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Fabrication of Farm Device for Agricultural Applications

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1. Introduction

Agriculture plays a vital role in the economy, and seed quality directly influences crop productivity. After harvesting, seeds often contain impurities such as dust, stones, husks, and damaged seeds. Removing these contaminants manually requires significant effort and time. Existing commercial seed-cleaning equipment is often expensive and inaccessible to small-scale farmers.

To address this challenge, a multi-seed cleaning and separation machine was developed using vibration and airflow-assisted separation techniques. The machine is capable of cleaning and grading various seeds including green gram, black gram, chickpea, wheat, soybean, maize, and paddy. The proposed system aims to provide an economical solution while improving separation accuracy and reducing labour dependency.

2. Literature Review

Several researchers have worked on seed cleaning and separation technologies. Li Yonglei et al. developed a batch seed-cleaning device that achieved improved seed purity and cleaning efficiency. Zheng Xiaoyan et al. investigated airflow optimization using CFD techniques for grain cleaning systems. Lian et al. introduced a double-layer vibrating air-sieve cleaning device with reduced impurity rates. Recent studies have also focused on intelligent seed sorting using machine vision, deep learning, and artificial intelligence techniques.

Although advanced technologies provide high accuracy, they are generally expensive and difficult to adopt for small-scale agriculture. Therefore, there remains a need for a low-cost and efficient seed separation machine suitable for rural farming applications.

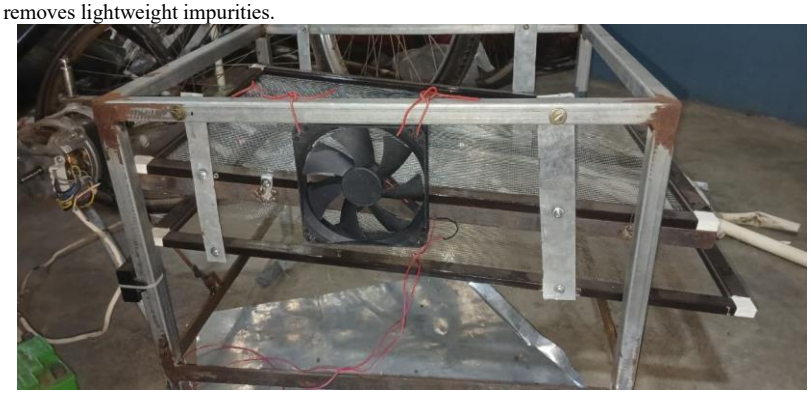
3. Materials and Methods

3.1 Machine Design

The developed machine consists of:

- Feed hopper
- Dual-stage sieve assembly
- Electric motor (1280 RPM)
- DC brushless blower fan
- ESP32 microcontroller
- Vibration sensor module
- Battery power supply
- Seed collection trays

The operating principle is based on differences in seed size and aerodynamic properties. The vibration generated by the motor causes seeds to move across sieves, while airflow removes lightweight impurities.



3.2 Working Principle

1. Mixed seeds are fed through the hopper.
2. The upper coarse sieve removes large impurities.
3. Seeds move to the lower fine sieve for further classification.
4. Airflow generated by the brushless fan removes lighter contaminants.
5. Cleaned and graded seeds are collected separately.

3.3 Electronic Monitoring System

The ESP32 microcontroller receives signals from a vibration sensor mounted on the machine. Continuous vibration monitoring helps identify abnormal operating conditions, enabling preventive maintenance and improving machine reliability.

4. Experimental Setup

The machine was tested using mixed agricultural seeds under different batch loading conditions. Performance was evaluated based on:

- Sorting efficiency
- Seed cleanliness
- Processing time
- Seed wastage
- Labor requirement
- Machine stability

The motor speed was maintained at 1280 RPM throughout testing.

5. Results and Discussion

5.1 Seed Cleaning Performance

The developed machine effectively removed impurities and classified seeds according to size.
The results indicate significant improvement in seed quality after separation.

5.2 Effect of Batch Size on Sorting Efficiency

Sorting efficiency increased with batch size:

Batch Size (kg)	Sorting Efficiency (%)
2	89
4	91.5
6	94

The highest efficiency of 94% was observed at a batch size of 6 kg. Improved seed distribution across the sieve surface contributed to better separation performance.

5.3 Performance Comparison

Parameter	Traditional Method	Developed System
Sorting Efficiency (%)	75	94
Sorting Time (min)	20	10
Seed Wastage (%)	12	5
Labour Requirement	3	1

The developed machine demonstrated superior performance compared with manual sorting methods by reducing labor requirements and processing time while improving separation efficiency.

6. Advantages of the Developed Machine

- Low manufacturing cost.
- Reduced manual labour.
- Improved sorting accuracy.
- Portable and easy to operate.
- Suitable for multiple seed varieties.
- Reduced seed wastage.
- Simple maintenance.
- Capability for future IoT integration through ESP32.

7. Future Scope

Future enhancements may include:

- Automatic adjustment of vibration frequency.
- IoT-enabled remote monitoring.
- Machine vision-based seed classification.
- Artificial intelligence for quality grading.
- Solar-powered operation.
- Increased processing capacity for industrial applications.

8. Conclusion

A multi-seed cleaning and separation machine was successfully designed, fabricated, and tested. The system integrates a vibrating sieve assembly with pneumatic cleaning to improve seed quality and grading accuracy. Experimental results showed a maximum sorting efficiency of 94%, reduced processing time, lower seed wastage, and significant reduction in labor requirements compared with conventional methods. The developed machine offers an affordable and practical solution for small and medium-scale farmers and has potential for further development through automation and intelligent monitoring technologies

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