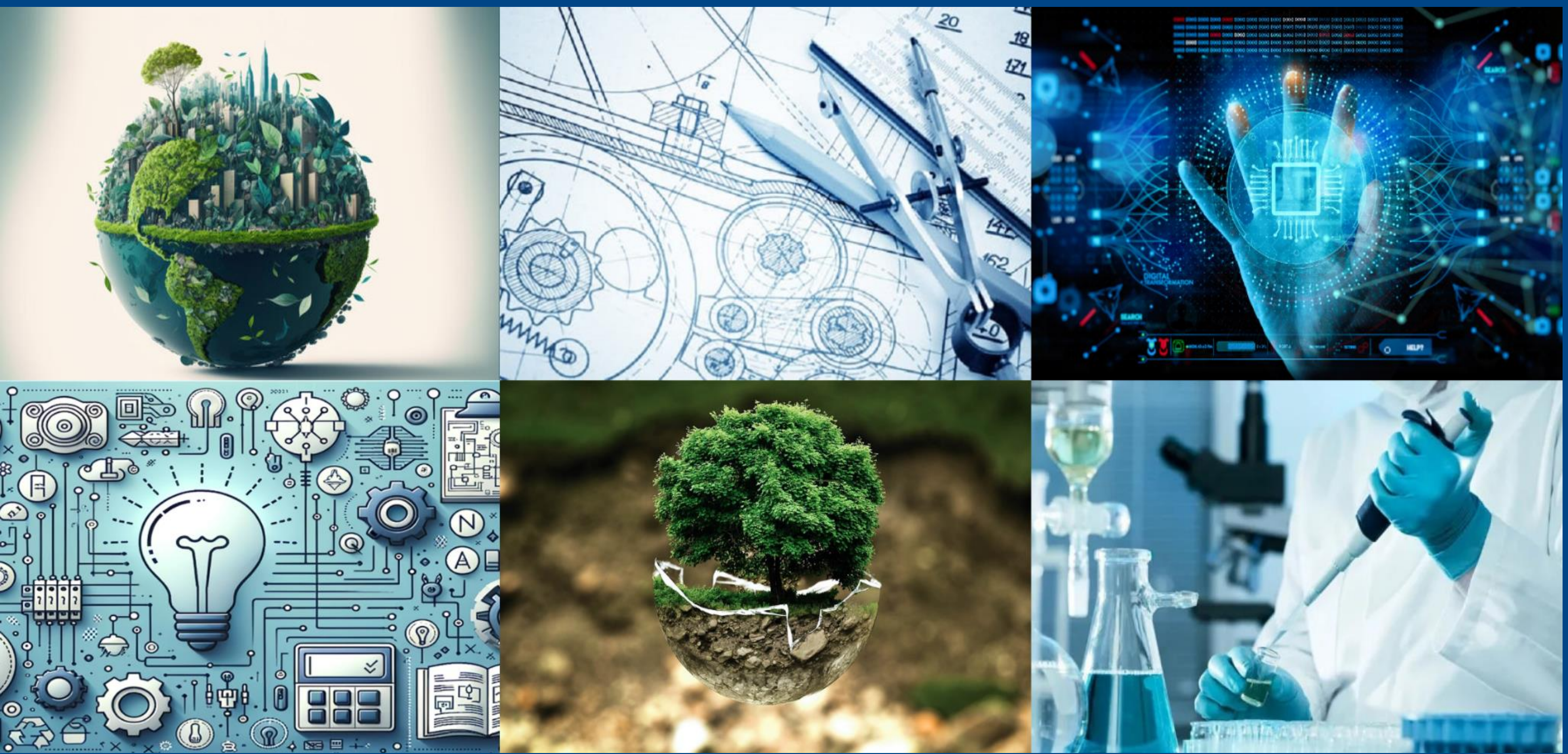
ISSN: 2582-7219

International Journal of Multidisciplinary Research in Science, Engineering and Technology

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.206

Volume 8, Issue 4, April 2025

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© 2025 IJMRSET | Volume 8, Issue 4, April 2025| DOI:10.15680/IJMRSET.2025.0804304

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

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Design and Fabrication of Stick Segregation from Fronds

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ABSTRACT: This research focusses on the design and implementation of a semi-automated system for separating sticks from fronds, which addresses an important demand in agricultural processing. A workable prototype was created with important mechanical components such conveyor belts, rotating drums, and precise sorting systems. To improve the design, computational simulations were run before to manufacture, reducing mistakes and increasing overall efficiency. The system was tested under a variety of scenarios, including changes in frond size, moisture content, and processing speed. The results indicated a high level of accuracy in segregation, which greatly reduced manual intervention and increased operational productivity. By automating this procedure, the system not only boosts output but also minimises labour dependency and encourages uniform quality. This strategy promotes environmentally friendly and technologically advanced agricultural techniques, with potential benefits for small-scale companies that rely on frond-based raw materials.

KEYWORDS: Mechanical Design, Fabrication, Automation, Stick Segregation, Experimental Validation, Efficiency, Labor Reduction, Cost Savings, Sustainability, Waste Management, Agricultural Processing, Productivity

Objectives

The primary aim of this project is to design and build a semi-automated machine that simplifies and speeds up the separation of midribs from coconut fronds. Traditionally done manually with simple tools, this process is time-consuming and physically demanding. By introducing a motorised mechanism, the project seeks to reduce human effort, enhance efficiency, and preserve the integrity of the midrib for broomstick production and other industrial uses. Emphasis is placed on using low-cost, locally available materials to make the machine affordable and accessible to small-scale rural farmers. The machine is also tested on coconut leaves in different conditions—fresh, sun-dried, and fallen—to identify the best input for consistent, high-quality output. Moreover, the project promotes sustainability by encouraging the reuse of agricultural waste and adding value to byproducts that are typically discarded or burned.

I. INTRODUCTION

Agricultural processing usually confronts significant challenges in separating sticks and fronds due to the reliance on outdated manual techniques. These methods are not only time-consuming and labour-intensive, but they also differ in separation quality, lowering overall efficiency and productivity. The lack of automated systems exacerbates these problems, necessitating significant human effort and raising operational costs. To address these issues, this research proposes developing an automated system that leverages mechanical engineering principles to ease the segregation process. By using current mechanised separation techniques, the system intends to boost output, ensure consistent separation quality, and significantly reduce dependency on manual labour. Automation also provides long-term cost savings by lowering labour costs while increasing scalability to meet rising processing demands. Aside from economic benefits, this innovation encourages sustainable agriculture practices by improving resource utilisation, reducing waste, and boosting environmentally beneficial activities. This study demonstrates how automation can help update agricultural processing processes, resulting in enhanced efficiency and environmental sustainability.

II. METHODOLOGY

1.System Design:

Design the system using CAD software to create a prototype with optimal dimensions for segregation efficiency. This involves multiple iterations to evaluate feasibility and effectiveness. Ensure the design includes safety features such as emergency stop mechanisms and protective guards. Conduct simulations to analyse system behaviour under different operational conditions and refine the design based on results. Consider ergonomic design aspects to enhance user interaction and minimize operational fatigue.

2. Material selection and fabrication:

Choose high-strength materials such as stainless steel and aluminium to ensure corrosion resistance and endurance. Conduct a material stress study to assure durability and dependability. Weld, cut, and assemble the system components, such as a conveyor belt, sorting mechanism, and collection bins. Perform quality control tests at each stage of fabrication to ensure structural integrity and compliance with design specifications. Ensure that the design is modular so that parts can be easily replaced and upgraded.

3. Experimental Testing:

Test the system with various frond samples to determine its efficiency, speed, and accuracy. Make real-time modifications to improve conveyor speed and stick separation efficiency. Measure performance measures such processing speed, mistake rate, and consistency. Run many test cycles with varied input conditions to confirm that the system is robust and adaptable. Document test findings and analyse outcomes to fine-tune the operational procedure and boost performance.

1. Sensor Integration and Automation:

Use sensors such as infrared sensors, ultrasonic sensors, or machine vision systems to detect material qualities and monitor system operations. Use microcontrollers and PLCs to automate conveyor movements and sorting systems based on sensor data. Use real-time feedback loops to improve accuracy and eliminate errors in stick segregation. Create a user-friendly interface for system monitoring and control. Implement data logging features to monitor system performance over time and aid in predictive maintenance.

2. Safety Features and Maintenance:

Implement safety measures such as emergency stop buttons, protective guards, and fail-safe mechanisms to prevent accidents. Conduct risk assessments to identify potential hazards and address them proactively. Establish a routine maintenance schedule involving inspections, lubrication of moving parts, and replacement of worn-out materials. Develop a maintenance manual detailing troubleshooting procedures and preventive measures. Train operators on safety protocols and emergency response procedures to ensure a secure working environment.

3. Deployment & Training:

Deploy the system in agricultural processing facilities and perform on-site evaluations to ensure seamless integration with existing workflows. Provide extensive training to operators on system operation, troubleshooting strategies, and maintenance protocols. Create instructional materials and training films to facilitate knowledge transfer. Ensure compatibility with current infrastructure to reduce installation issues. Gather operator feedback to improve training methods and the user experience.

4. Continuous improvement:

Gather feedback from operators on the ease of use and operational challenges. Perform periodic performance assessments to identify opportunities for improvement. Analyse operational data to improve system performance and implement new features such as enhanced sensors or AI-powered monitoring systems to improve segregation accuracy and efficiency.

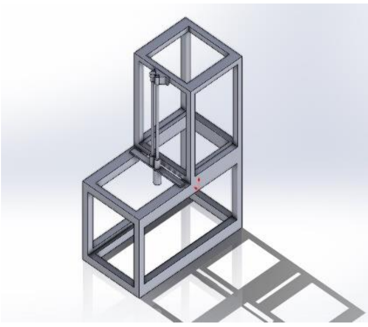

Fig: 1 Design of the Project

1. Components Used:

1. AC Motor (8000 RPM):

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A single-phase AC motor serves as the primary power source for the machine. It drives the rubber rollers used for midrib extraction. The high-speed motor ensures efficient processing and consistent torque, making it suitable for continuous operations.

2. Rubber Rollers:

A pair of circular rubber rollers (25 mm outer diameter, 19 mm inner diameter) are the main working components responsible for gripping and pulling the coconut leaves. The rubber surface prevents damage to the midrib and provides necessary friction for efficient separation.

3. Pillow Block Bearings:

These bearings support the rotating shafts and allow smooth operation. They are easy to install and maintain, and they hold the shafts in place while minimizing vibration and wear.

4. PVC Shafts:

Lightweight yet durable, PVC pipes are used as shafts to connect the motor with the rollers. They are chosen for their cost-effectiveness, availability, and ease of modification during the prototype stage.

5. Mild Steel Frame:

The structural base of the machine is made using mild steel (MS) due to its strength, durability, and affordability. The frame provides rigidity and supports the entire setup, ensuring safety during operation.

6. Switch and Wiring Components:

Basic electrical components such as on/off switches, wiring, and circuit protection devices (like fuses or breakers) are included to safely operate and control the motor.

7.Fasteners and Mounting Hardware:

Nuts, bolts, washers, and clamps are used for assembling various parts of the machine. These allow easy disassembly for maintenance or future upgrades.

8. Tachometer (for testing only):

A non-contact digital tachometer is used during the testing phase to measure the roller RPM. This helped in determining the optimal speed settings for different types of coconut leaves.

9. Working Principle:

The coconut midrib segregation machine uses a motorised roller mechanism to remove leaflets from coconut fronds while retaining the centre midrib. When a coconut frond is manually fed into the machine, it goes between two revolving rubber rollers mounted on shafts and powered by an alternating current motor. These rollers offer gentle, steady pressure to the frond, drawing it forward and separating the leaflets from the central rib. The rubber rollers' flexibility and surface texture protect the midrib from injury during the operation. The rollers are perfectly placed and spaced to handle sun-dried leaves, which have the highest stiffness for optimum processing. The entire process is semi-automatic, requiring little oversight once the machine is operational. As the rollers rotate, the leaflets are stripped and fall to the side, leaving the midrib clean and ready for collection. This concept of controlled friction-based separation ensures that coconut fronds are processed safely and efficiently.

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Fig 2: Design And Fabrication of Stick Segregation from Fronds

III. RESULT AND DISCUSSION

The comparison of manual and automated procedures demonstrated significant efficiency advantages with the mechanised technology. The machine consistently generated 150-180 sticks each batch from two-week sun-dried leaves, compared to 80-100 sticks from conventional methods over the same time period. Sun-dried fronds gave maximum stiffness and elasticity, resulting in smoother processing and less residue. Fresh leaves, on the other hand, clogged the rollers due to excess moisture, and extremely dry leaves disintegrated into powder. Adjusting the roller spacing and RPM was crucial for improving performance. The study also discovered that employing locally accessible materials helps cut fabrication costs while maintaining performance. Observations made during testing revealed the requirement for protective covers to reduce dust formation and assure operator safety. These findings support the system's ability to replace human labour in broomstick manufacturing processes while also promoting sustainable practices in rural industries.

IV. CONCLUSION

The suggested process automates stick separation from fronds, providing a more efficient alternative to manual methods. This study shows how mechanical separation and automation may increase efficiency and homogeneity. The system is designed with precise material selection and mechanical modifications to ensure effective segregation. Sensors and microcontrollers can be combined to increase real-time monitoring and optimisation, inspired by waste segregation technology. Automated waste segregation systems boost recycling rates by employing conveyor belts, magnetic separators, and IoT technologies to make real-time changes. Future enhancements can focus on increasing efficiency, including IoT for monitoring, and implementing a modular design that can be customised to a wide range of agricultural applications. Remote monitoring and control can increase performance, remove manual intervention, and widen the application to other agricultural duties, thereby increasing sustainability.

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V. FUTURE ENHANCEMENTS

The current prototype of the coconut midrib segregation machine has demonstrated good efficiency and usability, but several improvements can enhance its performance, ease of use, and industrial potential. Integrating microcontrollers and sensors could automate feeding and roller adjustments, reducing manual input and improving safety. A variable frequency drive (VFD) would enable speed control based on leaf condition, minimizing jams and leaf damage. Adding a dust extraction unit and protective enclosures would enhance operator safety and workplace conditions. A conveyor-based multi-stage design could support continuous operation and increased output. Using more durable, lightweight materials and modular roller sets would extend machine life and allow processing of various leaf types. Hybrid power options like solar with battery backup would make the machine suitable for off-grid or rural use. Finally, integrating basic data logging or mobile connectivity would support real-time monitoring, helping improve maintenance and productivity.

REFERENCES

1. Liu, Y., Zhang, Z., Li, Z., Wei, X., Zhao, F., Fan, C., & Jiang, Z. (2023). Surface Segregation Methods toward Molecular Separation Membranes. *Small Methods*, 7. https://doi.org/10.1002/smtd.202300737.
2. Elsayed, M., Eldadamony, N., Alrdahe, S., & Saber, W. (2021). Definitive Screening Design and Artificial Neural Network for Modeling a Rapid Biodegradation of Date Palm Fronds by a New Trichoderma sp. PWN6 into Citric Acid. *Molecules*, 26. https://doi.org/10.3390/molecules26165048.
3. Yoo, J., Kim, S., & Ko, H. (2021). Stick-and-play system based on interfacial adhesion control enhanced by micro/nanostructures. *Nano Research*, 14, 3143 - 3158. https://doi.org/10.1007/s12274-021-3533-6.
4. Yang, T., Hu, J., Wang, P., Edeleva, M., Cardon, L., & Zhang, J. (2023). Two-step approach based on fused filament fabrication for high performance graphene/thermoplastic polyurethane composite with segregated structure. *Composites Part A: Applied Science and Manufacturing*. https://doi.org/10.1016/j.compositesa.2023.107719.
5. , S., Sopian, K., Daud, W., Othman, M., & Yatim, B. (1999). Design of an experimental solar assisted dryer for palm oil fronds. *Renewable Energy*, 16, 643-646. https://doi.org/10.1016/S0960-1481(98)00243-2.
6. Martínez-González, J., Pablo-Pedro, R., Armas-Pérez, J., Chapela, G., & Quintana-H, J. (2014). Chiral segregation of hockey-stick shaped particles in two dimensions. *RSC Advances*, 4, 20489-20495. https://doi.org/10.1039/C4RA00617H.
7. Wahab, R., Sukhairi, M., Rasat, M., Sulaiman, M., Razak, M., & Mokhtar, N. (2021). Characterization of Oil Palm Fronds Panel at Different Conditions and Positions with Formaldehyde Adhesive. *Borneo Journal of Sciences and Technology*. https://doi.org/10.35370/bjost.2021.3.1-10.
8. Pratheep, V., Muralidharan, A., Rajan, N., & Suganesh, M. (2023). Design And Fabrication Of Waste Fabric Segregation System. *2023 9th International Conference on Electrical Energy Systems (ICEES)*, 1-4. https://doi.org/10.1109/ICEES57979.2023.10110286.
9. Sharma, K., Prajapati, R., Srivastava, S., Fore, V., & Amrish, A. (2025). Design and Fabrication of an Automatic Waste Segregation and Monitoring System. *Current World Environment*. https://doi.org/10.12944/cwe.19.3.15.
10. Al., M. (2018). SYNTHYSIS OF RAYON FROM DATE PALM FRONDS. *IRAQI JOURNAL OF AGRICULTURAL SCIENCES*. https://doi.org/10.36103/ijas.v49i6.141.
11. Bae, C., & Halloran, J. (2018). A segregation model study of suspension-based additive manufacturing. *Journal of the European Ceramic Society*. https://doi.org/10.1016/J.JEURCERAMSOC.2018.07.008.
12. Hanafi, I., & Nurrohkayati, A. (2023). Analysis of the Design of the Palm Frond Chopping Machine as a Basic Ingredient for Animal Feed. *Procedia of Engineering and Life Science*. https://doi.org/10.21070/pels.v3i0.1325.

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