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Design and Development of a Rack and Pinion Based Can Crushing Mechanism

Swarali Siddheshwar Nakate , Samarth Bhaskar Pawar , Rohit Uddhav Tambave, Laxman Arjun Thengal, Ganesh Shashikant Bhagwat, Sangameshwari Shivappa Kore

Student, Mechanical Engg, SVERI, Pandharpur, India

Student, Mechanical Engg, SVERI, Pandharpur, India

Student, Mechanical Engg, SVERI, Pandharpur, India

Student, Mechanical Engg, SVERI, Pandharpur, India

Student, Mechanical Engg, SVERI, Pandharpur, India

Student, Civil Engg, SVERI, Pandharpur, India

Abstract: The project presents the design and development of a compact can crushing mechanism using a rack and pinion transmission system. A 12V DC geared motor converts rotary motion into linear motion to compress aluminum cans, reducing their volume by approximately 75–80%. The system is intended for small-scale applications such as homes, hostels, and cafeterias, providing an affordable, energy-efficient, and user-friendly recycling solution. The mechanism was designed and validated using Autodesk Fusion 360 to ensure smooth operation, structural stability, and efficient force transmission. The proposed design promotes sustainable waste management while offering scope for future automation using sensors and IoT technologies.

Keywords: Can Crusher , Rack and Pinion , Waste Management Recycling , DC Geared Motor , Mechanical Design Automation

I. Introduction

The increasing consumption of aluminum beverage cans has created significant challenges in waste management and recycling. Although aluminum is a highly recyclable material, discarded cans occupy a large volume, making their storage, transportation, and recycling inefficient. Manual crushing methods require physical effort and provide inconsistent results, while industrial crushing machines are often expensive and unsuitable for small-scale application.

To address these challenges, this project proposes the Design and Development of a Motorized Can Crusher Using a Rack and Pinion Mechanism. The system uses a 12V DC geared motor to drive a pinion gear, which converts rotary motion into linear motion through a rack. The linear movement operates a crushing plate that compresses aluminum cans, reducing their volume by approximately 75–80%. This design provides smooth operation, low power consumption, and minimal manual effort. The proposed can crusher is compact, cost-effective, and suitable for homes, hostels, restaurants, cafeterias, and small recycling centers. The entire mechanism was designed and analyzed using Autodesk Fusion 360, ensuring proper alignment, structural stability, and reliable performance before fabrication. In addition, the design provides opportunities for future enhancements such as automatic can detection, IoT-based monitoring, and solar-powered operation, making it a sustainable solution for modern waste management.

II objective

The increasing consumption of aluminium beverage cans has created significant challenges in waste management and recycling. Although aluminium is a highly recyclable material, discarded cans occupy a large volume, making their storage, transportation, and recycling inefficient. Manual crushing methods require physical effort and provide inconsistent results, while industrial crushing machines are often expensive and unsuitable for small-scale applications.

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III METHODOLOGY (3D CAD DESIGN)

Concept Development – The can crusher concept was developed based on a rack and pinion mechanism.

3D CAD Modeling – A complete 3D model was created in Autodesk Fusion 360.

Component Assembly – The frame, DC motor, rack, pinion, guide rods, crushing plate, and base plate were assembled.

Motion Verification – The rotary motion of the DC motor was verified to convert into linear motion through the rack and pinion mechanism.

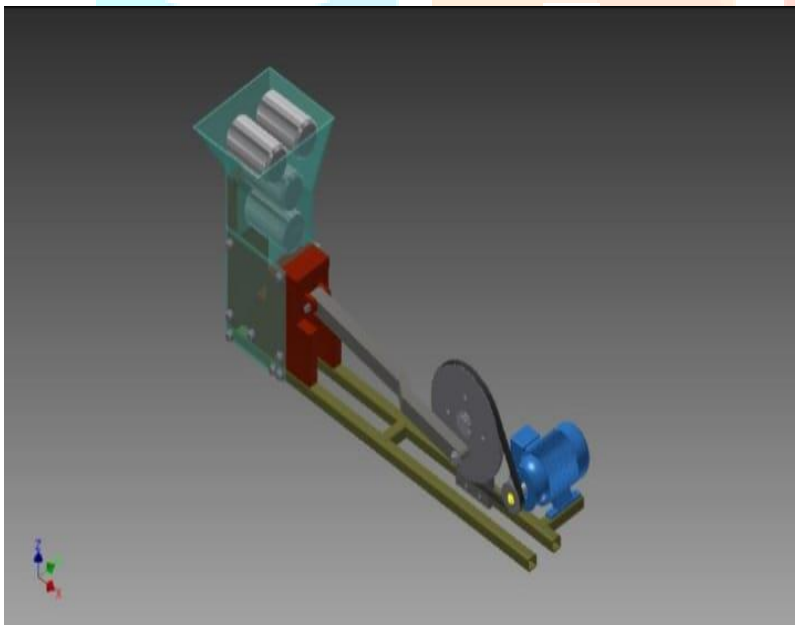
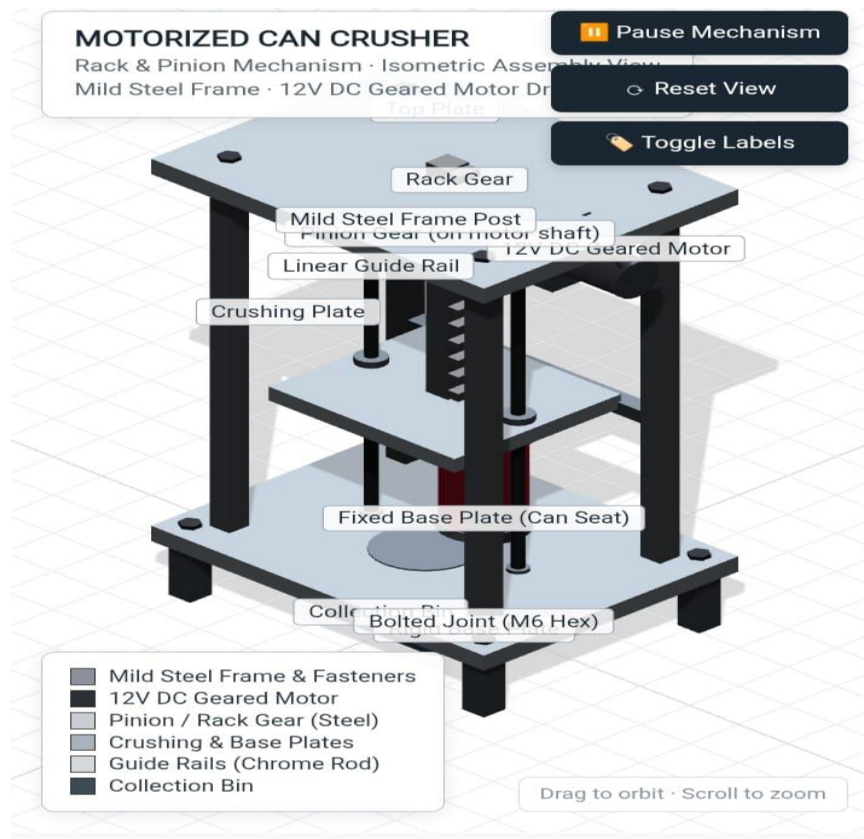
Design Validation – The assembly was checked for alignment, clearance, and smooth operation before fabrication.

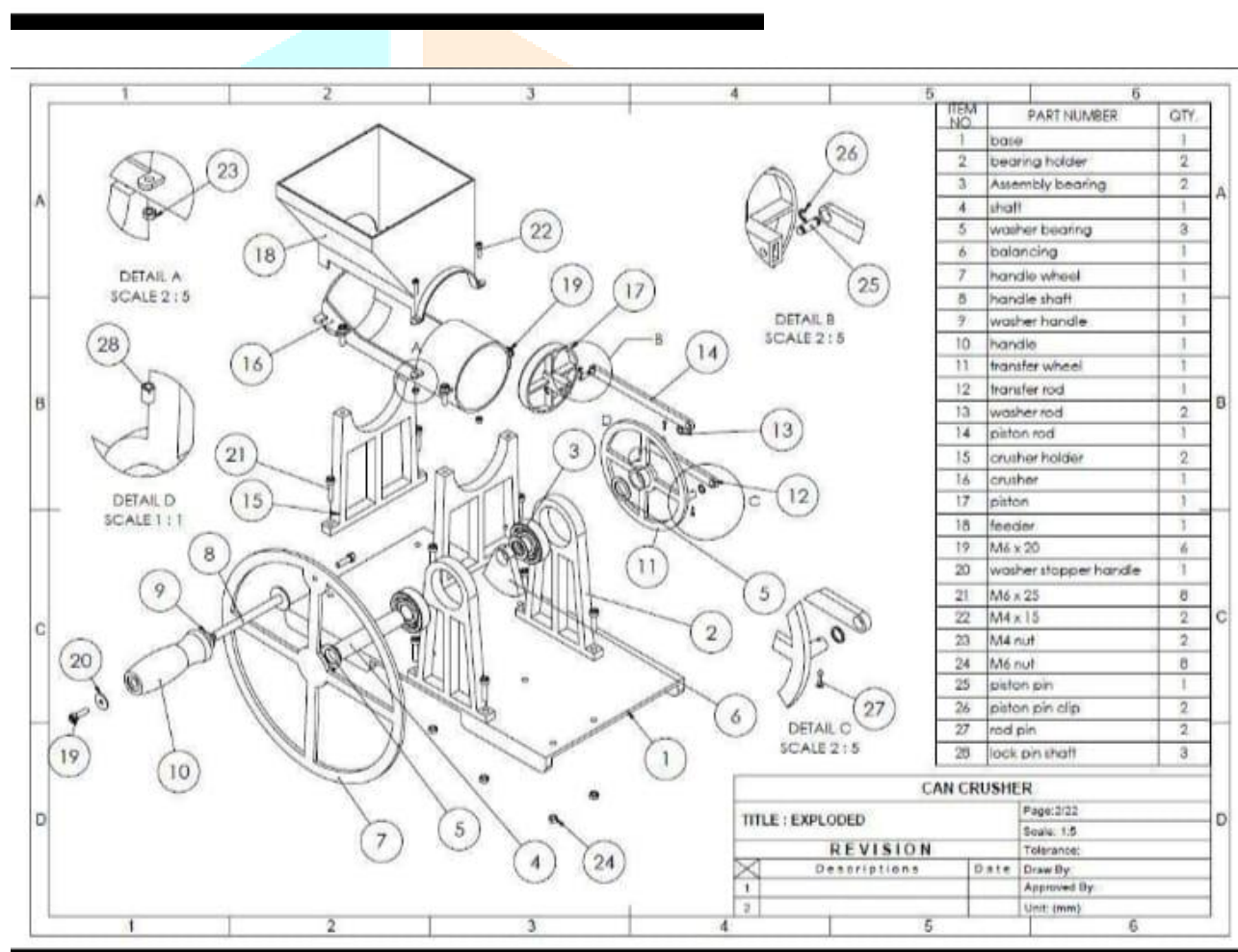
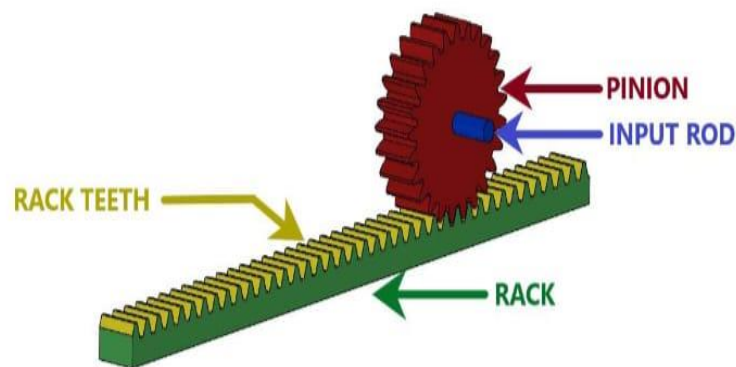
Final Design – The validated 3D CAD model was finalized for simulation, documentation, and future prototype development.

IV. ENGINEERING DESIGN

The proposed motorized can crusher employs a rack and pinion transmission driven by a 12V DC geared motor to convert rotary motion into linear motion. Dual guide rails maintain alignment of the crushing plate, ensuring smooth operation and uniform force distribution. The mild steel frame provides structural rigidity while keeping fabrication simple and economical. The design achieves approximately 75–80% reduction in aluminum can volume, making it suitable for small-scale recycling applications and future automation.

DIAGRAM.





V. CONCLUSION

The proposed motorized can crusher using a rack and pinion mechanism provides an efficient, compact, and economical solution for aluminum can waste management. The system effectively converts rotary motion into linear motion, reducing the volume of cans by approximately 75–80% while requiring minimal manual effort. The 3D CAD design demonstrates reliable operation, structural stability, and suitability for small-scale recycling applications. The proposed design also offers potential for future enhancements through automation and IoT integration, making it a sustainable solution for modern waste management.

VI. ACKNOWLEDGMENT

This project focuses on the design and development of a compact, motorized can crusher that uses a rack and pinion mechanism to convert the rotary motion of a 12V DC geared motor into linear motion for crushing aluminum cans. The system reduces the volume of cans by approximately 75–80%, making storage, transportation, and recycling more efficient. The proposed design is economical, easy to operate, and suitable for homes, hostels, cafeterias, and small-scale recycling applications. The complete assembly was designed and validated using Autodesk Fusion 360 to ensure smooth operation structural stability, and reliable performance before fabrication .

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