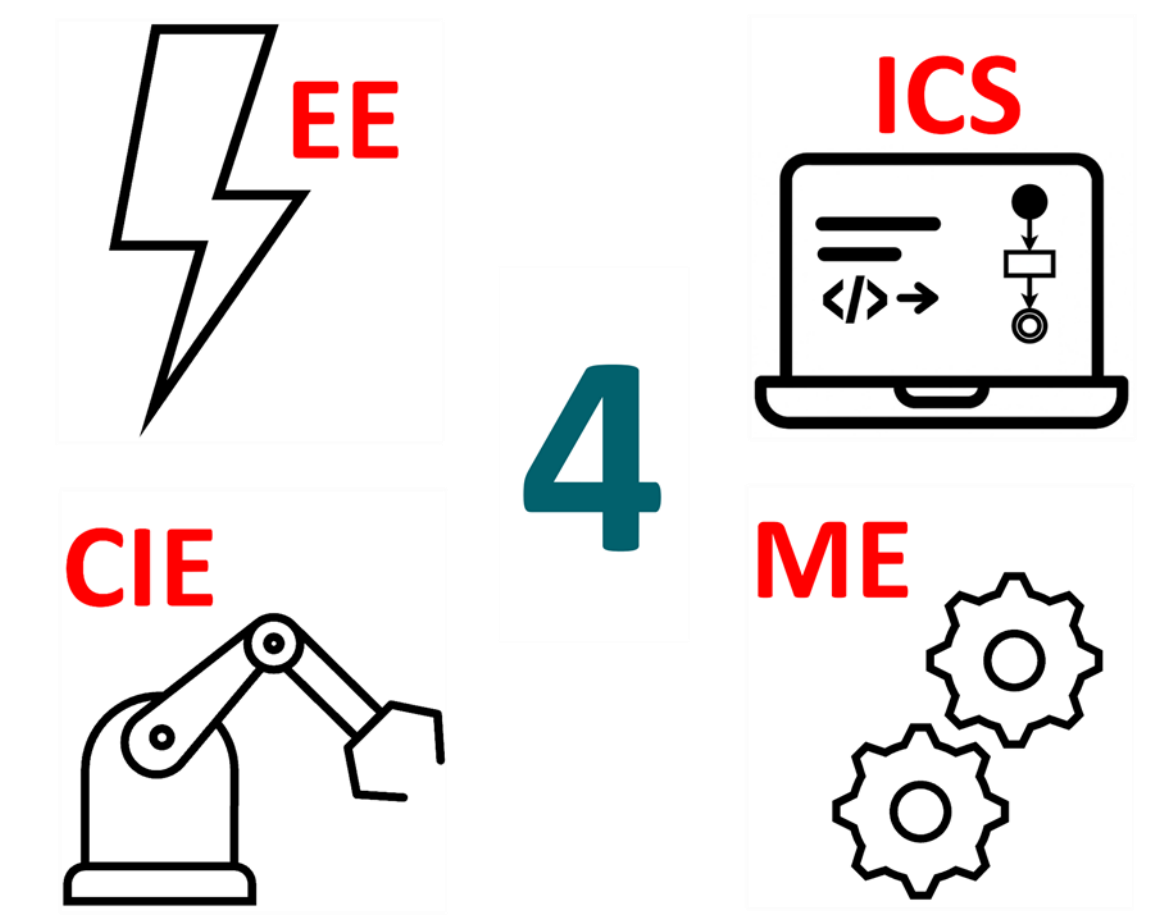


# Autonomous Vending Machine Robot

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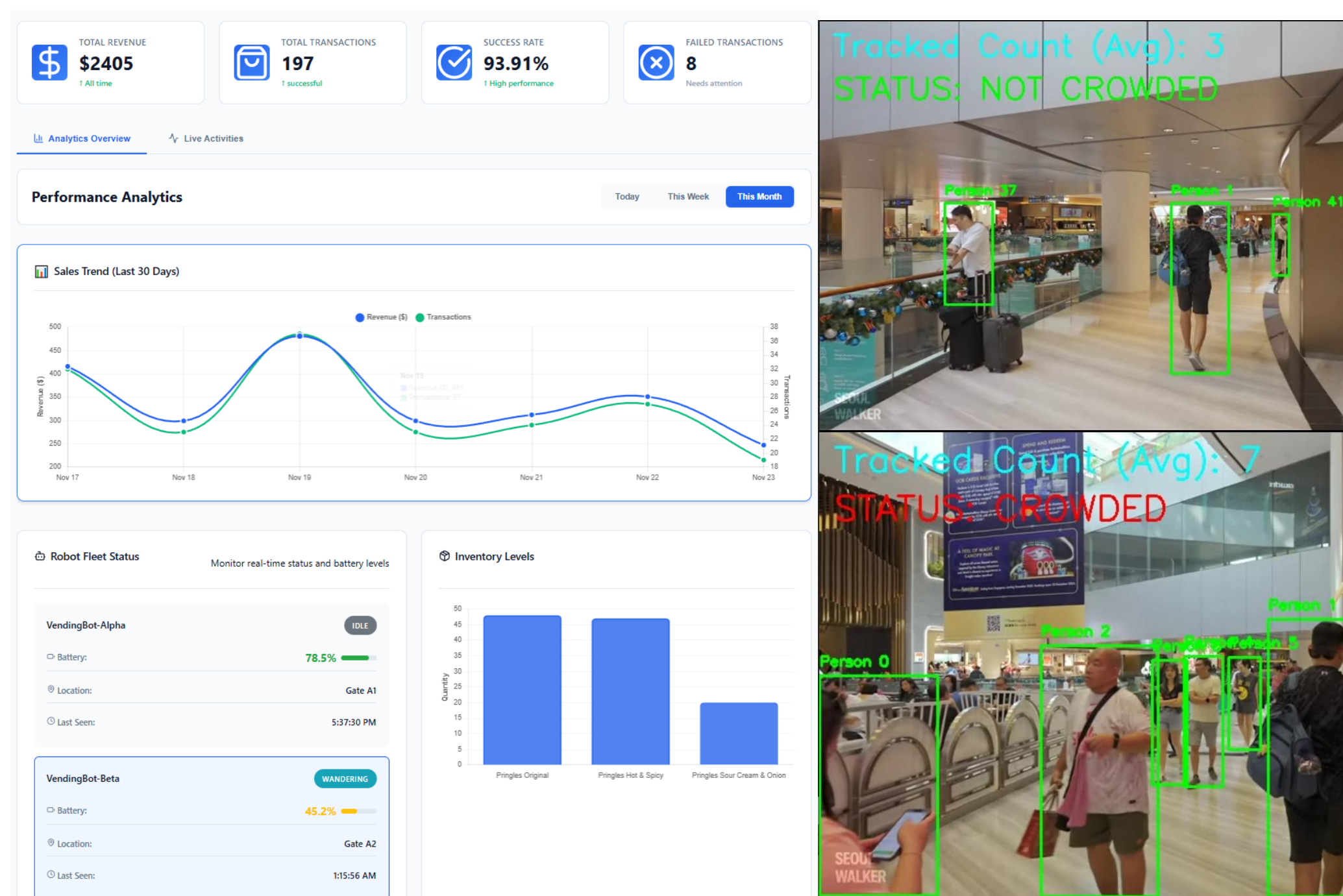
## Problem & Need

- Conventional vending machines are static, failing to adapt to dynamic foot traffic in large venues like malls and airports. Fixed locations result in lost sales opportunities during off-peak hours.

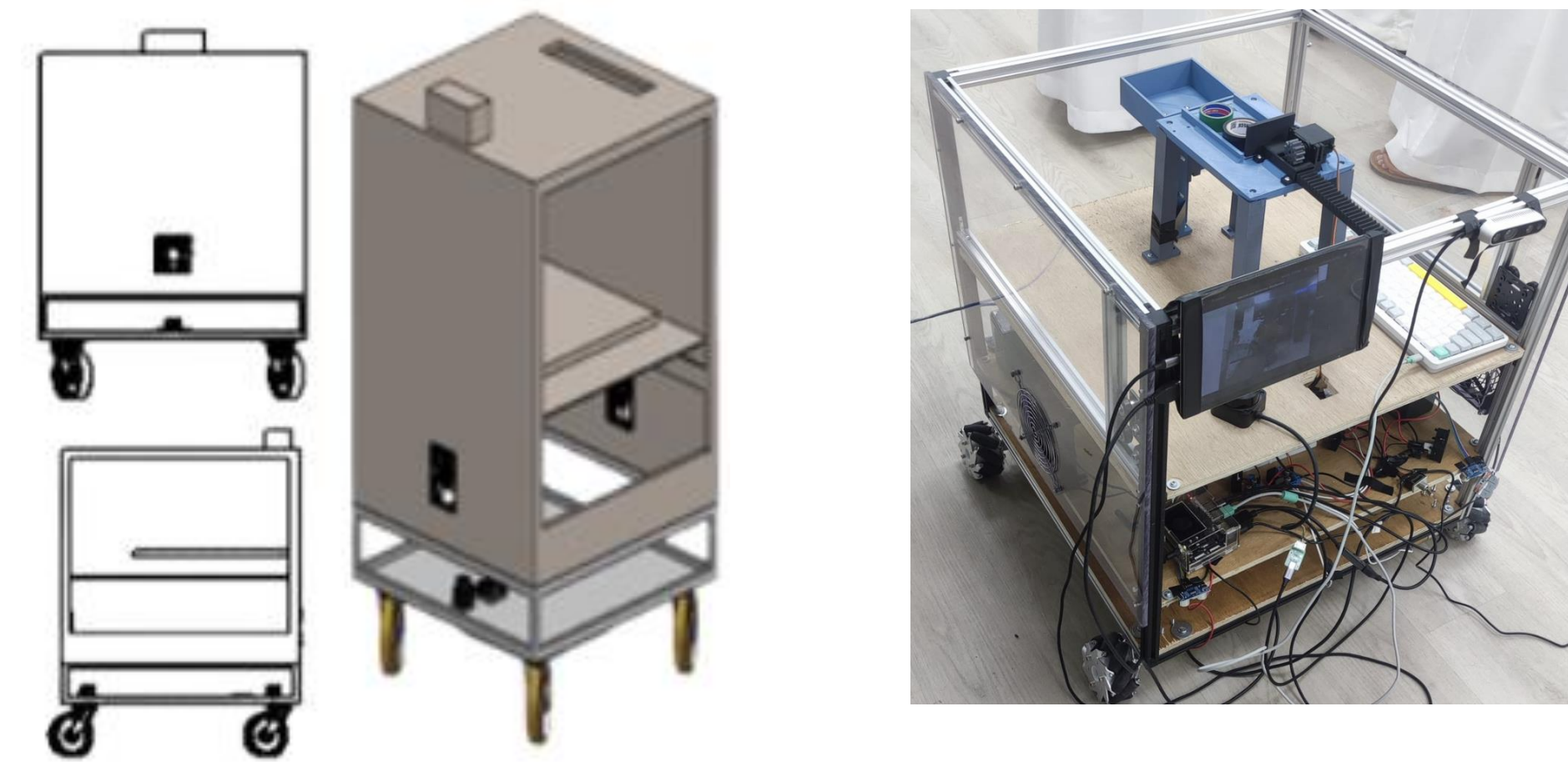
## Project Objective

Develop an Intelligent Crowd Seeker robot that uses AI to estimate crowd density and autonomously navigates to high-traffic areas (**hotspots**) to maximize sales.

- Privacy by Design: SDAIA compliant (on-device processing).
- Autonomy: Full self-navigation in indoor spaces.



## Prototype Design



- 0.6 m aluminum cube frame with four stacked levels (drive, power, vending, HMI), with four Mecanum wheels
- Enclosed body with internal tray for vending and protected electronics.
- Corner ultrasonic sensors monitor floor distance and detect drops or stairs, triggering a stop to prevent the robot from falling.

## Prototype Development

**Hardware Integration:** Assembled the modular aluminum frame, integrated the complete drive, power, and vending systems.

**Full-Stack Software:** Deployed onboard ROS & YOLO AI, and developed the user HMI, cloud database, and analytics dashboard.

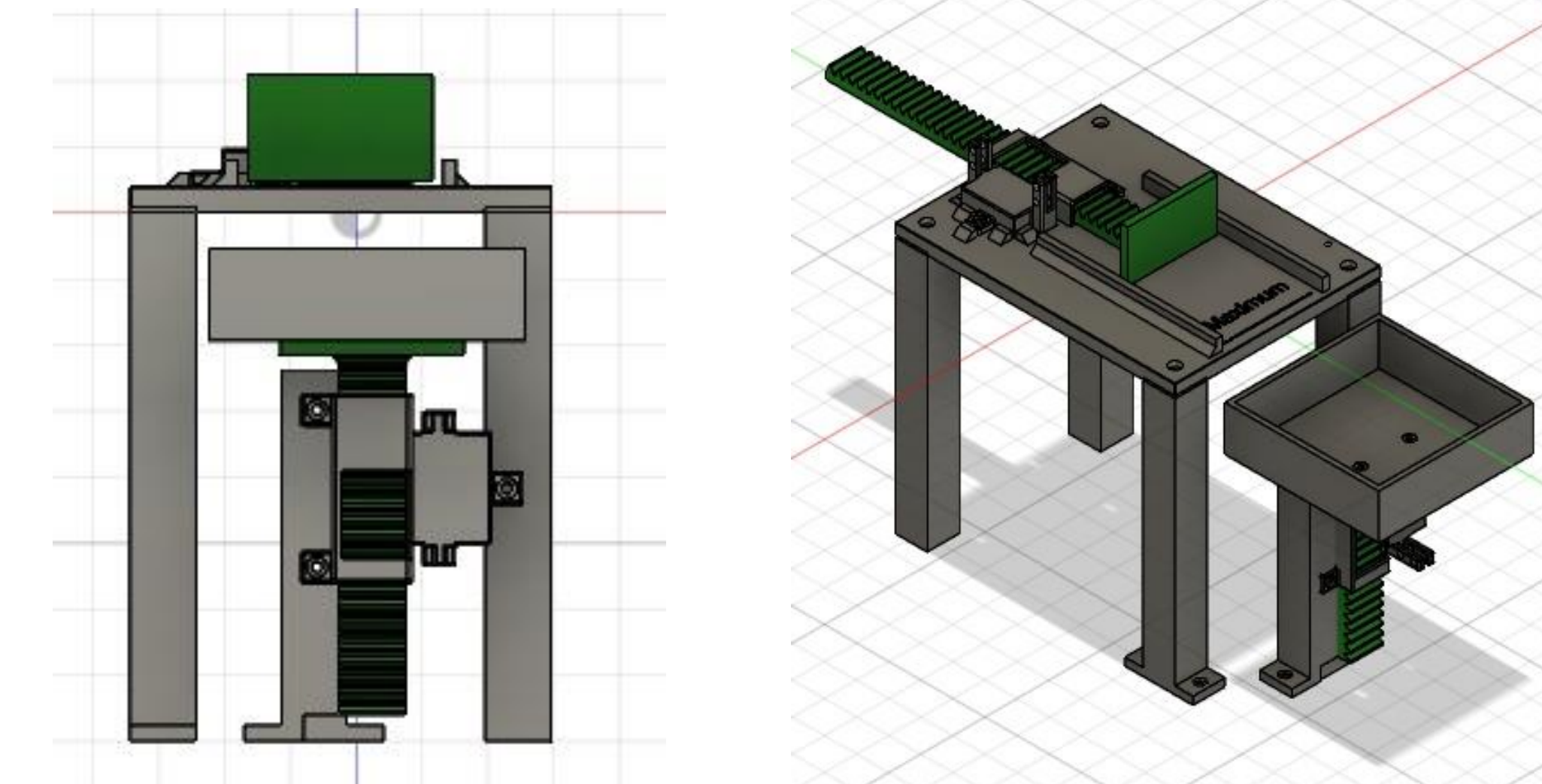
**Validation:** Conducted end-to-end system testing.

## Constraints & Specs

Requirement	Target
Dimensions	$\leq 0.6\text{m Cube}$
Safety (E-Stop)	$\leq 0.5\text{ s}$
Speed	$\leq 1.0\text{ m/s}$
Runtime	60-90 min
Vending	$\leq 10.0\text{ s}$

## Mechanical System

- Structure:** Modular 2020 aluminum extrusion frame.
- Locomotion:** 4 DC motors linked to Mecanum wheels drive for holonomic motion (omnidirectional) in tight spaces.
- Vending:** Four Rack-and-Pinion Pusher:



## Electrical System

- Power:** Dual 12V 7Ah SLA Batteries (~168 Wh).
- Protection:** System limited to 5A; Fused branches.
- Safety:** Hardware E-Stop cuts actuator power in <500ms.

## Validation & Conclusions

Test	Result	Status
Runtime	100 min	PASS
E-Stop	Stop time (instantaneous)	PASS
Vending	Dispense in 4s	PASS
Crowd AI	Accurate Counting	PASS

- An integrated autonomous vending robot was designed and built within size, power, and safety constraints.
- Tests indicate feasible indoor navigation, conservative approach to crowds, and acceptable vending reliability.
- The prototype forms a base for future work on fleet management, and data-driven operation.