Autonomous Port Stacking Crane

TEAM 007

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Problem/Objective

Ports today face major challenges in efficiently handling the growing volume of global trade. Container stacking and retrieval are often **slow, manual, and error-prone**, leading to congestion and delays across the supply chain. The need for **automation and optimization** is clear, port operations must become faster, and safer to meet increasing demands without compromising safety or space efficiency
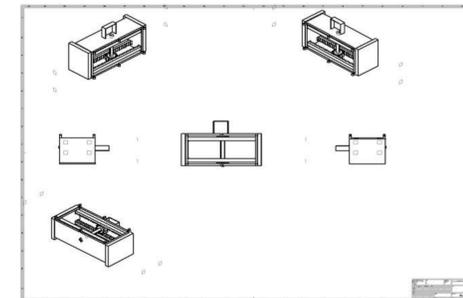
System Architecture

Prototype (PoC) System Architecture
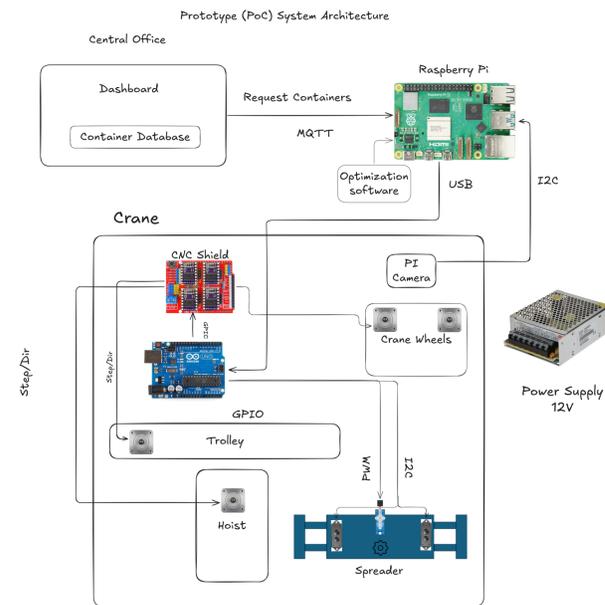
Prototype Development

- Chassis:

- Spreader:

Control & Verification

- PID controller to control sway to ensure smooth movement:


Optimization & Scheduling

Objective Function:
Minimize: $\sum w_{ij} \cdot v_{cij}$

MILP model determines optimal move sequence

- Relocates blocking containers before accessing the target
- **Minimizes** time via shortest-path logic
- Considers real-time container positions & space limits
- Increases throughput and **reduces crane idle time**
- Supports **scalability** to multi-cranes

Software & Communication
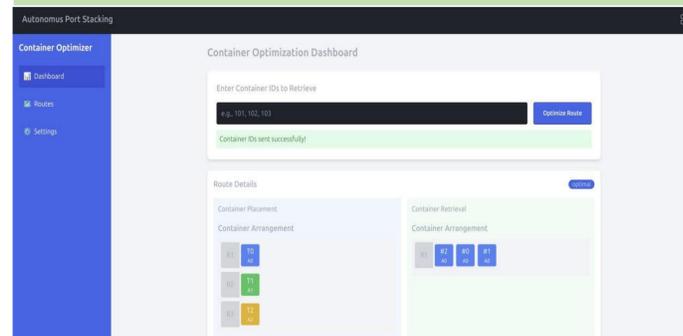
A **React/Next.js dashboard** communicates with an **optimization** engine via **MQTT**. A Raspberry Pi with an AI accelerator handles **OCR**, and optimized **sequences** are returned as feedback and sent to a microcontroller via **USB serial**.

Constraints/Specifications

Constraints		Specifications		Integrated Specifications	
Container Size	40ft / 20ft	Energy Consumption	200W	Precision	5mm
Field Layout	ISO 668	Lifting Capacity	3.21kg	Automation Level	100%
Budget	$7,000	Verification Time	115ms	Dimensions	40x56x37 cm
Spreader Weight	1kg	Response Time	5ms		
Safety Compliance	OSHA CFR 1910.179	Trolley Speed	5 cm/s		
		Container Throughput	25 / hour		
		Degrees of Freedom	3		

Future Works

Next steps include deploying the system with **industrial PLCs** and motors for real-world validation and integration with existing port infrastructure. This prototype marks progress toward **fully autonomous ports**, where cranes, trucks, and ships communicate and operate seamlessly. Realizing this vision will **unlock 24/7 operations**, improved reliability, and a major leap forward in **global trade efficiency.**