CargoX

Team Monospace

Team Members

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Design Principles / Goals

Maximal Automation

Prolonged exposure to microgravity impairs reaction time and duration judgement [1]. Astronauts should be able use the solution with a minimal number of interactions.

Minimal Cognitive Load

The solution should be easy to use and minimize the user having to think about their next action. The solution should present information and guide the astronauts through usage.

Resilience

Operating in space is always a fast evolving situation. Things break. The solution should be resilient to failures and self-recover.

1. https://pmc.ncbi.nlm.nih.gov/articles/PMC10063900/

Solution Overview

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Key Features

Manifest Import
Import bulk container and item manifests easily as a CSV file.

3D Visualisation
View container item arrangement in an interactive 3D object.

Efficient Placement
Perfect for finding placement plans in compute constrained environments.

Storage Optimizer
Suggests re-arrangement plans to optimise container storage usage.

Simulation
Plan ahead with a flexible simulation system.

Waste Identifier
Automatically identifies fully used or expired items to be returned later.

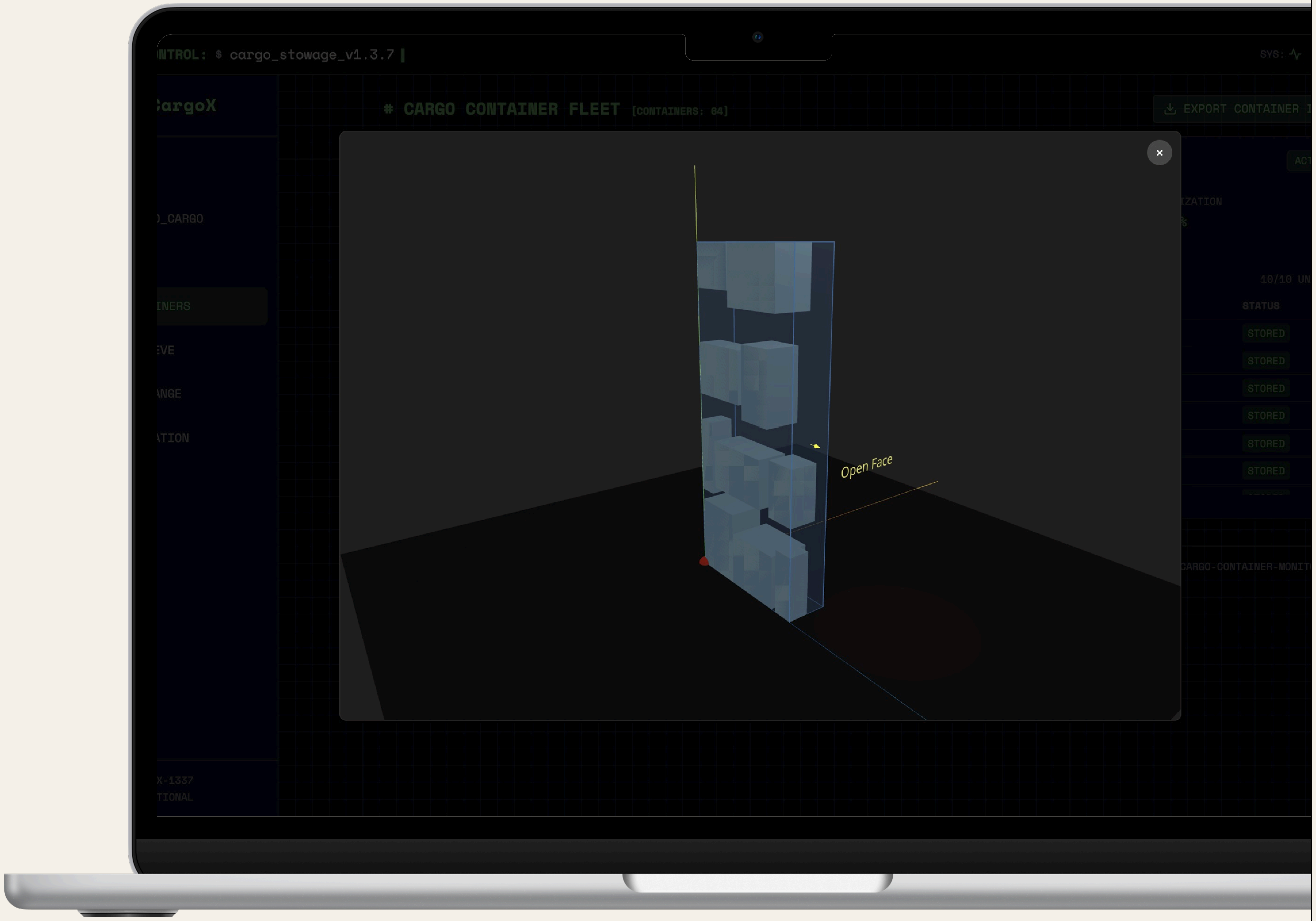
Self Healing
Services will automatically recover in case of a system crash.

Detailed Logs
All actions performed on the system are logged.

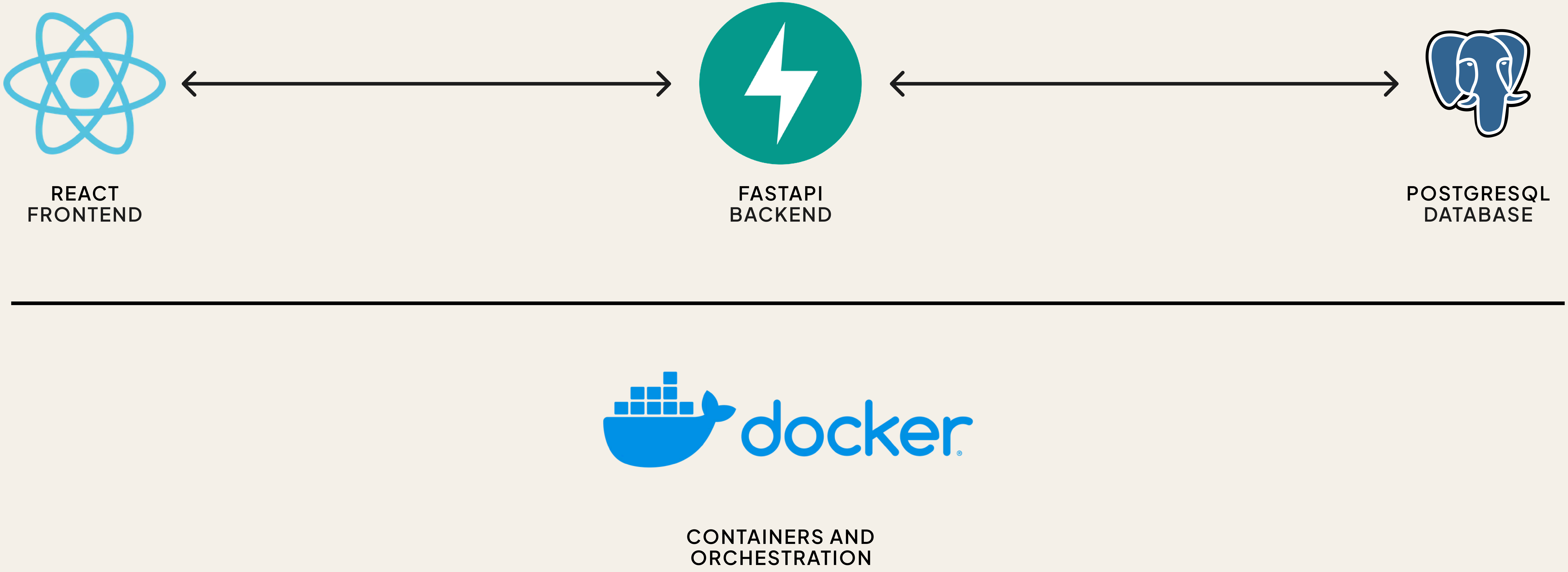
3D Visualisation

Astronauts can view a three dimensional render of the items in a container.

This will allow the astronauts to see where a certain item is placed so they don’t need to search for it in the container.



Technology Stack



Placement Algorithm

02

Design Considerations

Optimizer

- Favors computational efficiency to find a ***"good enough"*** solution using a greedy approach (places items sequentially by priority)
- Maintains performance as number of items scale. Good for compute constrained environments like space.

Zone Preferences

- Zones are used to group similar items which results in more efficient retrieval and logical organization.
- Optimal space utilization may be sacrificed to maintain zone coherence.

Priority Conflict

- Sometimes high priority items cannot be placed due to space constraints.
- A two-pass system is used which attempts to re-arrange lower priority items when needed.

Complexity Analysis

n → number of items
m → number of containers
v → container volume

$$O(n * m * v)$$

TIME COMPLEXITY

$$O(n + m * v)$$

SPACE COMPLEXITY

Rearrangement Algorithm

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Design Considerations

Utilisation

Prioritizes maximizing utilization of containers.

Accessibility

Surfaces higher priority items for easier access.

Efficiency

Finds solution with minimum number of steps to perform rearrangement of items.

Complexity Analysis

n → number of items
m → number of containers
k → maximum number of items

$$O(n + m + m^2k^2)$$

TIME COMPLEXITY

$$O(n + m)$$

SPACE COMPLEXITY

Conclusion

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Solution Impact

Increased Productivity

Astronauts can spend their time on higher leverage tasks that require their attention and expertise instead of planning organizational tasks.

Lower Cost

Efficient planning minimizes cost of cargo transport and organization reducing overall mission cost.

Future Improvements

Robotic Systems Integration

Manipulators can be integrated to automate retrieval of items from containers and other physical tasks.

Sensor Integration

Additional sensors can be integrated to remove the need for manually updating the manifest.

Source Code

kry0sc0pic/cargox

https://github.com/kry0sc0pic/cargox

Thank You.