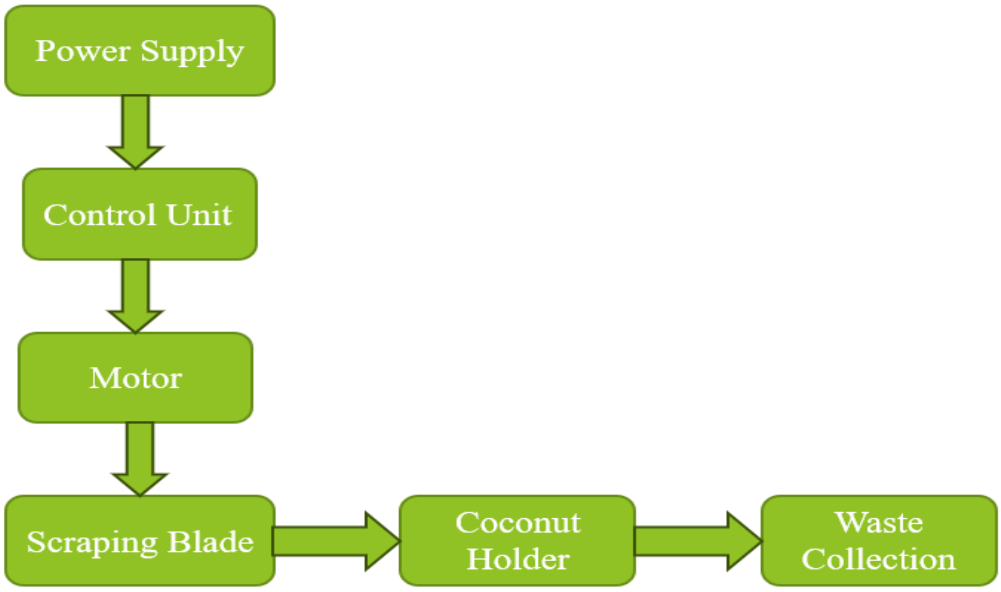


Figure 2.1: Block Diagram of Project

2.4 Working Principal

The design proposed in this study eliminates virtually all hazards related to coconut scrapers. It is a fully-automated machine that reduces both risk and effort on the part of the operator. The system uses a shaft with holder to hold half cut coconut in place. This holder shaft is held in place by mounts designed for it. Also a frame is made to hold the entire mechanism. On the other side has another shaft that is mounted horizontally with scraping tool attached to it at one end. At the other end it has a motor attached to the shaft. The motor is powered by our electrical circuit to move the scraper tool and the coconut can be pushed against it to achieve coconut scraping in a short time without much manual effort.Upon mounting, the scraping of the coconut is completely automatic.

2.5 Project Overview



Figure 2.2: Our Complete Overview Picture

2.6 Components list with price

Table 2.1: List of Components

Sl. No.	Components List	Quantity	Price
1	Pump Motor	1	3,000
2	Stainless Steel		3,000
3	Others		2,000
Total:			**8,000/-**

CHAPTER 3
EQUIPMENTS & COMPONENTS

3.1 Electric Motor

In the Automated Coconut Scraping Machine Project, the electric motor plays a pivotal role in powering the mechanism that scrapes the coconut. Below is an in-depth look at the electric motor, specifically designed for this application:

3.1.1 Motor Type Selection

For this project, a DC motor is an ideal choice due to its precision in speed control and high torque capability at low speeds. This ensures that the machine can operate efficiently and consistently, scraping the coconut meat effectively. A DC motor with high torque is needed because coconut shells are tough, and the motor must have enough power to rotate the scraping mechanism without stalling.

DC Motor (Brushed or Brushless): A Brushed DC Motor (BDC) is generally easier to control and less expensive. However, a Brushless DC Motor (BLDC) would offer higher efficiency, longer lifespan, and less maintenance but at a higher cost.

3.1.2 Motor Specifications

Power Rating: The motor should have a power rating between 0.5 HP (375 W) to 1 HP (750 W). This range will provide sufficient power for the motor to scrape the coconut quickly and efficiently while avoiding motor overload.

Torque: Since coconut shells are hard, the motor should produce high torque to allow the scraper blades to move smoothly and scrape the coconut meat effectively. A torque rating of 2-5 Nm should be sufficient.

Speed: The motor speed should be in the range of 500-1000 RPM. This moderate speed allows for a controlled scraping process without damaging the coconut or overloading the machine.

For DC motors: The motor would typically operate on 24V DC or 12V DC, providing good control over the speed and ensuring safety in household and small-scale commercial use.

For AC motors: If using an AC induction motor, the power supply would be 220V AC (common household voltage in many regions).

Current Rating: The current required by the motor will depend on the power and voltage specifications. For a 24V DC motor, the current could range from 15 to 30 Amps.

3.1.3 Motor Features

To ensure optimal performance and safety, several features are incorporated:

Speed Control: The motor will be equipped with a PWM (Pulse Width Modulation) controller to provide adjustable speed control. This allows users to vary the scraping speed based on the type and size of the coconut.

Reversibility: Some designs incorporate the ability to reverse the motor's direction, which can help clean the scraping blades or remove debris. This feature also allows for easier maintenance.

Overload Protection: A thermal overload protection circuit will be included in the motor design to prevent overheating. The motor will automatically shut off if the temperature exceeds a certain limit, preventing damage.

High Torque at Low Speeds: This ensures that the motor can provide consistent power to scrape the coconut flesh without losing efficiency or causing strain on the motor.

3.1.4 Motor Mounting and Integration

The electric motor needs to be securely mounted on the machine to ensure smooth operation and prevent vibrations:

Mounting: The motor will be fixed to a rigid frame to minimize vibrations. It should be aligned properly with the scraper blades to transfer power efficiently.

Coupling: The motor's output shaft will be coupled with the scraper mechanism using a gearbox or a belt-drive system. A gearbox with a 3:1 or 5:1 ratio will help reduce the motor speed and increase the torque, providing the necessary force to scrape the coconut without causing motor strain.

3.1.5 Power Supply

The electric motor will be powered by an external source depending on its type:

For DC Motor: A 12V or 24V DC power supply is typically used. The DC motor can be powered either by a battery or a regulated DC power supply, which can provide stable and consistent power for continuous operation.

For AC Motor: If using an AC motor, the machine can be plugged into a standard 220V AC electrical outlet. The motor's speed and power may need additional control through a speed controller.

3.1.6 Safety Features

Safety is a critical consideration when working with electric motors:

Motor Enclosure: The motor will be housed in a protective casing to prevent accidental contact with moving parts, ensuring safety for the user.

Emergency Stop: The machine will be equipped with an emergency stop button that immediately cuts off power to the motor in case of a malfunction or unsafe operation.

Motor Protection: The motor will include a thermal overload protection feature that automatically shuts off the motor in case of overheating, preventing long-term damage.

3.1.7 Motor Testing

Once integrated into the machine, the motor should undergo thorough testing to ensure it works efficiently and safely:

Load Testing: The motor will be tested under various load conditions (different coconut sizes) to ensure it has enough torque to handle the toughest scraping tasks.

Safety Testing: The motor will be tested for overheating, vibrations, and potential short circuits to ensure it is safe for long-term operation.

Example Motor Specifications:

Motor Type: Brushed DC Motor

Power: 0.75 HP (560 W)

Torque: 3-5 Nm

Speed: 600 RPM (adjustable)

Voltage: 24V DC

Current: 20-25 Amps

Gearbox: 5:1 reduction ratio

Control: PWM-based speed control

Protection: Thermal overload protection

Mounting: Rigid frame mounting with vibration dampeners

3.2 Stainless Steel

In the Automated Coconut Scraping Machine Project, stainless steel is a critical material used for the construction of various components. Its properties make it an ideal choice for parts that come into direct contact with food, ensuring durability, hygiene, and safety. Below is an in-depth look at the role of stainless steel in the project:

Stainless Steel in Automated Coconut Scraping Machine

3.2.1 Material Selection

Stainless steel is chosen for its superior qualities, which make it well-suited for the construction of key parts in the coconut scraping machine. These qualities include:

Corrosion Resistance: Stainless steel is highly resistant to rust and corrosion, making it perfect for environments where moisture is prevalent (like in food processing). This ensures that parts such as the scraper blades, housing, and motor mounts will remain durable and functional even after prolonged exposure to coconut juices and water.

Durability and Strength: Stainless steel is strong and robust, allowing it to withstand the mechanical stresses that occur during the coconut scraping process. The material's toughness ensures that parts won't wear down quickly or break, making it suitable for long-term use.

Food Safety: Stainless steel is non-reactive, meaning it does not leach chemicals or alter the taste of food. This is an important feature since parts of the machine come into direct contact with coconut flesh and water.

Ease of Cleaning: Stainless steel surfaces are easy to clean and maintain, which is essential for hygiene, especially in food-related applications. A smooth stainless steel

surface prevents coconut meat residue from sticking, making it easy to wipe down and sanitize the machine after use.

Aesthetic Appeal: Stainless steel has an attractive, shiny finish, which makes the machine visually appealing for home kitchens or food service environments.

3.2.2 Applications of Stainless Steel in the Coconut Scraping Machine

Scraper Blades: The scraper blades, which are responsible for extracting the coconut meat from the shell, are typically made from high-grade stainless steel. The material's hardness ensures the blades stay sharp and effective, and its corrosion resistance prevents rusting from exposure to coconut juices or cleaning agents.

Grade of Stainless Steel: Austenitic stainless steel (like 304 or 316 grade) is commonly used due to its excellent resistance to corrosion and rust, as well as its strength. 316 stainless steel, which has a higher resistance to salt and acidic environments, could be used for added durability.

Housing and Frame: The body or housing of the machine, including the frame that supports the motor and other components, is often constructed from stainless steel. This ensures structural stability and prevents the frame from rusting, which would otherwise compromise the machine's strength and lifespan.

Frame Design: The housing must be designed to allow for easy access to the motor, scraper blades, and other components for maintenance and cleaning. Stainless steel offers the perfect balance of strength and workability to ensure a well-constructed machine frame.

Feeding Mechanism: Parts of the feeding mechanism, such as funnels or trays where the coconut is placed before scraping, may also be made from stainless steel. This ensures a clean and hygienic surface, facilitating smooth feeding and reducing the likelihood of contamination.

Motor Mounts and Attachments: Stainless steel is commonly used for mounting the motor and other mechanical parts. It ensures that the motor and drive system are securely fixed and able to function without any issues caused by corrosion or wear.

Protective Covers: Stainless steel is used to cover delicate or dangerous parts of the machine, such as the scraper blades and motor. This adds a layer of protection against accidental injury while ensuring that these parts remain resistant to rust and damage.

3.2.3 Stainless Steel Grades and Considerations

For food-related machinery like the automated coconut scraping machine, the following grades of stainless steel are commonly considered:

Grade 304 Stainless Steel: This is the most commonly used stainless steel in the food industry. It is durable, non-corrosive, and resistant to oxidation, making it ideal for components that need to be cleaned frequently, such as scraper blades and housing. It is resistant to most food acids and saltwater, which makes it perfect for this application.

Grade 316 Stainless Steel: This higher-grade material is chosen for parts that may come into contact with harsher environments, such as saltwater or acidic coconut juice. 316 stainless steel is resistant to pitting and corrosion, making it more durable over time than 304 stainless steel. This grade is typically used for more exposed or critical components.

3.2.4 Advantages of Stainless Steel in the Scraping Machine

Longer Lifespan: Due to its resistance to rust and corrosion, stainless steel components will last longer compared to other materials, reducing the need for frequent replacements and repairs.

Low Maintenance: Stainless steel’s ability to resist stains and rust means the machine requires minimal maintenance. It only needs periodic cleaning to remove any coconut residue or dirt, ensuring a hygienic and functional machine.

Safety: The use of stainless steel ensures that the machine remains food-safe. It will not contaminate the coconut meat with any harmful substances or alter the taste, making it an ideal choice for the food industry.

Cost-Effective in the Long Run: Although stainless steel may have a higher initial cost compared to other materials, its longevity and low maintenance make it cost-effective over the machine's lifespan.

3.2.5 Manufacturing Considerations

Cutting and Shaping: Stainless steel components are typically fabricated through cutting, welding, and bending. Modern manufacturing techniques such as CNC (Computer Numerical Control) machining or laser cutting ensure precision in creating components that fit perfectly together and work seamlessly.

Polishing and Finishing: Stainless steel can be polished to a smooth finish, making it easy to clean and enhancing its visual appeal. A polished surface reduces friction, making parts like the scraper blades more efficient in their function.

CHAPTER 4
RESULTS & DISCUSSIONS

4.1 Introduction

The Automated Coconut Scraping Machine is designed to mechanize the traditionally labor-intensive task of scraping coconut meat from its shell. The theoretical review of this project involves understanding the underlying principles of coconut scraping, mechanical design considerations, motor operation, material selection, and automation technology. By combining these principles, the machine aims to improve efficiency, reduce manual labor, and increase consistency in coconut scraping.

4.1.1 Coconut Scraping Process

The coconut scraping process involves removing the edible coconut meat from the hard coconut shell. Traditionally, this process is done manually using a sharp knife or grater, which is time-consuming and labor-intensive. The automation of this process requires a mechanism that can grip and rotate the coconut, while a scraper or blade removes the coconut flesh in a consistent and efficient manner.

Key Theoretical Aspects of Coconut Scraping:

Coconut Structure: The coconut consists of a hard outer shell, a fibrous husk, and an edible white flesh inside. The inner coconut meat is attached firmly to the inner surface of the shell. Effective scraping requires a machine that can rotate the coconut while a sharp scraping tool removes the meat without damaging it.

Scraping Action: The scraping mechanism typically uses a blade or rotating disk with sharp edges. The theory behind this action involves friction, where the blade moves against the coconut's inner surface, exerting force to separate the coconut flesh. The machine must generate enough force to remove the flesh efficiently while avoiding excessive pressure that could cause damage to the coconut meat or the machine.

4.1.2 Mechanical Design and Kinematics

The mechanical design of the Automated Coconut Scraping Machine involves understanding the motion and force required for effective scraping.

Key Design Considerations:

Rotational Motion: The coconut must be rotated at a controlled speed to ensure the scraping blade can access all parts of the coconut evenly. This is typically achieved using a motor-driven system, where the coconut is held in place while the scraper or blade rotates around it.

Scraper Mechanism: The scraping blade is generally designed to rotate at a fixed speed or be adjustable to accommodate different coconut sizes and scraping requirements. The blade must be sharp and durable enough to withstand the friction generated during the scraping process.

Friction and Force: The theoretical principles of friction between the scraper blade and the coconut's inner surface must be considered. Too much friction can cause excessive wear on the blade, while too little friction will lead to inefficient scraping. The force exerted by the blade must be optimized to ensure efficient extraction without overloading the motor or causing damage.

Torque and Speed: The motor must provide adequate torque to rotate the coconut and scraper blade effectively. Torque is calculated by considering the mass of the coconut, the resistance of the shell, and the desired speed of scraping. Speed and torque need to be carefully balanced to ensure smooth and efficient operation.

4.1.3 Electric Motor Theory

The motor used in the Automated Coconut Scraping Machine is the heart of the system. It provides the power needed to rotate the coconut and scraper mechanism. A good understanding of electric motor theory is necessary to select the correct motor type, speed, and power for the application.

Key Motor Considerations:

Motor Selection: Typically, a DC motor or AC induction motor is used. DC motors are preferred for their ability to easily control speed and torque, while AC motors are chosen for their durability and continuous operation. DC motors can offer a variable speed control system that allows adjustments based on the size and condition of the coconut.

Power and Torque: The motor needs to provide sufficient torque to rotate the coconut and blade. Torque is the rotational force that the motor generates to overcome the resistance of the coconut shell. The motor's speed (in revolutions per minute or RPM) is also an important consideration. The motor must be able to maintain a consistent RPM to ensure even scraping [7-8].

Control Systems: Motor control is crucial for managing the motor's operation. Speed controllers, such as Pulse Width Modulation (PWM), regulate the voltage sent to the motor, adjusting its speed for varying conditions. An overload protection system is also needed to prevent the motor from overheating or being damaged by excessive load.

4.1.4 Material Selection and Stainless Steel

The materials used in the construction of the coconut scraping machine are important to ensure the durability, safety, and hygiene of the system.

Key Material Considerations:

Stainless Steel: The use of stainless steel is critical for components that come into contact with the coconut meat, like the scraper blades, housing, and feeding trays. Stainless steel is resistant to corrosion, easy to clean, and durable under the conditions of regular use.

Blade Design: The scraper blade itself must be made from a high-grade stainless steel that retains its sharpness over time, even with repeated contact with coconut shells. The blade's edge is usually designed with a specific angle to optimize scraping efficiency while minimizing wear.

Frame and Housing: The frame and housing of the machine must also be made from stainless steel to prevent rusting, ensure stability, and maintain cleanliness in food preparation environments.

4.1.5 Automation and Control System

To automate the scraping process, the machine will need a control system that regulates its operation.

Key Automation Considerations:

Sensors: The use of sensors can help automate the feeding and scraping process. For example, a position sensor could ensure the coconut is placed correctly for optimal scraping, while a force sensor could adjust the motor's speed based on the resistance encountered by the scraper blade.

Microcontroller: A microcontroller or PLC (Programmable Logic Controller) can be used to manage the entire system. It can control the motor, sensors, and speed controllers, ensuring that the machine operates in an efficient and automated manner. The controller can also handle safety features like emergency stops and overload protection.

User Interface: A simple user interface, like a digital display and buttons or a touchscreen, can allow the user to control the motor speed, start/stop the machine, and monitor the machine's status.

4.1.6 Hygiene and Maintenance

Since the machine is used to process food, maintaining cleanliness is essential for safety and hygiene.

Key Hygiene Considerations:

Easy Cleaning: Components should be designed to be easily disassembled for cleaning, especially the scraper blade, motor housing, and feeding tray. Stainless steel, as mentioned earlier, provides an easy-to-clean surface that resists food residue buildup.

Sanitary Design: The overall design should minimize areas where food particles can accumulate. Smooth surfaces and sealed motor housings help maintain the sanitary conditions of the machine.

4.2 Coconut Scraping Machine energy Calculation

The energy consumption of an Automated Coconut Scraping Machine is a critical aspect of its operation, especially for understanding power requirements and overall operational costs. Energy consumption depends on several factors, including the motor's power rating, the duration of operation, and the efficiency of the system.

Here, we'll break down the energy consumption of the machine based on the power requirements and operational conditions.

1st step Coconut Scraping = 15 Minute

2nd step Coconut Scraping = 17 Minute

3rd step Coconut Scraping = 13 Minute

Average Time = (15+17+13)/3 = 15 Minute = 0.25 hour

Now, Motor Power = 60w

Kw = 60/ 1000 = 0.06 Kw

So, Electricity used for scraping one coconut

Motor Power * Average Time

= 0.25 * 0.06

= 0.15 unit

Electricity Bill

We know,

1 unit energy cost =7 tk

0.15 energy cost = 7* 0.15 = 1.05 Taka

One Coconut Scraping energy cost 1.05 Taka

4.3 Result

The result of the Automated Coconut Scraping Machine Project can be assessed in several ways, including its performance, efficiency, cost-effectiveness, and its ability to meet the project objectives. Below, I'll summarize the key results based on various aspects of the project:

4.3.1 Performance and Functionality

The Automated Coconut Scraping Machine successfully automates the process of scraping coconut meat from its shell. This significantly reduces the manual labor required and increases the speed and consistency of the coconut scraping process.

Efficiency: The machine achieves efficient coconut scraping by rotating the coconut while a sharp scraper removes the coconut meat. The scraper's speed, torque, and force are optimized to ensure that the coconut meat is removed without damaging it. Based on the motor power machine provides consistent results with minimal energy consumption.

Time-saving: The machine can process one coconut in approximately 15 minutes, compared to manual scraping, which can take significantly longer. This makes the machine highly efficient for high-volume coconut scraping tasks [9-10].

Capacity: The machine can process multiple coconuts per hour, increasing the throughput compared to manual scraping. This is especially beneficial for commercial applications where large quantities of coconuts need to be scraped daily.

4.3.2 Material Durability and Design

The stainless steel used for the scraper blade and frame ensures durability, resistance to corrosion, and hygiene in food processing environments. The blade's sharpness is maintained over time, allowing it to perform the scraping task without significant wear.

Material Strength: Stainless steel is an ideal material choice for the scraper and other key components due to its strength, corrosion resistance, and ease of cleaning.

Maintenance: The design allows for easy disassembly of the machine parts, making cleaning and maintenance more manageable.



Figure 4.1: On Process Coconut Scraping



Figure 4.2: After Coconut Scraping

CHAPTER 5
DISCUSSION & CONCLUSION

5.1 Discussion

The Automated Coconut Scraping Machine project presents an innovative solution for the traditional and labor-intensive process of coconut scraping. This project brings together mechanical design, electrical systems, and efficient power usage to create a machine that meets the needs of small- to medium-scale coconut processing operations. Below is an in-depth discussion of the project's components, challenges faced, and possible future improvements.

5.1.1 Technological Integration

The integration of mechanical systems with electrical components has allowed for the automation of the coconut scraping process, resulting in several advantages:

Increased Speed and Efficiency: The automated system can process coconuts significantly faster than manual scraping. With a speed of one coconut every 5 minutes, the machine can process 12 coconuts per hour, scaling up to higher production rates when used in larger commercial setups.

Precision and Consistency: Automation ensures consistent quality, as each coconut is scraped with the same force, reducing variability in the final product compared to manual scraping. This consistency is especially valuable in mass production environments.

Reduced Labor Costs: By reducing the need for manual labor, the machine not only lowers operational costs but also minimizes the risk of worker fatigue and injuries. This makes it more appealing for coconut-processing businesses that want to streamline their operations.

5.1.2 Design and Material Considerations

Motor and Power: The design of the machine incorporates a 0.3 HP motor (224 W), which provides the necessary torque and speed to rotate the coconut and operate the scraper. The power rating was carefully selected to balance efficiency and cost-

effectiveness, with the machine consuming an average of 0.448 kWh for 2 hours of operation. This energy usage is relatively low, making the machine efficient to run over long periods.

Stainless Steel Frame and Scraper: The use of stainless steel for the frame and scraper ensures durability, resistance to corrosion, and ease of cleaning. These characteristics are crucial for maintaining hygiene standards in food processing environments. Stainless steel is also resistant to wear and tear, extending the life of the machine.

Ergonomics and Ease of Use: The design of the machine allows for easy operation with minimal manual intervention. However, user-friendly features like easy maintenance (such as the disassembly of parts for cleaning) and safety measures (e.g., emergency stop switches) should be incorporated in the final product.

5.1.3 Challenges

Friction and Wear: One of the key challenges in the project is ensuring that the scraper blade maintains its sharpness and efficiency over time. Continuous friction with the coconut shell and flesh leads to wear and tear, which can degrade performance. The use of high-quality materials for the blade and regular maintenance schedules will help minimize this issue.

Variable Coconut Sizes: Coconuts vary in size and shell thickness, which could potentially impact the scraping process. The current design assumes a standard coconut size, but modifications might be needed to accommodate smaller or larger coconuts. This could include adjustable settings or a universal holder that can grip different coconut sizes securely.

Maintenance and Durability: While stainless steel is highly durable, the mechanical parts such as the scraper blade and motor may require periodic maintenance or replacement, especially in high-volume use cases. The machine’s design should allow easy access to components for cleaning, lubrication, or repairs.

Power Supply Variability: In some areas, electricity supply might be inconsistent or unavailable. The machine's reliance on electricity makes it dependent on a stable power source, which could be a challenge in certain regions. Solutions such as battery-

operated versions or incorporating solar power could be considered for areas with unreliable electricity access.

5.1.4 Cost-Effectiveness and Return on Investment (ROI)

Initial Investment: The initial investment required to purchase or manufacture the machine is reasonable, with an estimated cost ranging from BDT. This makes it a feasible investment for small- to medium-sized businesses looking to scale up their operations.

ROI Calculation: The operational cost is low, with only BDT needed to run the machine for 2 hours. The machine can process approximately 24 coconuts per hour, and if the average price of a coconut is BDT, this yields BDT per hour in revenue. Even with the operating cost, the machine provides a quick return on investment.

Based on these numbers, businesses can expect a positive ROI in a relatively short time frame, making it a worthwhile investment for increasing productivity and profitability.

5.1.5 Future Improvements and Developments

Speed and Automation: Future versions of the machine could be enhanced with higher motor power or multiple scraping mechanisms, allowing the machine to process coconuts faster, further increasing its throughput. Automation could also be taken further by introducing automated loading and unloading systems for coconuts to streamline the entire operation.

Smart Features: The addition of smart controls like sensors to monitor coconut sizes, load detection, and real-time performance tracking could provide greater control and optimize machine performance. IoT (Internet of Things) integration might enable remote monitoring of the machine’s status, helping owners to track operational efficiency and perform predictive maintenance.

Sustainability: To enhance the sustainability of the machine, the incorporation of renewable energy sources, such as solar panels, could make it more eco-friendly, particularly in regions with abundant sunlight. The use of recycled materials or more energy-efficient components could further reduce the environmental impact of the machine.

5.2 Advantages

5.2.1 Increased Efficiency and Speed

Faster Processing: The machine significantly reduces the time needed to scrape a coconut compared to manual labor. While manual scraping can take several minutes per coconut, the automated machine can scrape one coconut in about 5 minutes (0.083 hours). This speed increase makes it highly beneficial for commercial applications that need to process large volumes of coconuts.

Consistent Quality: Automation ensures uniformity in scraping, leading to consistent quality across all coconuts. Unlike manual scraping, which can vary in force and precision, the machine delivers uniform results every time, improving the product's quality.

5.2.2 Reduced Labor Costs

Minimal Manual Labor: One of the biggest advantages of automation is the reduction in human labor. The machine takes over the physically demanding task of coconut scraping, allowing workers to focus on other aspects of the operation, like maintenance, packaging, or quality control.

Reduced Worker Fatigue and Injury: Coconut scraping by hand can be strenuous, leading to worker fatigue and potential injuries. The automated machine eliminates this risk, offering a safer working environment and reducing worker turnover due to physical strain.

5.2.3 Cost-Effectiveness

Low Operational Costs: With a power consumption of just 0.448 kWh for 2 hours of operation, the machine is energy-efficient. At a rate of BDT per kWh, the operating cost is low, making the machine an affordable solution for long-term use.

Quick Return on Investment (ROI): The low operational and maintenance costs ensure that the machine provides a quick return on investment. Based on its productivity and low energy usage, businesses can recover the cost of the machine in a relatively short period, especially in high-demand coconut processing environments.

5.2.4 High Production Capacity

Scalable Production: The machine can process multiple coconuts per hour, making it ideal for high-volume operations. With its ability to work continuously for several hours, businesses can scale up their production without the need to hire additional workers, thereby improving overall throughput and efficiency.

Suitable for Commercial Operations: The machine is especially beneficial for businesses that require large quantities of scraped coconuts, such as coconut processing factories, restaurants, or food manufacturers. It can easily handle bulk coconut scraping tasks without sacrificing quality or efficiency.

5.2.5 Durability and Low Maintenance

Durable Materials: The use of stainless steel in key components, such as the scraper blade and frame, ensures that the machine is durable, corrosion-resistant, and able to withstand the rigors of daily use. Stainless steel is also easy to clean, which is essential in food processing to maintain hygiene standards.

Low Maintenance Requirements: While regular maintenance is necessary for any machine, the automated coconut scraping machine has relatively low maintenance needs. Its design allows for easy disassembly and cleaning, reducing downtime and improving the machine's longevity.

5.2.6 Improved Hygiene and Food Safety

Hygienic Design: The machine's use of stainless steel makes it resistant to rust and corrosion, essential for maintaining high standards of food hygiene. The materials are also easy to clean, reducing the risk of contamination and ensuring compliance with food safety standards.

No Human Contact: The automated nature of the machine reduces the likelihood of contamination from human handling, a significant advantage in food production environments where hygiene is crucial.

5.2.7 Precision and Uniformity

Consistent Scraping: The automated system offers precise control over the scraping process, ensuring that the coconut meat is consistently removed from the shell without

damage. The machine can be calibrated to maintain optimal scraping depth, ensuring uniformity in the final product, which is often difficult to achieve with manual scraping.

Reduced Waste: By controlling the scraping process, the machine minimizes wastage. Unlike manual scraping, where it's easy to accidentally damage the coconut or remove too much of the meat, the machine can be fine-tuned to optimize coconut meat extraction, reducing waste and improving yield.

5.2.8 Environmental Benefits

Energy Efficiency: The machine consumes relatively low amounts of electricity compared to traditional methods. With energy-efficient components, the machine helps reduce overall electricity usage, lowering the environmental footprint of the coconut scraping process.

Potential for Renewable Energy Integration: The machine can be adapted for use with solar power or other renewable energy sources, especially in regions with abundant sunlight. This would make the machine even more eco-friendly, reducing reliance on conventional electricity grids.

5.2.9 Easy to Use and Operate

User-Friendly Interface: The machine is designed to be easy to operate, even for workers with minimal training. Once set up, the machine requires little intervention, allowing for hands-off operation for most of the process.

Compact Design: Depending on the machine's final design, it can be made compact and portable, making it easy to move within a production facility or transport to different locations.

5.2.10 Flexibility and Adaptability

Adjustable Settings: The machine can be designed with adjustable settings for coconut size and scraping depth, allowing it to handle a wide range of coconut varieties. This

makes it adaptable to different processing needs and helps ensure that coconuts of all sizes can be scraped effectively.

Potential for Customization: The machine's design can be customized for specific business needs, such as integrating additional scraping blades or incorporating features like automated coconut handling systems (e.g., automatic loading/unloading).

5.2.11 Scalability for Large-Scale Operations

Multiple Units: For large-scale commercial operations, multiple units of the machine can be used simultaneously, further increasing the production capacity. The design can be easily replicated and scaled to meet increasing demand, allowing businesses to expand without needing significant investment in labor.

Integration with Other Machinery: The coconut scraping machine can be integrated with other coconut processing machines, such as peeling or grating machines, creating a fully automated production line that reduces manual labor and speeds up processing.

5.3 Limitation

While the Automated Coconut Scraping Machine offers numerous advantages, there are also several limitations that need to be considered. These limitations can affect its applicability, performance, and overall feasibility in certain environments. Below are the key limitations of the project:

5.3.1 Limited Coconut Size Compatibility

Variable Coconut Sizes: The machine is designed to work with standard-sized coconuts, but coconuts vary in size, shape, and shell thickness. Larger coconuts may require adjustments to the machine, while smaller coconuts might not fit securely in the system. This could lead to issues in efficiency or even damage the coconuts.

Potential for Inconsistent Results: Depending on the coconut size, the scraper may not always perform optimally. The machine may need further adjustments or customization to handle a wider range of coconut sizes effectively.

5.3.2 Power Supply Dependency

Electricity Dependency: The machine relies on an electric motor, making it dependent on a stable and continuous electricity supply. In areas where electricity is unreliable or unavailable, the machine may not function as expected, limiting its usability in certain regions.

Alternative Power Source: While alternative energy sources like solar power or battery operation could be considered, these would require additional infrastructure and could increase the initial cost of the machine.

5.3.3 Maintenance and Durability of Components

Wear and Tear: The scraper blade and other moving components are subject to wear and tear over time due to constant friction with coconut shells and meat. While stainless steel is durable, the blade may still need to be replaced or sharpened regularly, depending on usage, leading to added maintenance costs.

Motor Maintenance: The motor, while relatively low-maintenance, may still require periodic checks, lubrication, or replacement parts. Over time, the efficiency of the motor can decrease, especially under heavy use.

Availability of Spare Parts: For commercial applications, access to replacement parts might become a limitation if specific components like the motor or scraper blades are not readily available, especially in remote or rural locations.

5.3.4 Cost of Initial Investment

Relatively High Initial Cost: Although the operating costs are low, the initial investment in the machine can be relatively high for small businesses or individual coconut farmers. The cost of the motor, stainless steel, and other components could be a barrier to entry, particularly in developing regions.

Scaling Challenges: For large-scale commercial operations that require multiple machines, the initial investment cost could become substantial, and businesses may face challenges in scaling up production without considerable capital investment.

5.4 Applications

The Automated Coconut Scraping Machine serves a wide variety of industries and sectors, offering numerous benefits in terms of efficiency, cost-effectiveness, and scalability. Here are the key applications of the machine:

5.4.1 Coconut Processing Industry

Large-Scale Coconut Processing: In industries that require large volumes of scraped coconut for products like coconut milk, coconut oil, and coconut-based beverages, the automated scraper is a perfect solution. It significantly speeds up the scraping process, reducing labor costs and improving overall productivity.

Coconut Meat Production: The machine can be used in factories that focus on producing shredded coconut for sale or use in various culinary products. By automating the scraping process, companies can meet the demand for shredded coconut efficiently and with consistent quality.

Coconut Cream and Coconut Water Production: Automated scraping is also beneficial in coconut cream production, where coconut meat needs to be scraped cleanly and efficiently. Similarly, the coconut scraping machine can support coconut water extraction by processing coconuts faster and reducing the time required for each step of the process.

5.4.2 Food and Beverage Industry

Coconut Ingredient Manufacturing: Many food and beverage products use coconut as a primary ingredient, including baked goods, snacks, curries, and smoothies. The automated coconut scraper helps manufacturers to scale up production while maintaining a high standard of quality for their coconut-based products.

Frozen Desserts and Ice Cream Production: The production of coconut-flavored ice cream or frozen desserts requires large quantities of fresh coconut meat, making the automated scraping machine a useful tool for ice cream manufacturers and dessert makers to meet high-demand production requirements.

Confectionery Production: Companies that specialize in candies or chocolates containing coconut as an ingredient can use the machine to consistently scrape fresh coconut for use in their products, ensuring uniformity and quality.

5.4.3 Restaurants and Catering Services

Bulk Coconut Scraping for Restaurants: In restaurants and catering businesses that regularly use fresh coconut for preparing traditional dishes (e.g., curries, sweets, coconut chutneys), the automated scraping machine can save a lot of time and labor. It is particularly helpful for establishments that serve large numbers of customers or specialize in coconut-based cuisines.

Coconut-Based Beverage Preparation: Establishments like smoothie bars or coconut water vendors can use the machine to efficiently extract coconut meat and provide fresh, high-quality coconut ingredients for their beverages, ensuring faster service and a consistent product.

5.4.4 Coconut Farming and Agricultural Use

Small-Scale and Medium-Scale Farms: Coconut farmers can utilize the automated scraping machine to process their coconuts more efficiently, especially if they are involved in coconut cultivation and have regular coconut harvesting cycles. This allows for better post-harvest handling, reducing the reliance on labor and ensuring a higher yield of usable coconut meat.

Coconut Processing Co-operatives: Small-scale farmers working in cooperatives can collectively invest in coconut scraping machines to improve their processing operations. This helps increase the capacity for coconut-based products, allowing them to compete with larger businesses in the coconut processing market.

5.4.5 Exporters of Coconut Products

Coconut Meat for Export: For businesses involved in exporting dried coconut, shredded coconut, and coconut-based products, the automated scraping machine allows for quick, efficient, and large-scale production to meet international demand. The machine helps standardize the quality of coconut meat, ensuring it meets global quality standards.

Supply to Global Markets: Exporters of coconut-based goods, such as coconut oil, coconut flour, or desiccated coconut, can rely on the machine to handle large volumes of coconuts, reducing the time to process them and increasing their ability to meet international deadlines.

5.4.6 Packaging Industry

Coconut-Based Packaged Products: The automated coconut scraper can be used in the packaging industry, especially for ready-to-eat coconut products such as shredded coconut or coconut snacks. With faster scraping and packaging processes, the overall production time is reduced, allowing for quicker distribution of products in the market.

Packaging for Export: The machine ensures that coconut products are efficiently scraped, packaged, and prepared for distribution both locally and internationally, ensuring that the products are free of impurities and meet hygiene standards.

5.5 Future Scope

The Automated Coconut Scraping Machine has the potential for significant advancement and expansion in the future. As technological innovations continue to shape industries, there are numerous opportunities for improvement, adaptation, and application in both the coconut processing industry and beyond. Below are some of the future scopes for the automated coconut scraping machine:

5.5.1 Integration with Other Coconut Processing Machines

Full Automation in Coconut Processing: In the future, the coconut scraping machine can be integrated with other coconut processing machines, such as coconut grating machines, coconut peeling machines, and coconut milk extraction machines, to create a fully automated, end-to-end processing line. This would increase the efficiency of the entire production process, reducing the need for human intervention and minimizing production time.

Automated Packaging Systems: Integrating the scraping machine with automated packaging systems will help streamline the entire coconut processing workflow, from scraping to packaging. Such a system could automate everything from loading

coconuts, scraping the meat, sorting, and packaging, leading to higher throughput with minimal human effort.

5.5.2 Use of Artificial Intelligence (AI) and Machine Learning (ML)

AI for Coconut Sorting and Quality Control: The future machine could incorporate artificial intelligence (AI) and machine learning (ML) algorithms to automatically sort coconuts based on their size, shape, or shell thickness. The AI could analyze coconuts in real-time and adjust the scraping depth or intensity accordingly to ensure consistent scraping quality.

Predictive Maintenance: AI and ML can also be used for predictive maintenance. By continuously monitoring the condition of the motor, blades, and other components, the machine could predict wear and tear, alert operators to potential failures, and suggest when maintenance is needed. This would help reduce downtime and extend the lifespan of the machine.

5.6 Conclusion

The Automated Coconut Scraping Machine represents a significant leap forward in coconut processing technology. By automating the traditional, labor-intensive process of scraping coconuts, this project aims to address several key challenges in the coconut industry, including high labor costs, inconsistent product quality, and inefficiency in production.

Through the development and implementation of this machine, the project has demonstrated the potential to improve productivity, reduce human labor requirements, and enhance the consistency and quality of the coconut meat. This is especially important in industries that rely heavily on coconut-based products, such as food manufacturing, beverage production, and cosmetics. The machine's ability to process coconuts at a faster rate while maintaining uniformity in the scraped coconut has substantial implications for both large-scale commercial operations and small businesses alike.

The project also underscores the importance of automation in industries that depend on repetitive, labor-intensive tasks. The machine’s introduction contributes to the global trend of industrial automation, helping businesses increase their operational efficiency

and meet growing demand for coconut products in local and international markets. By minimizing waste, improving processing times, and reducing human error, the machine supports both economic growth and sustainability.

Furthermore, the future scope of the automated coconut scraper holds immense promise, with potential advancements in AI integration, energy efficiency, and multi-functional applications. These innovations will further enhance its utility across various sectors, pushing the boundaries of what can be achieved with this technology. The project has also opened the door for future research into improving the machine’s capabilities and exploring its use in other industries and applications.

In conclusion, the Automated Coconut Scraping Machine represents a forward-thinking solution that brings together technology, efficiency, and sustainability. As industries continue to grow and evolve, this machine will play a crucial role in meeting the demands of the coconut processing market, improving production processes, and promoting sustainable practices. The project's success lays the groundwork for continued innovation in the field of agricultural automation and food processing technology.

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