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Development and Performance Evaluation of a Conveyor-Based Magnetic Burr Collector for Workshop Scrap Management

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Abstract

This study presents the design, development, and experimental performance evaluation of a semi-automated conveyor-based magnetic burr collector designed for effective metal scrap management in small- and large-scale machining workshops. Traditional manual picking and sweeping methods for collecting metallic chips and burrs present severe workplace safety hazards and suffer from low operational efficiency. The developed system utilizes a continuous belt conveyor powered by permanent bar magnets and a rear collection container to separate and collect ferrous waste. Mechanical design and structural analysis of the mild steel support frame and drive shaft (EN 24 steel) were conducted to guarantee operational safety under torsional shear and bending stress constraints. Experimental validation across varying operational floor areas revealed that the prototype achieved up to reduction in surface metallic burrs. Specifically, the collector processed a target area of of metallic burrs in {min} fulfilling performance criteria without thermal or mechanical degradation.

Keywords: Burr Collector; Magnetic Separation; Neodymium Magnets; Conveyor System; Workshop Safety; Scrap Management; Torsional Stress Analysis.

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Introduction

During mechanical machining operations—such as turning, milling, drilling, and grinding—copious amounts of metallic scrap and sharp burrs are generated continuously. These waste pieces disperse rapidly across workshop floors, creating serious hazards for operators, increasing risk of lacerations, and threatening equipment integrity. Traditional cleaning methods relying on manual picking or brooms are inefficient, time-consuming, and expose workers to physical injury.

A modern machining facility demands technology-driven scrap management systems utilizing physical principles like magnetism to safely automate scrap recovery. Conveyor-based material handling equipment provides an effective framework for continuous waste transfer. Scrap metal is categorized into ferrous (iron-containing) and non-ferrous groups. By integrating high-energy permanent magnetic fields with belt conveyors, ferrous burrs can be continuously attracted from workshop surfaces, conveyed against gravity, and automatically

Research Gap and Novelty

While high-end automated guided vehicles (AGVs) and complex robotic collectors exist, their substantial capital cost, complex programming requirements, and high maintenance render them unviable for typical small-to-medium enterprise (SME) machine shops. Conversely, basic manual magnetic sweepers lack continuous conveying mechanism capability, resulting in rapid surface saturation and requiring frequent operational pauses.

The primary novelty of this work lies in the development of an affordable, compact, semi-automated conveyor-based magnetic burr collector. It uniquely combines a high-energy NdFeB permanent magnetic arrangement beneath a moving conveyor belt with an integrated rear collection vessel. The machine operates without requiring skilled labor, functions under low power constraints, and eliminates manual contact with hazardous metallic waste.

Objectives

Design and fabricate a compact, cost-effective magnetic burr collector tailored for machining workshops.

- Achieve floor cleaning coverage for target benchmark areas ranging from
- Efficiently collect metallic burr within a short operational timeframe
- Minimize worker exposure to sharp metal hazardous scrap through mechanical containment.

Literature Review

D. M. Mate demonstrated the feasibility of a solar-powered scrap collector, integrating photovoltaic panels and battery storage to ensure continuous operation while reducing operational costs. B. Shaik evaluated mobile garbage-collecting robots for sorted waste handling, highlighting significant labor reductions. Y. M. Raut developed an automatic electromagnetic scrap collector capable of clearing an area per minute, demonstrating suitability for localized industrial areas [1].

B. Bhoir presented a low-cost modular garbage collector robot operated remotely via an application, confirming the viability of modular chassis design. A. Mulani demonstrated IoT-integrated waste tracking systems using real-time video surveillance and battery management. J. B. Mule designed a magnetic burr collecting machine utilizing front buckets, observing that chip collection efficiency improved markedly at lower vehicular speeds[2]

Prof. C. Edward established that automated deburring and chip removal prevented loose fragments from damaging finished machine components. S. Ashokkumar developed an automatic scrap collecting vehicle utilizing rechargeable power sources and auxiliary blowers. P. Valsalan constructed a metallic scrap collection robot guided by electromagnetic arms and multi-camera trajectory mapping. T. Arun analyzed automated waste segregators differentiating between static and dynamic objects as well as metallic and non-metallic waste streams[3]

S. S. Kumar applied Faraday's law of electromagnetic induction in metal chip recycling through electromagnetic separation. A. A. Mohite investigated an Arduino-controlled magnetic collector with an integrated oil-soak mop system for dual liquid-solid workshop cleaning. M. Iyyappan designed automated deburring fixture tools to eliminate component rejections without penalty to cycle time. R. Vishnu achieved a 20% reduction in shift cleaning downtime on conventional lathes via automated chip cleaning. R. Waykole implemented a combined electromagnetic-vacuum system for comprehensive debris collection[4]

R. S. Gorde verified that continuous automated burr removal reduced tool wear and enhanced final product accuracy. C. J. Shende detailed structural blade and chassis optimization for small utility power equipment. S. Pradeep integrated motor shields and Arduino microcontrollers for automatic guided metallic recovery vehicles. R. C. Naik confirmed that mechanically driven belt systems utilizing rare-earth magnets provided superior chip capture, transfer, and discharge characteristics[5]

The system functions via continuous surface sweeping. As the machine moves across the workshop floor, the low-clearance belt conveyor feeds magnetic material over an internal array of NdFeB permanent magnets mounted above a sheet metal plate. Ferrous burrs are attracted onto the moving belt surface, transported past the frame apex, and dropped into the rear storage container as they move beyond the magnetic field zone[6].

Experimental Results and Performance Analysis

Fig. 1. *Metallic burr collector*

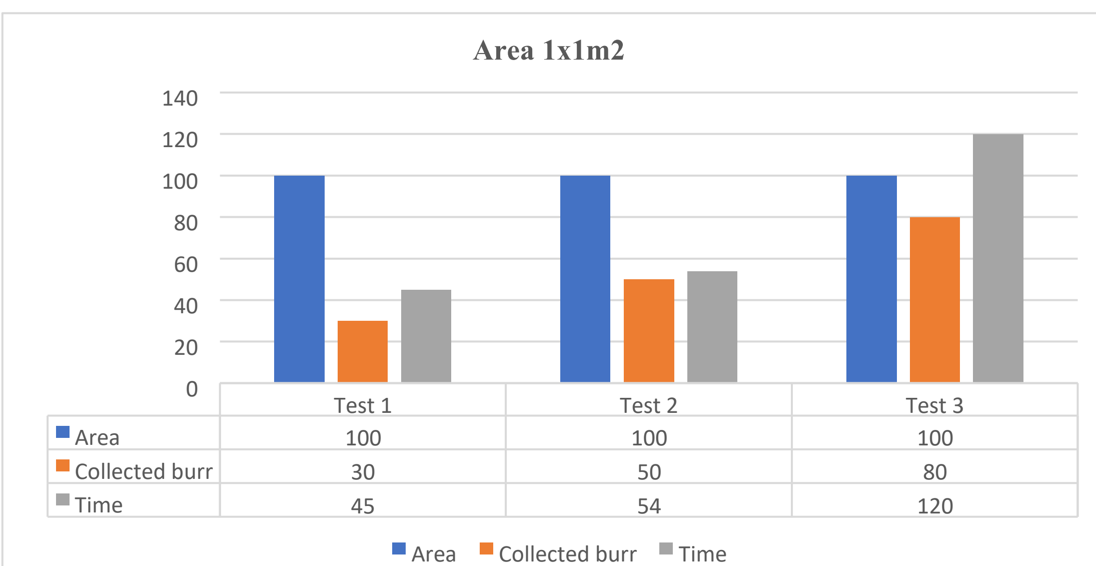
Observations

Trial 1 -Considering Area as 1x1m2

Table 1. *Trial 1*

Sr. No.	**Area (m2)**	**Speed (in rpm)**	**Collected Burr (g)**	**Time**
1.	1x1	30	30	45secs
2.	1x1	30	50	54secs
3.	1x1	30	80	1min20Secs

Graph 1:

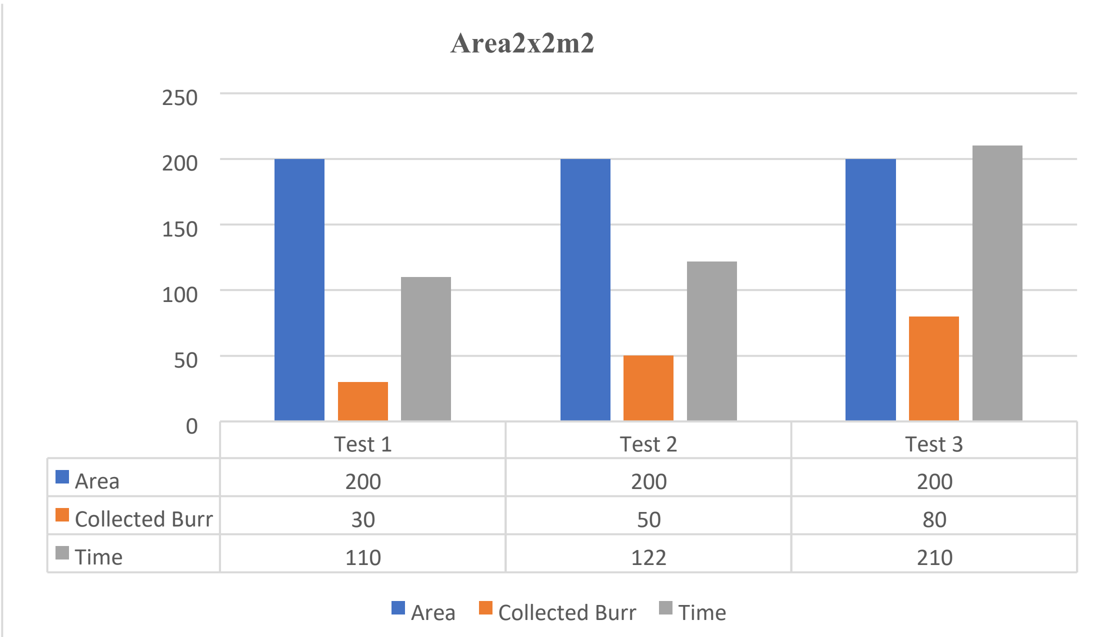


Trial 2 - Considering Area as 2x2m2

Table 2. *Trial 2*

Sr. No.	Area (m2)	Speed (in rpm)	Collected Burr (g)	Time
1.	2x2	30	30	1min 10secs
2.	2x2	30	50	1min 22 secs
3.	2x2	30	80	2min10Secs

Graph 2:

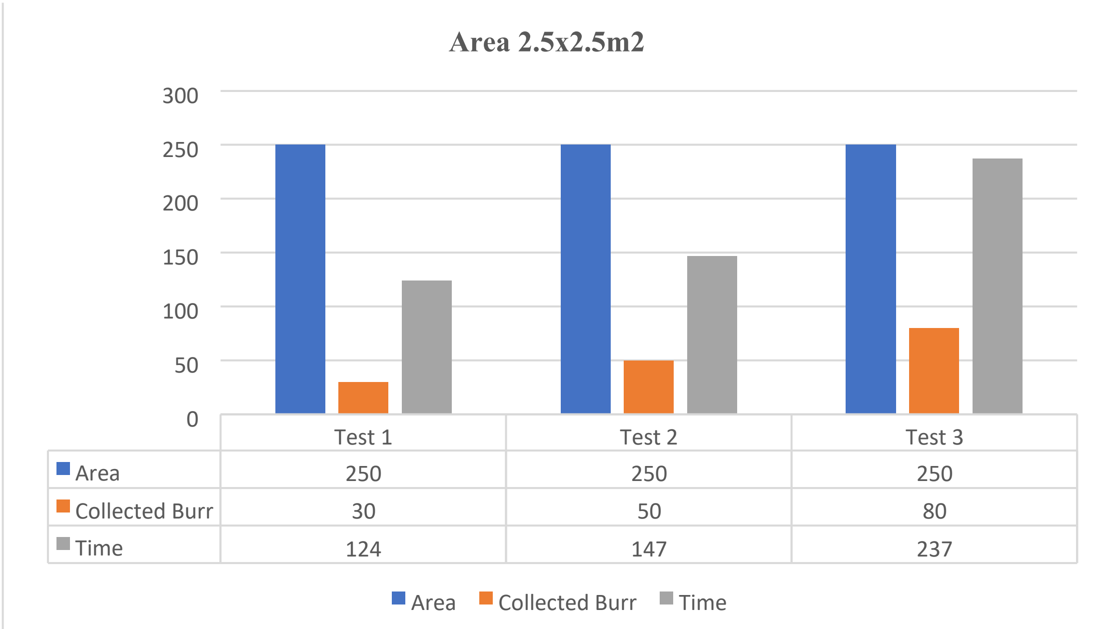


Trial 3 - Considering Area as 2.5x2.5m2

Table 3. *trial 3*

Sr. No.	Area (m2)	Speed (in rpm)	Collected Burr (g)	Time
1.	2.5x2.5	30	30	1min 24secs
2.	2.5x2.5	30	50	1min 47secs
3.	2.5x2.5	30	80	2min37secs

Graph 3:

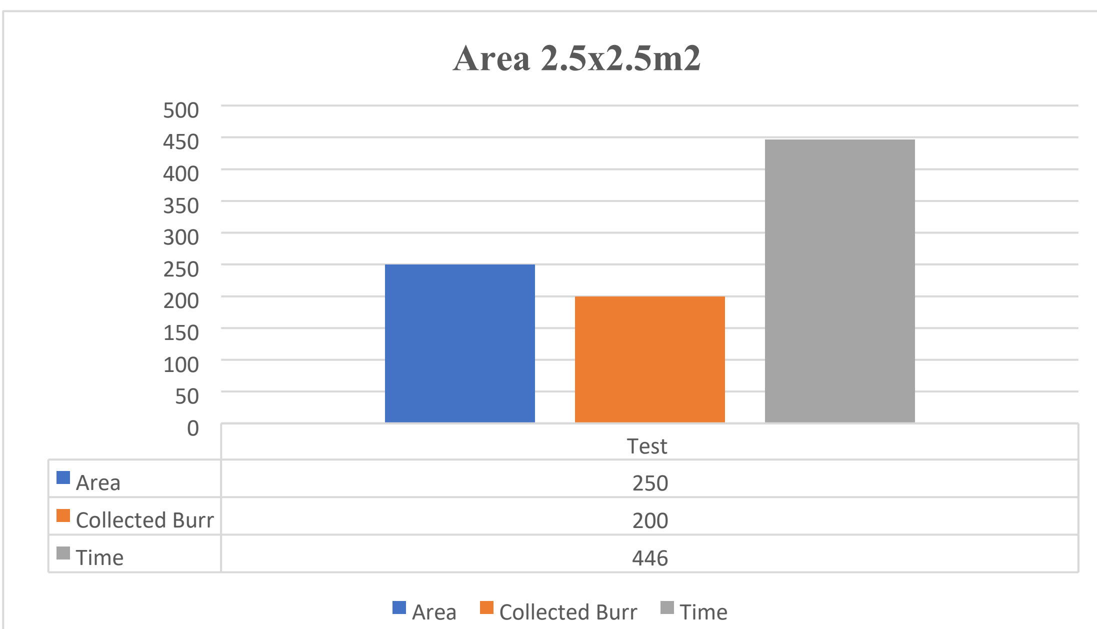


Trial 4-Considering Area as 2.5x2.5 m2

Table 4. *trial 4*

Sr. No.	**Area (m2)**	**Speed (in rpm)**	**Collected burr (g)**	**Time**
1	2.5x2.5	30	200	4min 46secs

Graph 4

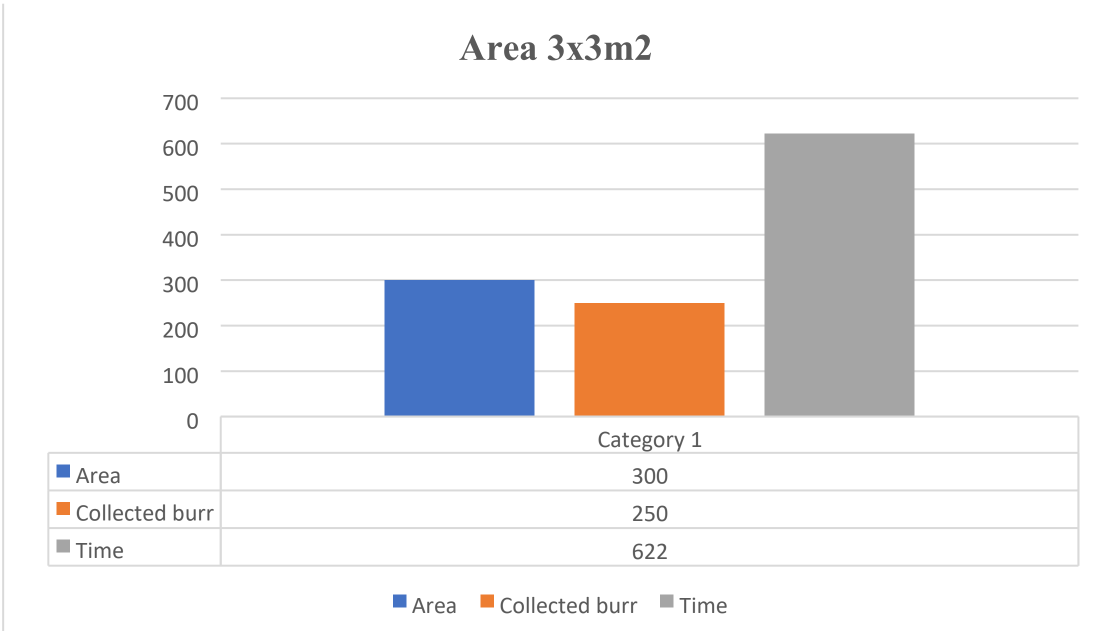


Trail 5-Considering Area as 3x3 m2

Table 5. *Trial 5*

Sr. No.	Area (m2)	Speed (in rpm)	Collected burr (g)	Time
1	3x3	30	250	6min 22secs

Graph 5



Conclusion

About 200grams of metallic burrs were collected by the burr collector. The amount of burrs found on floors and machinery surfaces was reduced by 90% by using burr collector. It only collects ferrous metals and non-ferrous metals cannot be attracted.

Big size of burr attracts the conveyor belt and causes restriction which takes time to clean the specific area.

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