

Design and Fabrication of Pineapple Peeling Machine

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ABSTRACT: Pineapple, a significant food crop in India, faces a major challenge in the peeling process. This study addresses this issue by focusing on designing and fabricating a cost-effective pineapple peeling machine tailored for small-scale businesses. Inefficient peeling methods hinder the crop's economic value by lacking efficient solutions. Peeling pineapples manually is a time-consuming process, often resulting in inefficiencies and increased labor costs for small and midcap firms. In response to this challenge, we present a cost-effective pineapple peeling machine designed to significantly reduce peeling time compared to manual methods while minimizing waste. Our machine employs a nut and bolt locking mechanism to securely hold the pineapple in place, along with an AC motor-driven blade rotation and a DC gear motor-driven pineapple rotation system. Pineapple is fed into the machine gradually; allowing the rotating blade to peel off a consistent thickness of the outer shell ensures efficient and precise peeling of pineapples, including B and C grade varieties. The project involves the design, fabrication, and testing of the machine to optimize its performance and efficiency. The semi automated Pineapple Peeling Machine offers significant benefits to pineapple processing industries, including increased productivity, improved product quality, and reduced labor requirements. This project strives to provide an affordable solution, contributing to the economic viability of small-scale pineapple processing in India.

KEYWORDS: DC motor , AC motor , Nut and bolt mechanism , spring steel blade

I. INTRODUCTION

Pineapple, a tropical fruit cherished for its sweet and tangy flavor, is a staple in cuisines worldwide. However, the process of peeling pineapples manually poses several challenges, hindering efficiency and productivity in pineapple processing industries. Traditionally, pineapple peeling involves labor-intensive methods that are time-consuming and prone to inconsistency.

The existing manual peeling process involves skilled laborers using knives or specialized tools to remove the tough outer shell of the pineapple. This process is not only tedious but also presents several inherent problems. Firstly, the manual peeling process is highly dependent on the skill level of the operators, leading to variations in peeling thickness and product quality. Inconsistency in peeling thickness can affect the appearance and texture of the final product, impacting consumer satisfaction.

Moreover, manual pineapple peeling is associated with high labour costs and increased production time. The need for skilled labourers adds to operational expenses, while the time-consuming nature of manual peeling limits production throughput. Additionally, the manual handling of sharp tools poses safety risks to workers, increasing the likelihood of workplace accidents.

In light of these challenges, there is a pressing need for an automated solution that can streamline the pineapple peeling process, enhance productivity, and ensure consistency in product quality. The development of a semi-automatic Pineapple Peeling Machine addresses these challenges by leveraging modern technology to automate the peeling process, thereby improving efficiency and reducing labour costs. By

automating pineapple peeling, this project seeks to revolutionize pineapple processing industries, making them more competitive and sustainable in the global market.

The current project focuses on the design and implementation of an semi automated Pineapple Peeling Machine. The machine incorporates a rotating mechanism powered by a DC motor for rotating the pineapple and an AC motor for rotating the peeling blade. The specifications include a DC motor with a torque of 3.15 Nm and a rotational speed of 15 rpm, and an AC motor with a torque of 1.2 Nm and a rotational speed of 1440 rpm. The peeling blade is made of

spring steel material, chosen for its durability and ability to maintain a sharp edge over time. These specifications have been carefully selected to ensure efficient and reliable operation of the machine.

II. DESIGN AND FABRICATION

Design: SolidWorks 2021 was used to complete the entire design. Fig. 1 (a) shows the developed a design with more compact and suitable mechanisms and components.

All components in the modified design are mentioned in Table 1

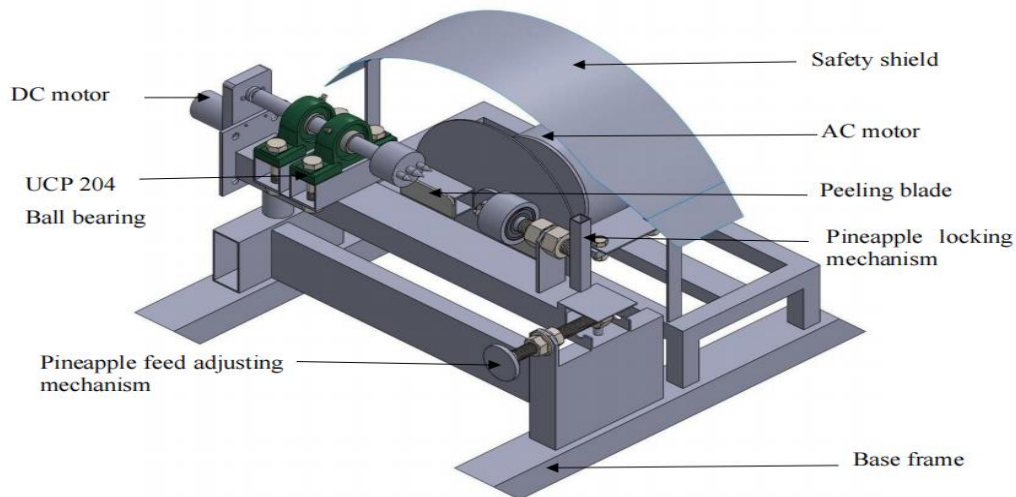


Fig 1: Design of peeling machine

PARTS	DESCRIPTION
Peeling blade	Spring steel is used as material for peeling blades due to its durability and flexibility. Its ability to withstand repeated use and maintain sharpness over time makes it ideal for various peeling tasks.
AC induction motor	It is used to rotate the pineapple peeling blade . The motor used is 0.25 HP and rotating at 1440 rpm to ensure smooth peeling of pineapple
DC gear motor	The pineapple is rotated by the 12v dc motor by reducing the speed to a 15 rpm by using gear mechanism.The motor has a torque of 3.15 Nm and a 20 mm shaft is connected to the motor
UCP 204 ball bearing	The shaft is supported by the 2 UCP 204 bearings to support the rotating shaft and to reduce the vibration while rotation.
Pineapple locking mechanism	It utilizes two fixtures, one fixed and the other movable, with the movable side adjusted via a screw mechanism to lock the pineapple securely based on its dimensions.

Table1 – Main components

Design Calculations

AC induction motor

Assumptions,

Required rpm= 1450rpm

maximum load on AC motor shaft= 2kg

Diameter of shaft = 32 mm

Radius = $r = 16\text{mm} = 0.016\text{ m}$

Force exerted on motor shaft = $2 \times 9.81 = 19.62\text{ N}$

Torque = $F \times r = 19.62 \times 0.016 = 0.31392\text{ Nm}$

Power of motor required= $2\pi NT/60$

= $(2 \times \pi \times 1450 \times 0.31392)/60 = 64.10\text{ W}$

Factor of safety = safe load/Applied load

Power in HP = 0.086 HP

FOS= 2

Safe load = $2 \times 0.086 = 0.172\text{ HP}$

Next available standard motor = 0.25 HP, 1440rpm

DC motor

Required rpm = 15rpm

Shaft diameter = 20mm

radius = $10\text{mm} = 0.01\text{ m}$

Load = 4 kg

Force = $4 \times 9.81 = 39.24\text{ N}$

Torque = $39.24 \times 0.01 = 0.39 \approx 0.4\text{ Nm}$

Consider FOS = 2

The torque = 0.8 Nm

chosen motor

15 rpm Rectangular gear Dc motor with gear box ratio 196:1

Output torque = 3.156 Nm

Force exerted on blade

Assumption,

Weight of the pineapple = $m = 2\text{kg}$

Maximum diameter of the pineapple = 12 cm

Radius $r = 6\text{ cm} = 0.06\text{ m}$

Speed of motor $N = 15\text{ rpm}$

Centripetal force(FC)

$F_c = m r \omega^2$

$\omega = 2\pi N/60$

$2\pi * 15/60 = 1.57\text{ rad/sec}$

$F_c = 2 * (1.57)^2 * 0.06 = 0.296\text{ N} \approx 0.3\text{ N}$

Fabrication

Fabrication of body: The body is mainly consists of two parts, one for holding the AC motor and blade and another part consist of frames to support the pineapple and feeding mechanism. Both the parts are welded to the two rectangular steel pipe of dimension 60x40 mm and 570 mm long and distance between the two base pipe is 550 mm. The support frame for motor is made up of GI square tube of 25 mm at a height of 130 cm from the base frame.

Fabrication of peeling blade: Two identical peeling blade made is made up by cutting the spring steel material to 2 mm thickness and

length of 80 mm and 45 mm width. One edge of both blades is sharpened for providing smooth cutting of pineapple and the both the peeling blade were fixed to a disc frame and it is connected to the motor shaft.

Fabrication of pineapple locking mechanism: A 6204 2 RS bearing is fixed in the locking jaw by boring the jaw in the lathe machine. And threaded shaft of 20 mm diameter is connected to the bearing. Two M20 Nuts is fixed in path on the shaft to regulate movement of the jaw forward and backward. For smooth rotation of shaft a handle is welded to the end of the shaft.

Fabrication of feeding mechanism: For smooth feeding of pineapple towards the blade a rotatable M16 Nut is connected to the frame in which the pineapple is to fixed and in path of the nut and M16 bolt of 5 inch long is provided and two M16 nylock nuts is provided to control the feed. A disc frame is welded to the head of the bolt for smooth rotation of the bolt. As the pitch of the bolt is 1 mm, we can provide 1 mm feed per revolution of the disc.

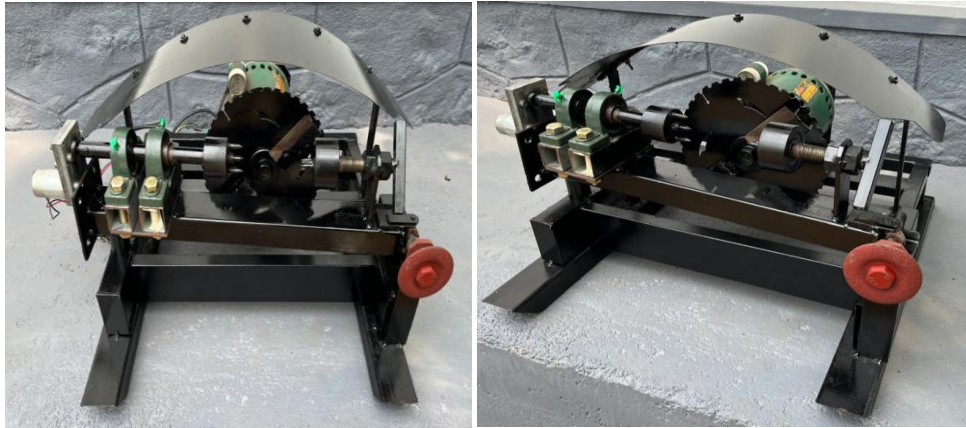
Fabrication of safety cover: For safety protection of the worker a Shield is provided to the cutting part of the machine. The shield is made up of sheet metal and is fixed above the arc shaped frame which is made up of MS flat.

III. WORKING

The primary function of the pineapple peeling machine is to efficiently remove the thick outer shell of a pineapple, facilitating easier consumption and processing. The pineapple peeling machine is powered by an electrical motor system, comprising a DC motor for rotating the pineapple and an AC induction motor for driving the blade mechanism. The process begins by loading a whole pineapple into the machine. Once the pineapple is loaded, a DC motor rotates it at a speed of 15 RPM. The motor applies torque to the pineapple, causing it to rotate smoothly. The feeding mechanism involves the user manually placing pineapple between two rotating jaws, each equipped with three spikes on both sides. The pineapple is securely held in place by a threaded fastening mechanism, resembling a lathe arrangement. Once the pineapple is securely locked in place, it is fed into the machine using a screw-type mechanism. As the pineapple rotates, the outer shell comes into contact with a rotating blade, which is driven by a 0.25 HP AC induction motor with an RPM of 1440. The blade is positioned perpendicular to the rotating pineapple. The blade is carefully aligned to make contact with the pineapple's surface. As the rotating blade makes contact with the rotating pineapple, it begins to peel

off the outer shell of the pineapple. The blade removes a consistent thickness of the outer layer with each rotation.. A shield covering is provided

around the blade to ensure operator safety during the peeling process.



Images of peeling machine

IV. RESULT AND DISCUSSIONS

The development and fabrication of the Pineapple Peeling Machine were successfully completed, representing a significant advancement in automated fruit processing technology. The machine reduces peeling time to just 30 seconds, a remarkable improvement compared to manual methods.

Through meticulous design and engineering, the machine achieves efficiency and precision in its operation. The locking and feeding mechanism has been optimized to increase speed, facilitating quicker processing of pineapples. With this enhancement, the machine now operates at an accelerated pace, ensuring rapid throughput in fruit processing operations.

Looking ahead, future advancements in technology hold promise for further enhancing the performance of the Pineapple Peeling Machine. By integrating high-speed motors and advanced

control systems, we can continue to increase the efficiency and productivity of the machine. Additionally, implementing sensors and machine learning algorithms can enable real-time adjustments to optimize peeling quality and minimize waste.

The future of automated fruit processing systems is bright, with ongoing innovation driving continuous improvement. Integration with emerging technologies such as artificial intelligence and robotics will further enhance adaptability, precision, and overall performance. By focusing on refining key components and processes, we can ensure that the Pineapple Peeling Machine remains at the forefront of fruit processing technology, contributing to increased productivity, reduced waste, and sustainable practices in the food industry.

The image of peeled pineapple and result table are shown below.



Peeled pineapple

NO	PARAMETER	RESULT
1	Loadingandunloadingtime	20- 25 sec
2	Operatingtime	30- 35 sec
3	Totalleadtimerequiredforsinglepineapple	50- 60sec
4	Numberofpineappleinanehour	60 pineapples
5	Effectiveworkingof8hour(productionrate)	480 pineapples

Result table

SOME OF THE ADVANAGES FROM THE ABOVE RESULTS

1. Time Efficiency: Faster pineapple peeling compared to manual methods, reducing processing time.
2. Dual Motor System: Smooth operation and consistent peeling results ensured by two motors with different functions.
3. Compact Design: Suitable for small-scale firms with limited space, easy to install and integrate.
4. Cost-Effectiveness: Affordable GI frame construction and simple design make it accessible to small and mid-sized firms.
5. Enhanced Safety: Minimizes accidents and injuries compared to manual cutting methods.
6. Durability and Low Maintenance: Robust construction ensures longevity with minimal upkeep, reducing downtime.
7. Improved Product Quality: Consistent peeling enhances the appearance and market competitiveness of the final product.
8. Cost Advantage: Affordability compared to traditional machines enables investment without significant financial burden.
9. Productivity Enhancement: Automates peeling process, boosting output per worker and overall operational efficiency.
10. Employee Welfare: Relieves workers from physically demanding tasks, improving job satisfaction and potentially reducing injuries.

V. CONCLUSION

In conclusion, the development of the Automated Pineapple Peeling Machine represents a significant advancement in pineapple processing technology. By automating the labor-intensive peeling process, this project has demonstrated the potential to enhance efficiency, reduce labor costs, and improve product quality in pineapple processing industries. The successful implementation of this machine underscores its potential to revolutionize pineapple processing operations, paving the way for increased

competitiveness and sustainability in the global market. With a production rate of 480 pineapples in an 8-hour shift, and the capability to process 60 pineapples per hour, the machine exhibits high effectiveness in meeting industry demands. With further refinement and demonstration through real-world applications, this innovative solution holds promise for widespread adoption and impact across the pineapple industry.

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