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ScrapX- An AI-Powered Scrap Management

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ABSTRACT

This survey explores how Machine Learning (ML) and Computer Vision can improve scrap waste management. Using CNNs for image-based classification, it enables accurate detection of plastics, metals, and e-waste. ML models further predict real-time resale values, ensuring fair pricing and encouraging recycling. A digital reward system provides wallet credits to motivate sustainable practices. The survey reviews existing methods, compares their performance, and proposes a hybrid ML-based framework for efficient, transparent, and user-friendly waste management.

Keywords — Scrap management, machine learning, computer vision, CNN, classification, resale prediction, recycling, reward mechanism

1. INTRODUCTION

Overview

Scrap waste, especially metals, plastics, and e-waste, contributes significantly to environmental degradation. Manual disposal is often inefficient, inconvenient, and lacks transparency. To solve this, modern waste management integrates AI and digital technologies to automate classification, estimate resale value, and motivate users with financial rewards. This paper surveys current trends, identifies research contributions, and proposes a system architecture that blends machine learning, IoT, and fintech features for sustainable scrap management.

In recent years, advancements in Machine Learning (ML) and Computer Vision have opened new opportunities to address these limitations. By leveraging Convolutional Neural Networks (CNNs) and image-based classification techniques, different categories of scrap such as plastics, metals, and e-waste can be accurately identified and segregated. Furthermore, ML-driven predictive models can estimate the real-time resale value of scrap, ensuring fair and transparent pricing for users.

To further encourage sustainable practices, digital reward systems such as wallet credits can be integrated into recycling platforms, motivating users to dispose of waste responsibly. This research aims to consolidate existing approaches, analyze their effectiveness, and propose a hybrid ML-based framework that combines accuracy, transparency, and user engagement for efficient scrap waste management.

Traditional waste disposal systems often rely on manual segregation and valuation, which are time-consuming, inconsistent, and prone to human error. To address these challenges, technological interventions have become essential. Machine Learning (ML) and Computer Vision techniques have demonstrated significant potential in automating the process of waste detection, classification, and valuation. Convolutional Neural Networks (CNNs), in particular, have proven effective in image-based classification tasks, enabling accurate identification of scrap categories such as plastics, metals, and e-waste. Once identified, predictive ML models can further estimate real-time resale values, ensuring fairness and building trust among users.

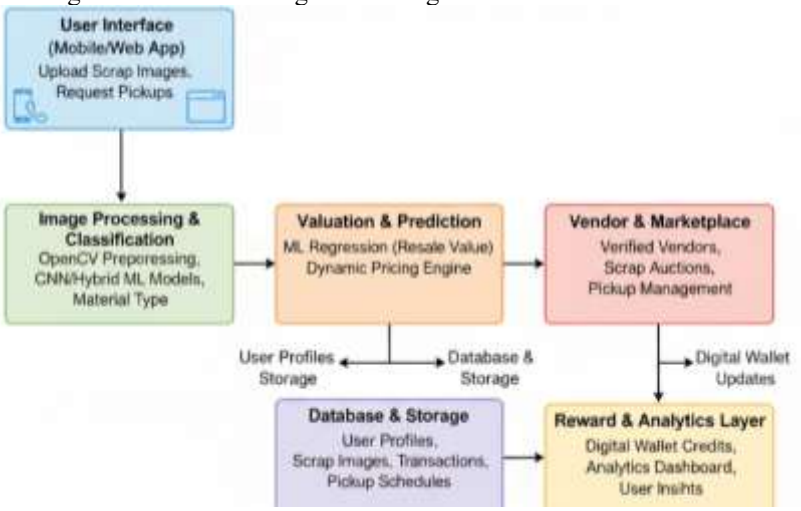

Fig 1: General Workflow of ScrapX Platform

Types of Scrap Waste

Scrap waste is broadly categorized into different streams depending on its material and recyclability.

- **Metal Scrap**: Includes iron, copper, steel, and aluminum waste from households, vehicles, and industries. Metals have high recycling value and can be melted and reused with minimal loss of quality.
- **Plastic Scrap**: Consists of bottles, packaging, and synthetic polymers. Plastics are difficult to degrade naturally, making their recycling crucial for reducing pollution.
- **E-Waste**: Covers discarded electronic items like smartphones, laptops, and batteries. E-waste contains hazardous materials (lead, mercury) but also valuable metals like gold and silver.

ML-based classification systems primarily target **metal, plastic, and e-waste**, since these categories are most suitable for automated detection and resale pricing. (1)

ScrapX Principles*:*

- Scrap classification adapts to material type.
- Price prediction ensures fair valuation.
- Credit-based rewards improve user engagement.

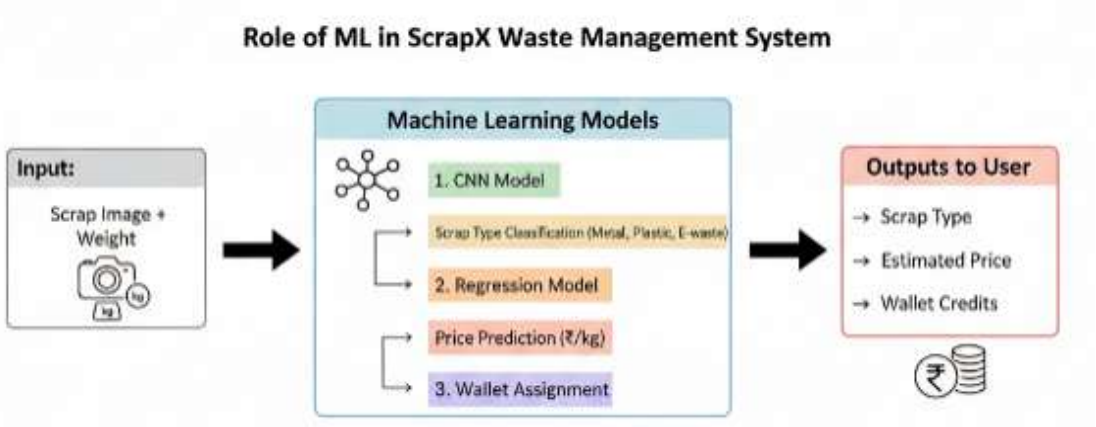

Fig . 2: Role of algorithms in ScrapX

2. LITERATURE REVIEW

Online Kabadiwala (2024) – Provides Android/web platforms for door-to-door scrap pickup, using OpenCV and AI to scan items and estimate resale value. It also integrates a scrap store to promote circular economy. However, it faces scalability issues due to its first-come-first-serve model.

iScrap Algorithm Platform (2023) –Lets users upload scrap images for ML-based detection, supports only verified vendors for secure trading, and reduces transportation costs to increase profits. Built with Kotlin and MySQL, it is designed to be region-independent.

Echo Trade (2024) –Focuses on sustainable online auctions for institutions and industries. It converts waste like plastics, metals, and cooking oil into resources for other industries, ensuring transparency, seller-buyer matchmaking, and waste tracking. It aligns with India's challenge of managing 62M+ tons of waste annually.

Advanced E-Waste Management using A-BiCNN-RNN (2024) –*Proposes a deep learning approach combining CNN and RNN for e-waste classification. It integrates IoT sensors and smart bins to track environmental factors and optimize e-waste handling.*

3. METHODOLOGY

The proposed system architecture for ML-driven scrap waste management integrates user interaction, automated classification, valuation, and vendor coordination into a single framework. Users upload scrap images via a mobile or web app, where OpenCV preprocessing and CNN-based models classify materials like plastics, metals, and e-waste. For complex cases, hybrid deep learning models such as A-BiCNN-RNN improve accuracy. Resale values are then predicted using ML regression models with real-time dynamic pricing. All data, including user profiles, scrap images, and transactions, is stored in a centralized database that also manages pickups and wallet credits. Verified vendors are linked to ensure transparent and secure transactions, while a scrap marketplace supports resale and circular economy practices. Finally, a reward system incentivizes users, and an analytics dashboard tracks recycling trends and system performance. This layered approach ensures efficiency, transparency, and sustainability in scrap waste management.

A verified vendor network ensures fair trade and builds trust between buyers and sellers, while an integrated scrap marketplace supports auctions and resale for a circular economy. The system also features a reward wallet that provides credits for successful recycling, motivating user participation.

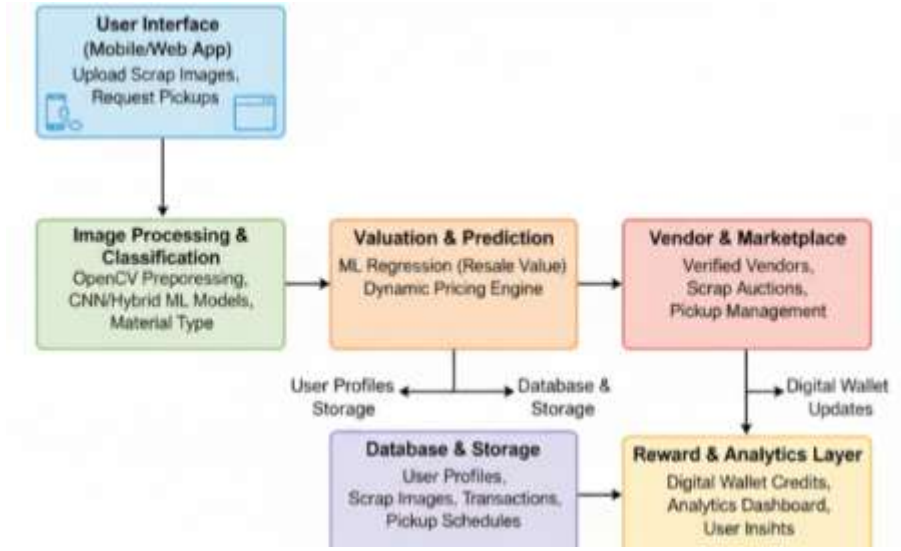

Fig. 3: System Architecture

4. COMPARATIVE ANALYSIS AND FINDINGS

The proposed ML-driven scrap waste management framework advances beyond existing scrap-handling platforms in multiple dimensions. Unlike traditional disposal methods that rely on manual sorting and inconsistent pricing, the system integrates computer vision and machine learning for automated scrap classification and real-time value prediction. This ensures both efficiency and transparency. The architecture also introduces a digital reward mechanism to incentivize users, which most existing solutions lack. Furthermore, the inclusion of a verified vendor network and an integrated scrap marketplace enhances trust, promotes circular economy practices, and expands scalability. However, challenges remain, such as handling large-scale load balancing, ensuring high classification accuracy across diverse scrap types, and integrating dynamic pricing models in rapidly fluctuating markets.

Table I: ScrapX Advancements and Challenges

Dimension	Advantage	Challenge
Automated Classification	CNN + hybrid deep learning models enable accurate detection of plastics, metals, and e-waste.	Maintaining accuracy across diverse scrap categories and conditions.
Transparent Valuation	ML-based predictive pricing ensures fairness and real-time market alignment.	Adapting to fluctuating scrap market values dynamically.
User Engagement & Incentives	Reward wallet and digital credits motivate recycling and sustainable practices.	Preventing misuse of incentives and ensuring long-term adoption.
System Scalability	Centralized database with vendor-user integration supports smooth operations.	Handling load balancing and real-time processing at large scale.

5. FUTURE DIRECTIONS

Future work for ScrapX includes:
Multimodal Waste Recognition: Use images, videos, and sensor data for more accurate classification.
Advanced Valuation Metrics: Improve resale value prediction using market trend analysis and advanced ML techniques.
Expanded Scrap Categories: Include hazardous, construction, and organic waste.
Gamified Recycling & Education: Embed game-like challenges to increase user engagement.
Collaborative Vendor & Community Features: Enable peer-to-peer exchanges and AI-assisted vendor matchmaking.

6. CONCLUSION

This survey analyzed literature on scrap waste management, highlighting limitations in traditional and existing digital platforms. The proposed ML-driven framework integrates automated classification, predictive pricing, vendor verification, and user incentives. By addressing efficiency, transparency, and user engagement, the system contributes toward promoting sustainable recycling practices. Future work will focus on multimodal waste recognition, expanded scrap categories, advanced valuation, gamified user engagement, and collaborative vendor-community features.

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