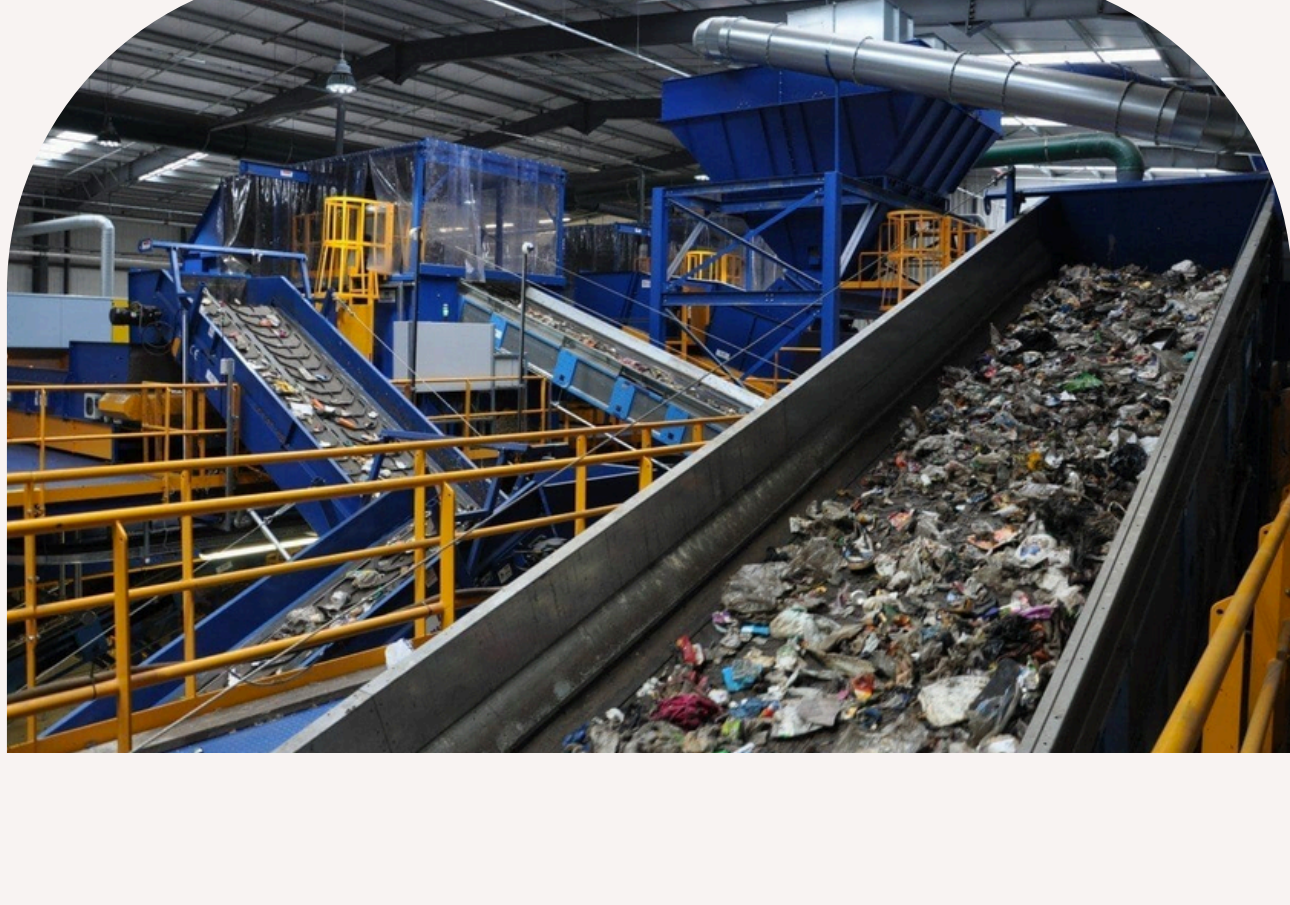




ZeroWaste Robotics

SMART WASTE MANAGEMENT ROBOTIC ARM



Exigence

The exigence for our robotic arm comes from the inefficiency, inaccuracy, and safety risks of current waste-sorting methods. Manual sorting leads to high contamination rates and exposes workers to hazardous conditions. A robotic arm can sort materials faster and more precisely while reducing human risk. Without this solution, recycling efforts will remain ineffective and environmentally costly.



Our Solution

We came up with the robotic arm by examining why current waste sorting is inefficient and unsafe. Research showed that manual labor lacks the speed and accuracy needed, while new advances in sensors and machine learning allow precise material identification. Combining these insights led us to design a robotic arm to sort waste more efficiently and safely.

What does it do?

Built with a flexible, human-like structure and guided by machine vision, the robotic arm can identify and handle mixed, irregular waste items that are difficult for traditional rigid machines to manage. It acts as a better alternative to waste management and filtering, differentiating and operating on different waste types. Unlike conventional systems that rely on fixed programming, this robot is designed to adapt to new objects, reducing the need for constant manual reconfiguration.

By automating waste sorting, this project aims to:

- Improve worker safety
- Increase recycling accuracy
- Reduce contamination
- Lower operational costs
- Support cleaner, more sustainable waste management

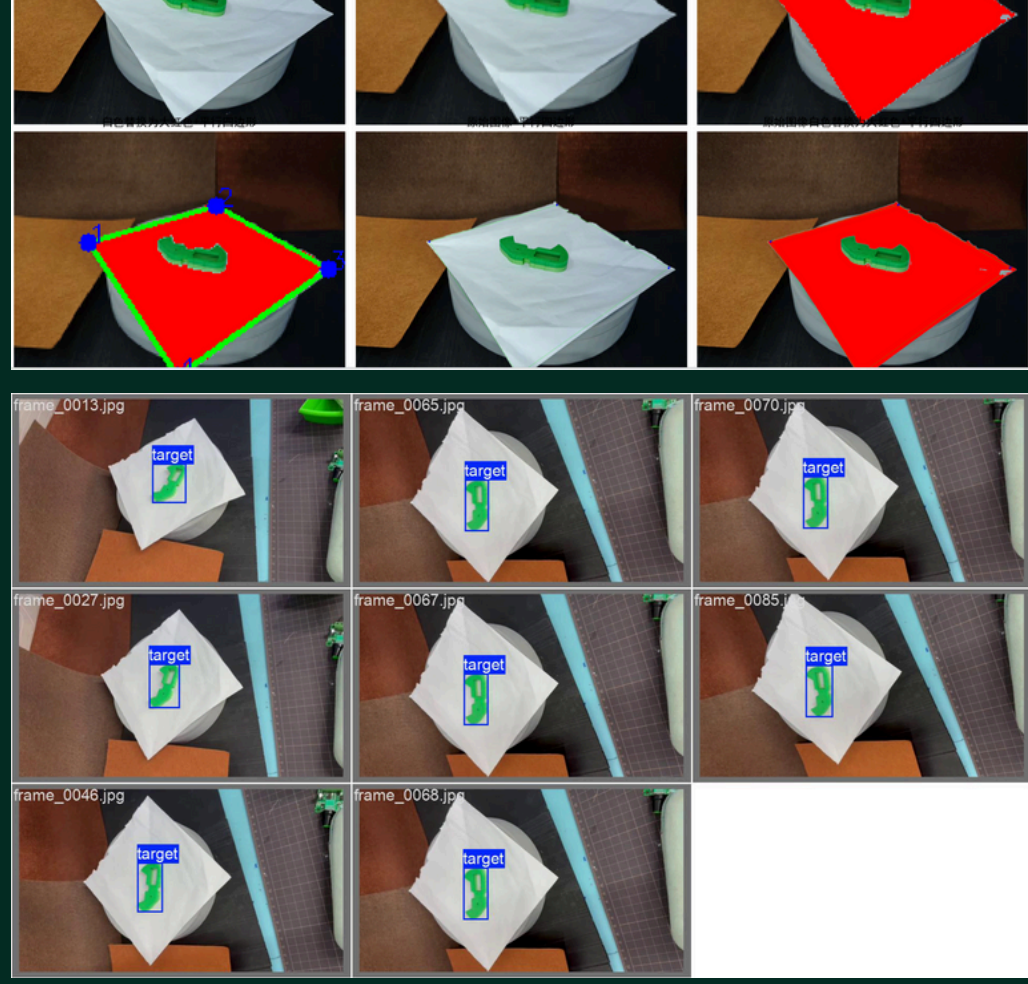
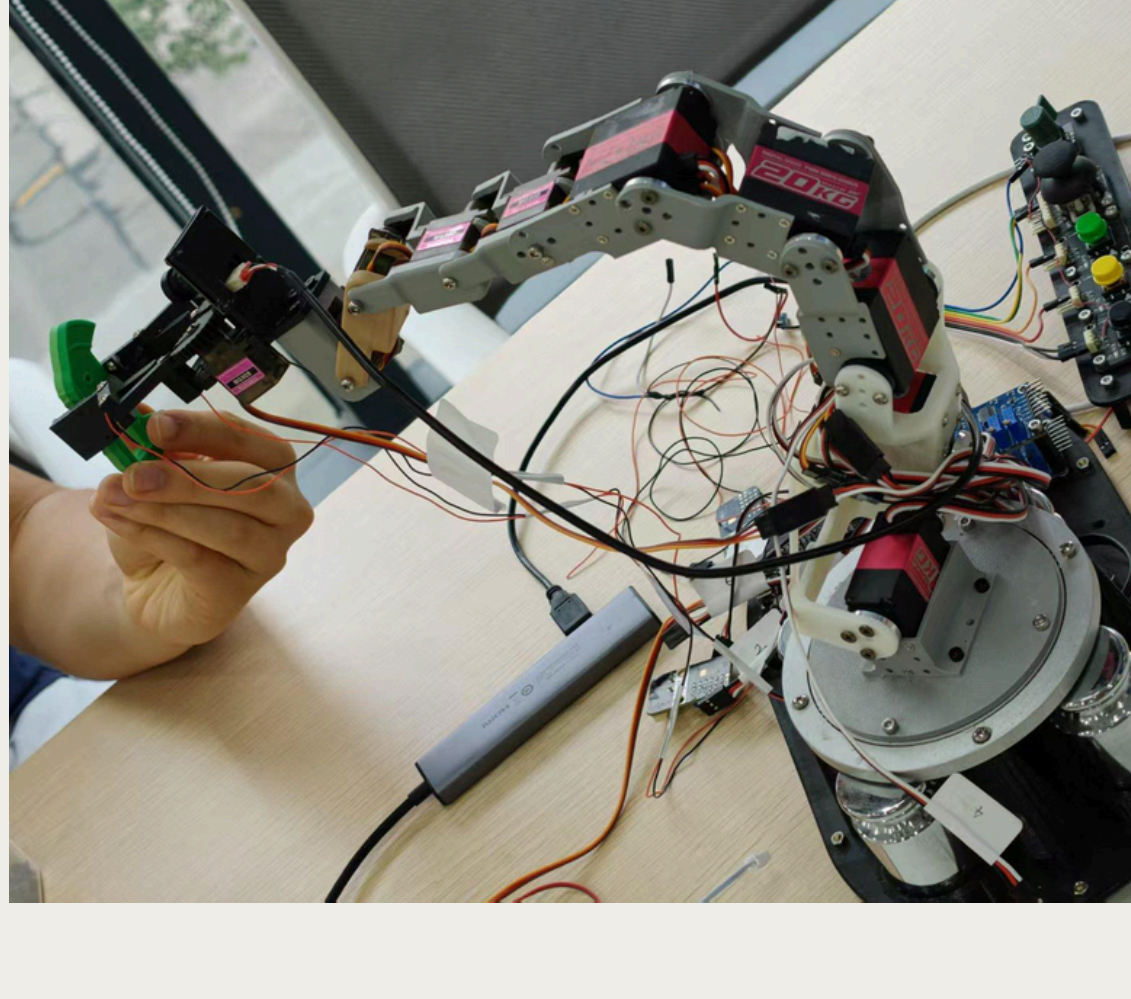


Fig 1. Processed Image Sets after RGB Value Filtering & Quadrilateral Approximation

How does It Work?

The robotic arm uses machine vision and flexible hardware to identify, pick up, and sort waste automatically.

- A camera mounted near the gripper captures images of nearby waste in real time
- A deep learning vision model analyzes shape, color, and texture to recognize different materials
- The images are passed through custom RGB value filtering, and convex hull approximations, and later serves as inputs into a deep learning neural network to extract patterns.
- Once identified, item's position calculated through algorithms
- The multi-axis robotic arm adjusts its joints and utilizes its two finger geared gripper to retrieve waste parts.
- The item is then moved to the correct sorting location

By combining self-learning vision algorithms with a flexible, human-like robotic arm, the system achieves fast, accurate, and adaptable waste sorting in complex environments.

Advantages

ADAPTABILITY

- Most waste-sorting systems in the market rely on fixed object categories and pre-trained dataset,
 - requires new training when new materials/contaminants appear.
- Self-learning machine vision pipeline allows autonomous adaptation to new waste objects
 - more resilient to waste variability.

EASY MAINTANENCE

- Modular multi-joint design
 - if one joint of the robotic arm breaks or malfunctions, it can be quickly replaced or repaired individually.
 - reduces downtime
 - Individual joint replacement is inexpensive compared to replacing the whole system.

FLEXIBILITY

- Conventional industrial waste robots use rigid arms and high-speed pickers
 - struggle with tangled, crushed, or deformable items.
- Multi-axis continuum hardware enables human-like motion and finer positioning
 - allows reliable avigation of dense waste piles or irregular objects

Market Analysis & Alternatives

The global waste management industry faces critical challenges in efficiency and safety, creating a multi-billion dollar opportunity for a smarter, more accessible solution.

A Multi-Billion Ton Opportunity

Market Scale:

• 2 Billion+ Tons of waste annually.-br>• Thousands of incineration plants & treatment facilities globally.

Core Customer Demands:

Efficiency • Safety • Cost-Effectiveness • Compliance

Our Position: The Smart & Accessible Solution

We fill the market gap between expensive, rigid automation and unsafe manual labor, delivering the cost-effective, safe, and flexible solution the industry demands.

Current Solutions are Failing

The Alternatives:

1. Industrial Robot • Failure: Prohibitively expensive & too rigid for mixed waste.
2. Automated Systems • Failure: Extremely costly (~\$80k) & struggle with complex waste.
3. Mechanical Systems • Failure: Unreliable, with frequent breakdowns & misidentification.
4. Manual Sorting • Failure: Unsafe (43.9% illness rate), inefficient & inconsistent.

Our Business Model: A Clear Path to Profitability

A LEAN COST FOUNDATION

Our disciplined financial strategy minimizes risk and maximizes efficiency.

Fixed Costs

- One-Time R&D: ¥400,000
- Monthly Facility Rent: ¥3,200

Variable Costs

- Manufacturing: ¥8,000 / unit
- Maintenance: ¥500 / incident

First-Year Financial Projection

(Based on a conservative sales target of 30 units)
Annual Revenue: ~¥880,000
Annual Net Profit: ~¥200,000

A POWERFUL REVENUE ENGINE

We generate income through a diversified, multi-tiered model.

Core Hardware Sales

- Unit Price: ¥24,999
 - Tiered discounts available for bulk orders.

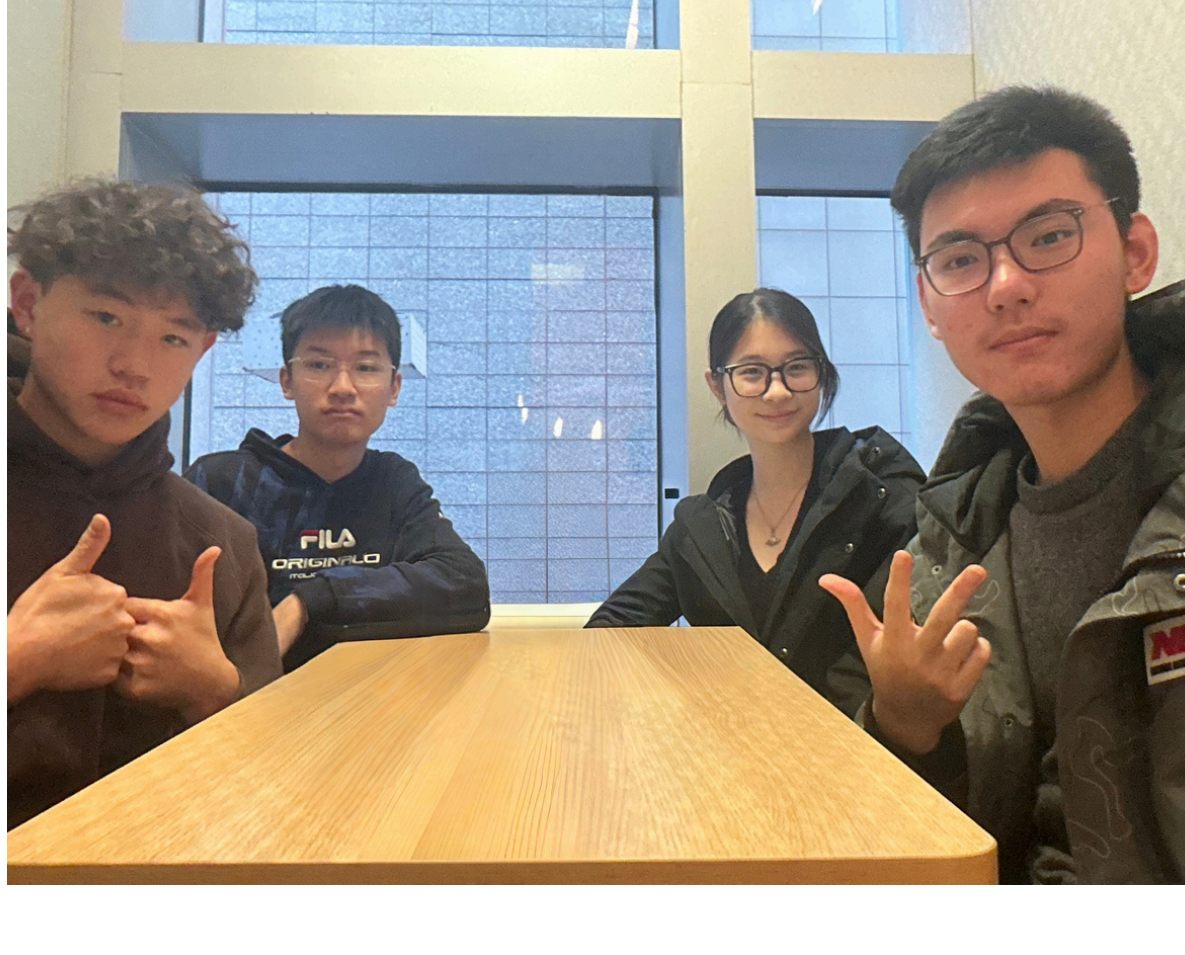
Optional Premium Subscription

- Price: ¥499 / month
 - Provides AI updates & daily data reports.

After-Sales Services

- Annual Maintenance: ¥3,999 / year
- Single Repair: ¥799 / incident

OUR TEAM



A group of enthusiasitc teenagers passionate about robotis, sustainability, and real-world problem solving. Coming from four different high schools in Shanghai, our members are united to pursue a greener future through the design of innovative and practical solutions for waste management challenges.

Members and Roles



Michael Wu

Responsible for software and hardware development, prototype testing, and product refinement.

Background in 3D design, computer science, and mechanical engineering



Alvin Zhao

Responsible for market analysis and investigating customer needs

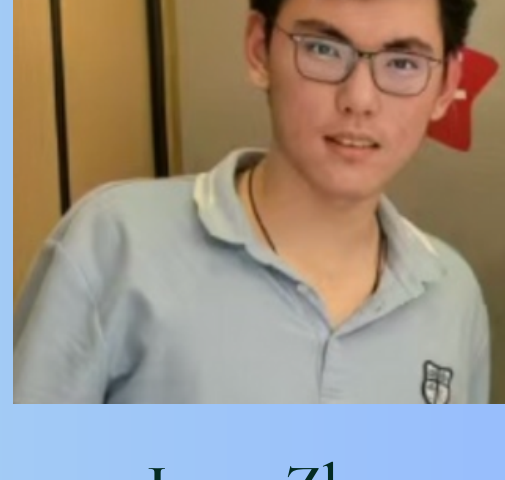
Background in computer science, statistics, and mathematics



Ricky Gu

Responsible for commercialization strategy, budget allocation, and profit maximization.

Background in finance, strategic planning, and mathematics.



Jerry Zhu

Responsible for identifying real customer needs , finding target customer and making 3D model display.

Background in computer science, statistic, Artificial Intelligence