Faculty Meeting Presentation

Date: 05/4/2026

Group: sddec26-11

OUR TEAM

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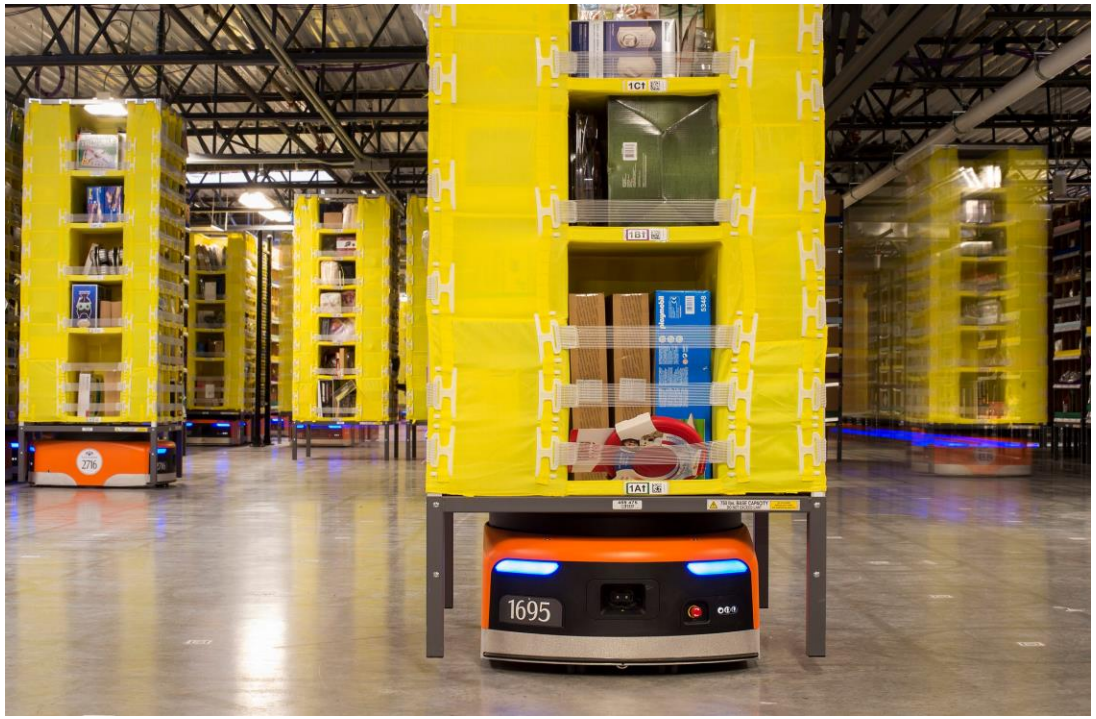
PROBLEM CONTEXT

Problem:
- Inventory Management
- Safety

The need:
- Faster accurate tracking
- Automated system

CURRENT SOLUTIONS - AUTOMATION



Amazon warehouses "Kiva" robots

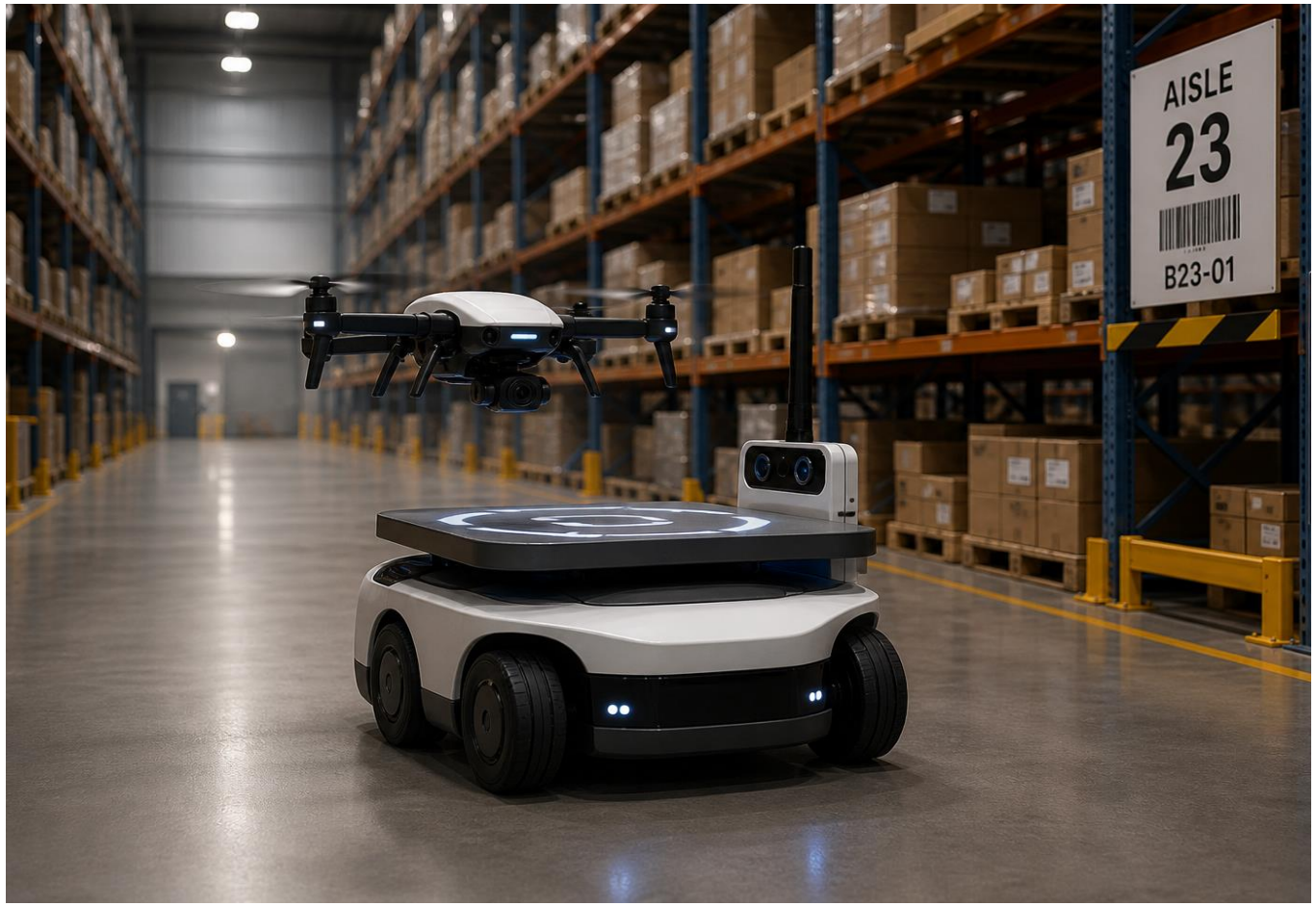
Ocado warehouses using "The Hive"

PROS	CONS
Highly Accurate	Requires new infrastructure
Improves efficiency	Expensive

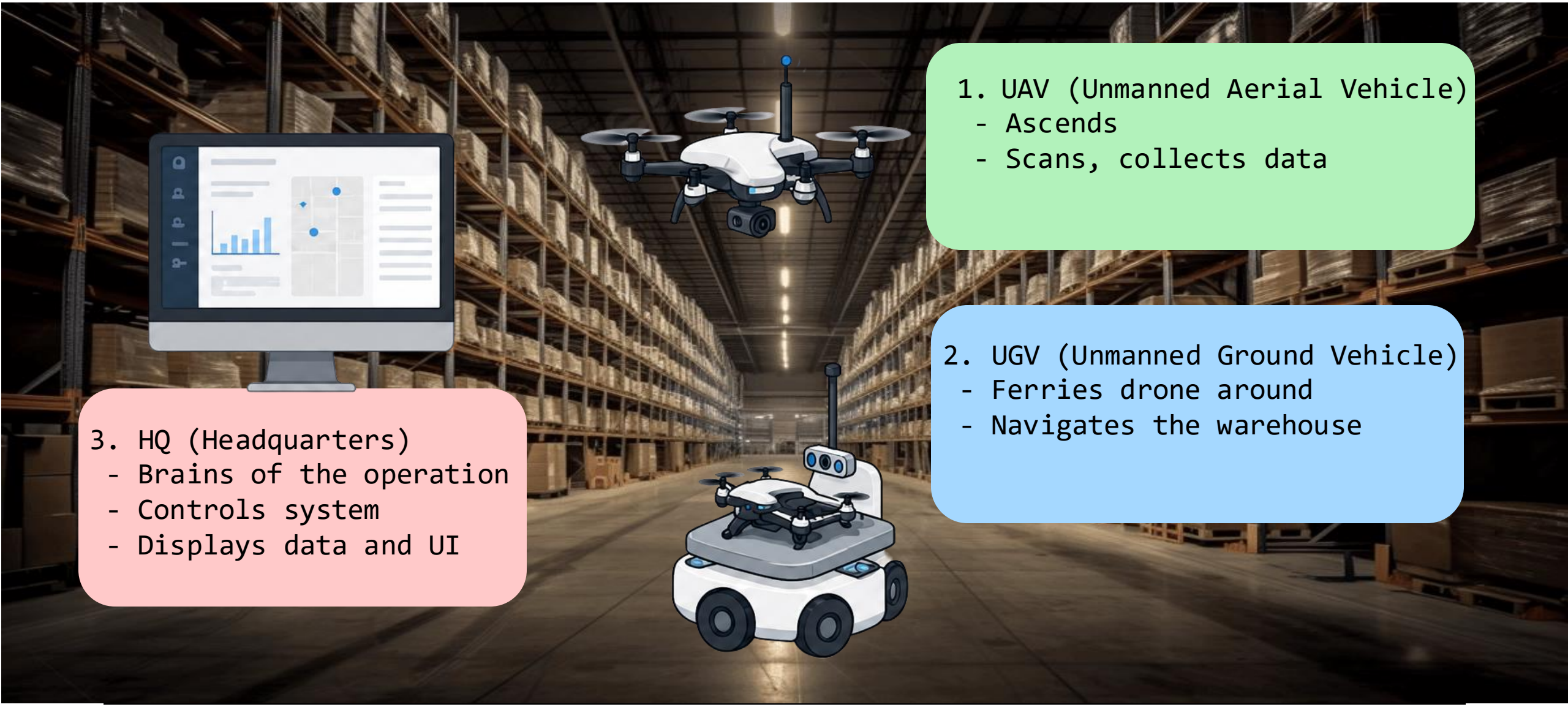
OUR SOLUTION

Coordinated aerial-ground robotic system for warehouse inventory management

- Lower cost
- Scalable
- Verticality
- Existing Infrastructure



DESIGN - OVERVIEW



1. UAV (Unmanned Aerial Vehicle)
   - Ascends
   - Scans, collects data

2. UGV (Unmanned Ground Vehicle)
   - Ferries drone around
   - Navigates the warehouse

3. HQ (Headquarters)
   - Brains of the operation
   - Controls system
   - Displays data and UI

DESIGN - OVERVIEW

1 UAV Scans

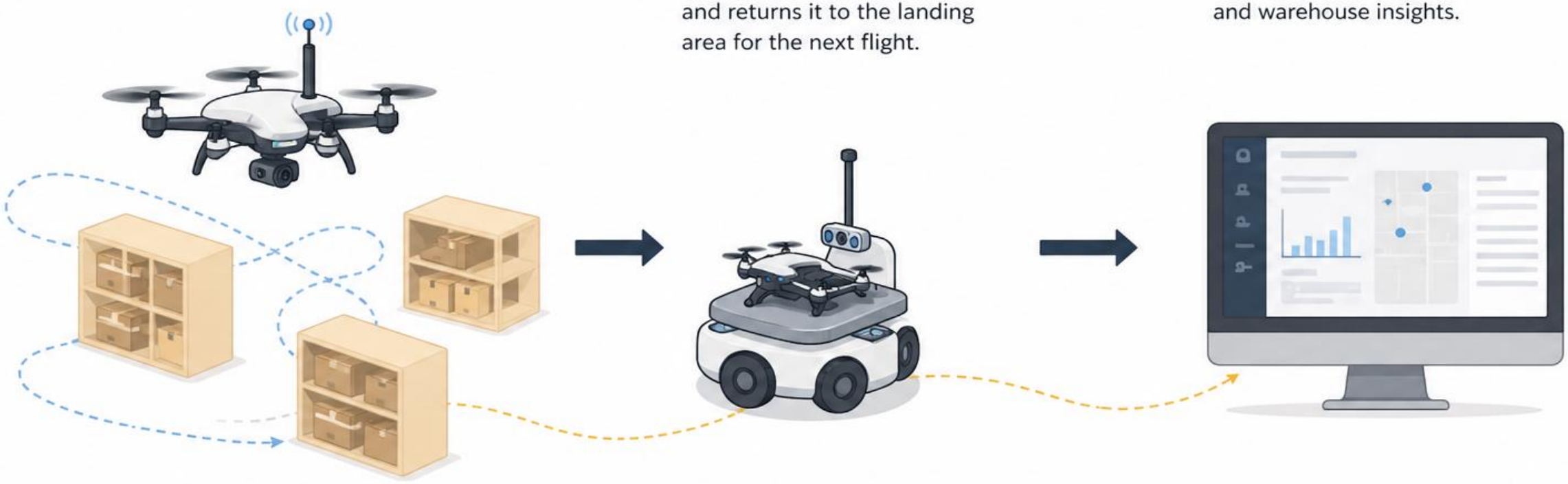
The UAV flies through the warehouse to capture images and inventory data.

2 UGV Transports

The UGV picks up the UAV, moves it between locations, and returns it to the landing area for the next flight.

3 Data & Insights

All data is sent to the computer, providing up-to-date inventory and warehouse insights.



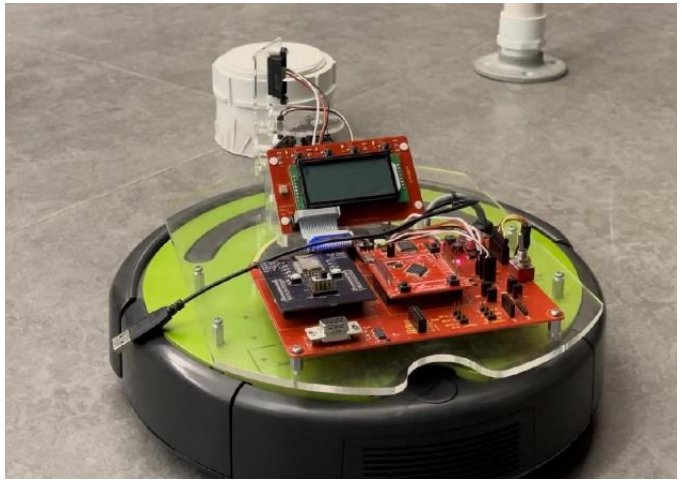
DESIGN - UGV

Functions
Navigate warehouse
Avoid obstacles
Landing pad

Challenges
Environment sensing
Stability

Plans
Adding Lidar
Charging station
Larger frame

Elegoo/CyNot



CyBot

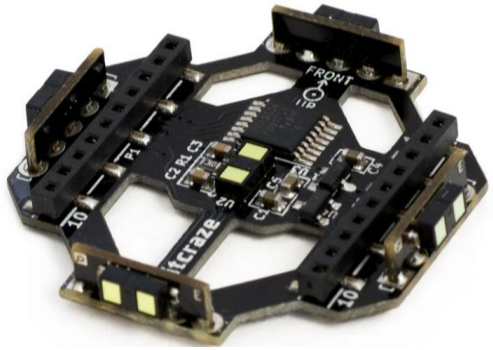
DESIGN - UAV

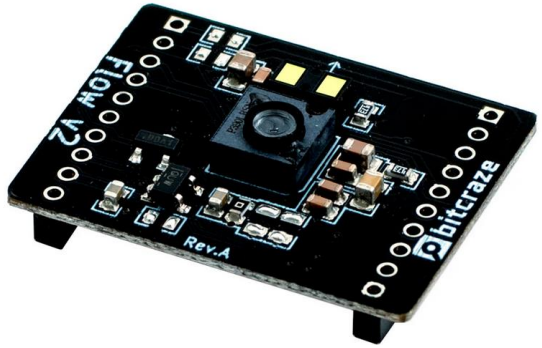
Functions
Navigate warehouse
Avoid obstacles
Scan inventory

Challenges
Power
Localization

CrazyFlie 2.1
Open-Sourced
Expandable with "decks"
Palm-sized
10 minutes of flight
Controlled via radio

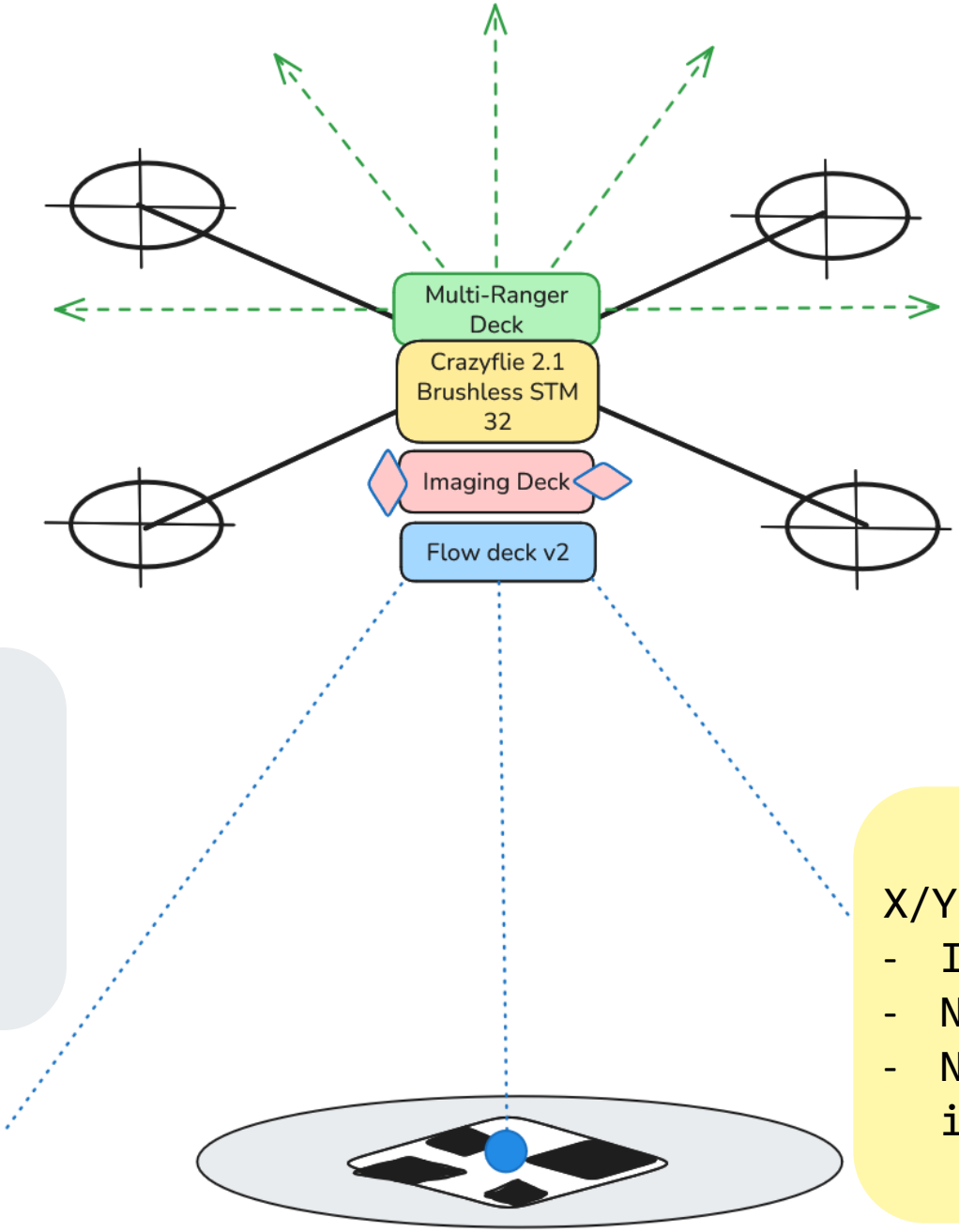
CrazyFlie 2.1 Brushless





Available "expansion decks"

DESIGN - UAV



1. Multi-Ranger Deck
   - 5 ToF lasers
   - Object detection

2. Imaging Deck
   - Forward / Downward facing cameras
   - Streams image data

3. Flow deck v2
   - Monitors ground
   - Improved stability
   - Altitude/Velocity

4. Landing pad
   - On top of UGV
   - ArUco markers assist in landing

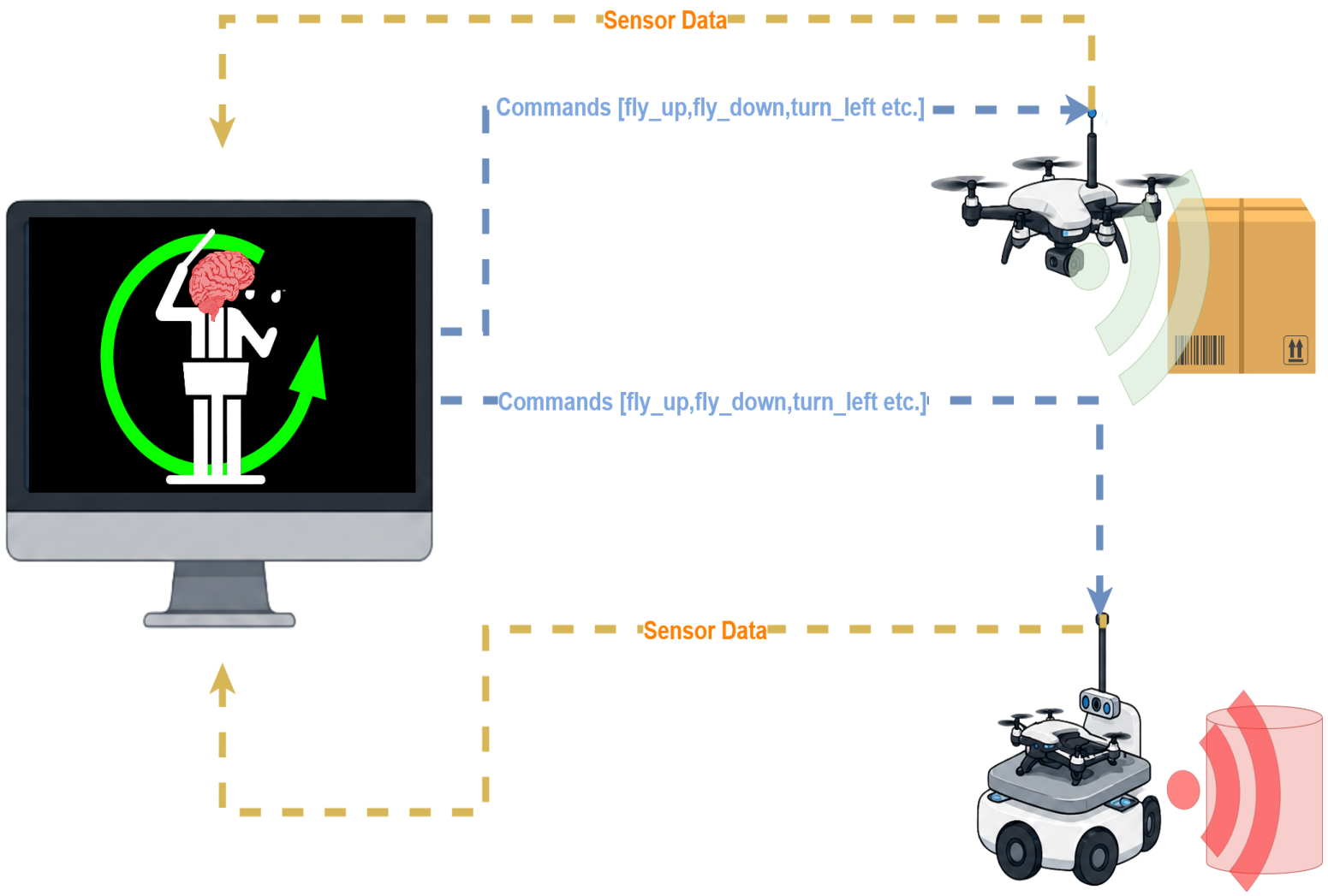
Result
X/Y/Z position estimate
- Indoors
- No GPS
- No external infrastructure

DESIGN - HQ

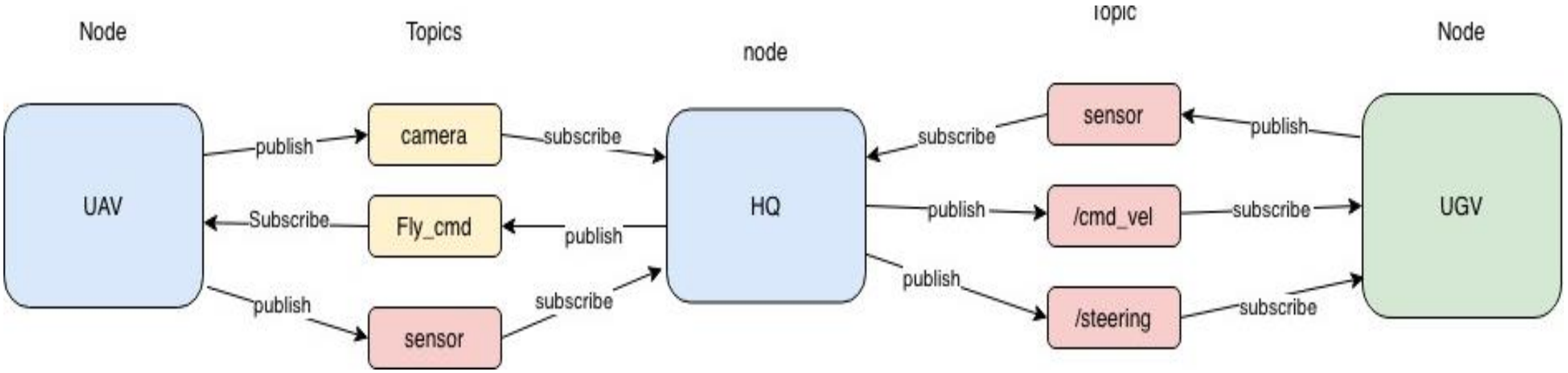
Functions
Conductor
Processes data
User Interface

Challenges
Time constraints
Coordination

Software
ROS 2
OpenCV



DESIGN – ROS 2



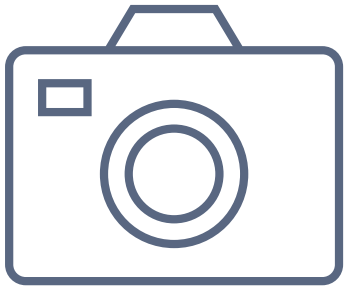
Functions	Challenges	Solution
Robot centered framework	Coordination	ROS 2
Control / Communication	Maintainability	

DESIGN - IMAGE RECOGNITION

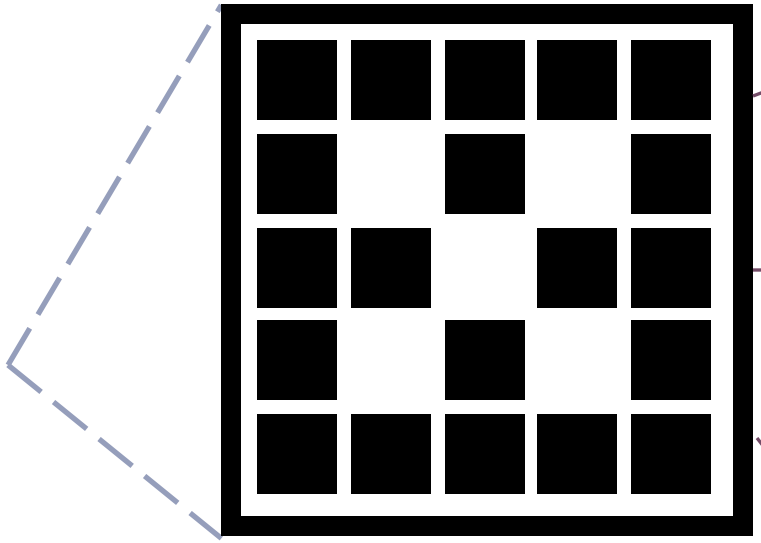
Functions
Recognize items in frame
Estimate pose & distance

Challenges
Variety
Low-light conditions

Solution
ArUco markers



Camera



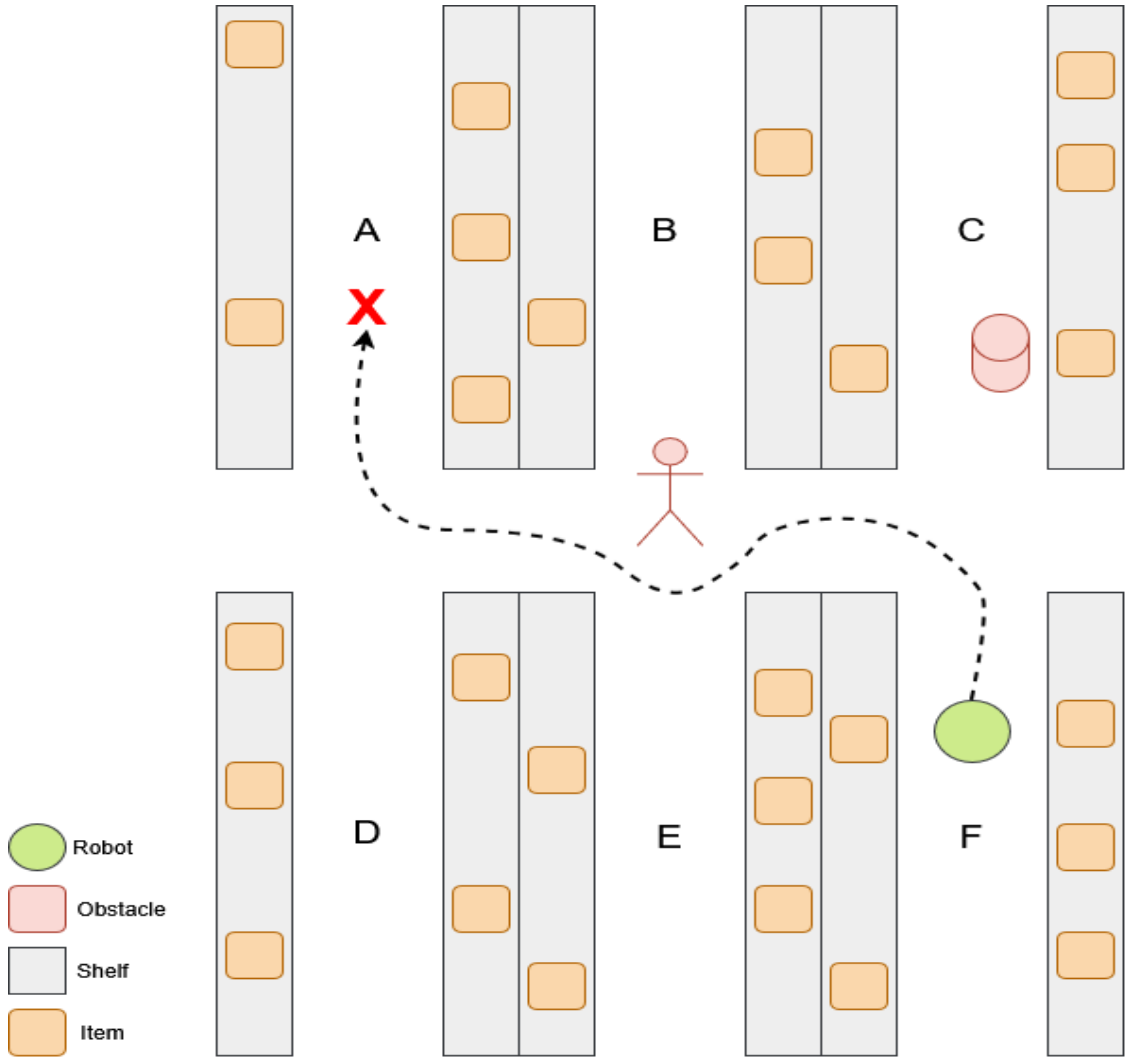
ArUco Marker

DESIGN - MAPPING

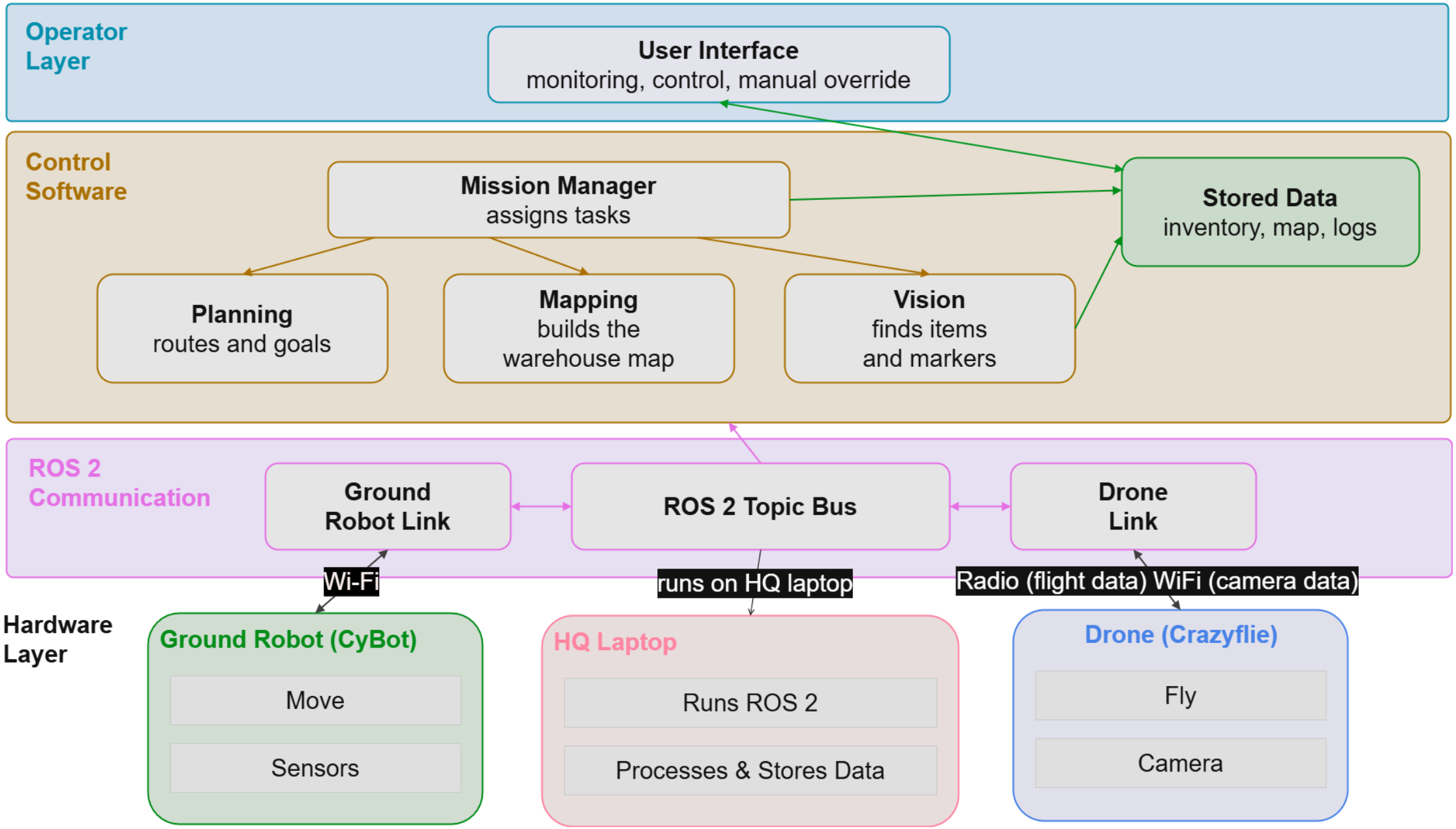
Functions
Navigate warehouse
Avoid obstacles

Challenges
Unknown obstacles
Efficiency

Solution
Slam_toolbox Nav2

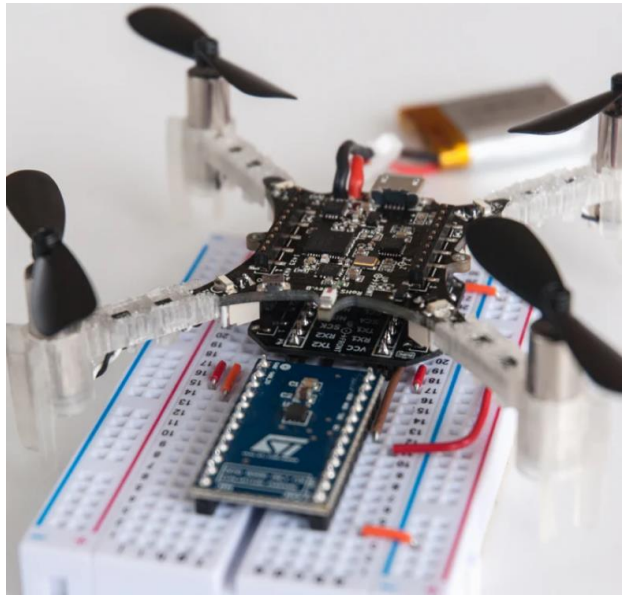


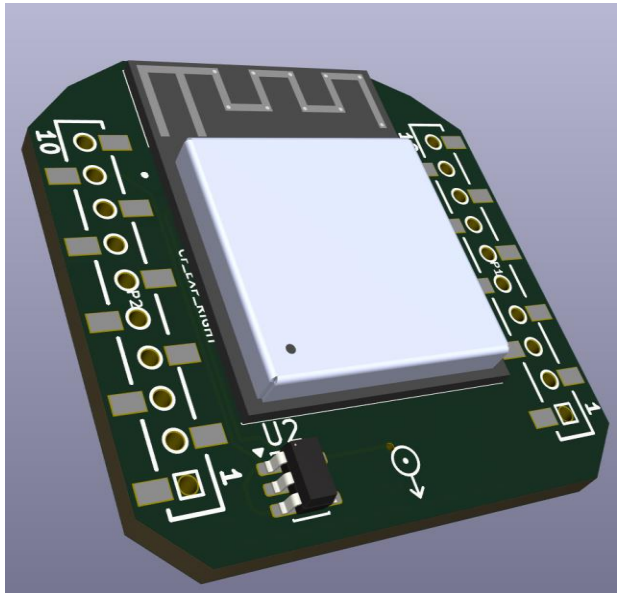
DESIGN - HIGH LEVEL



PROTOTYPE TESTING - HARDWARE

Hardware

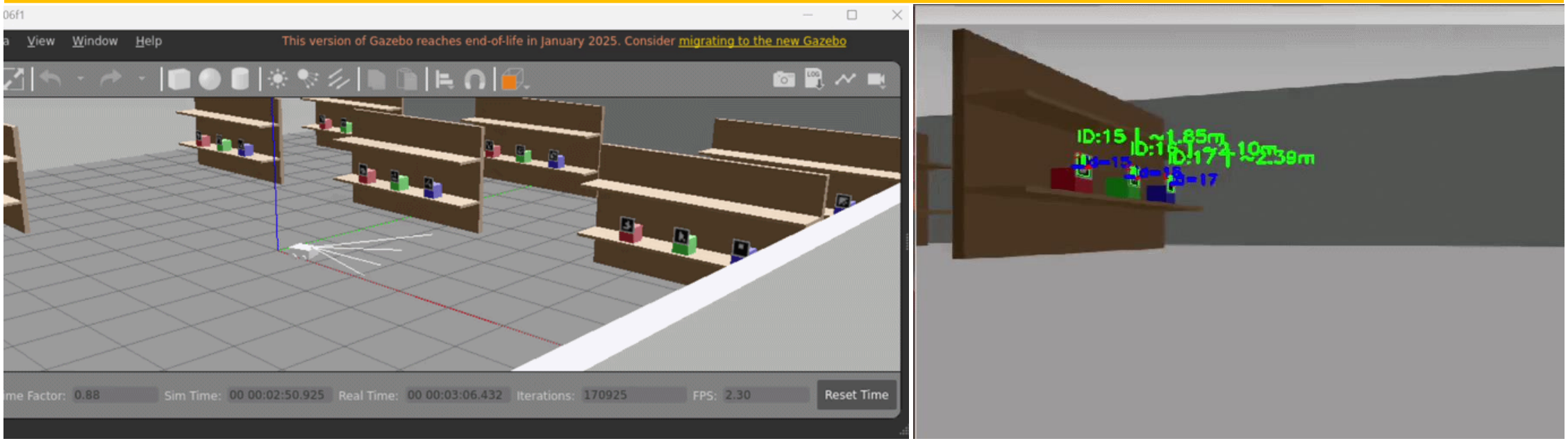




"Hands on approach"
Designing Hardware
Validating performance

PROTOTYPE TESTING - SOFTWARE

Software



Simulations of system within Gazebo

Isolated Environment
Testing code
Finding bugs

PLAN MOVING FORWARD & GOALS

Goals	Stretch Goals
- Finalize design of UAV, Imaging deck, and UGV - Merge software and hardware beyond just simulations - Complete bill materials - Working UI - Complete Production by October 1st - Finish Testing and Refinement by November 15th	- Real-time object detection - Recharging station - Smartphone app - Test in a variety of real warehouses

FINAL WORDS - LESSONS LEARNED

So many choices

Some planning

Now we're rollin

SUMMARY & Q / A

EXTRA DESIGN - IMAGING DECK

Functions

Operate two cameras
Transmit images

Challenges

Space
Must fit on CrazyFlie
Two cameras one microcontroller?

Components

ESP 32 Microcontroller
OV 2640 Camera
OV 5640 Camera