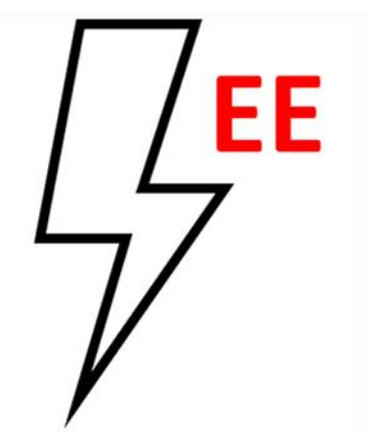


Autonomous RFID Drone for Warehouse Inventory Management

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Coach: Dr. Muhammad Emzir



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Objective

- To design and prototype an autonomous drone capable of navigating warehouse aisles, reading RFID tags with high accuracy, and seamlessly integrating with existing Warehouse Management Systems to reduce labor cost, errors, and safety risks.

Background & Problem Statement

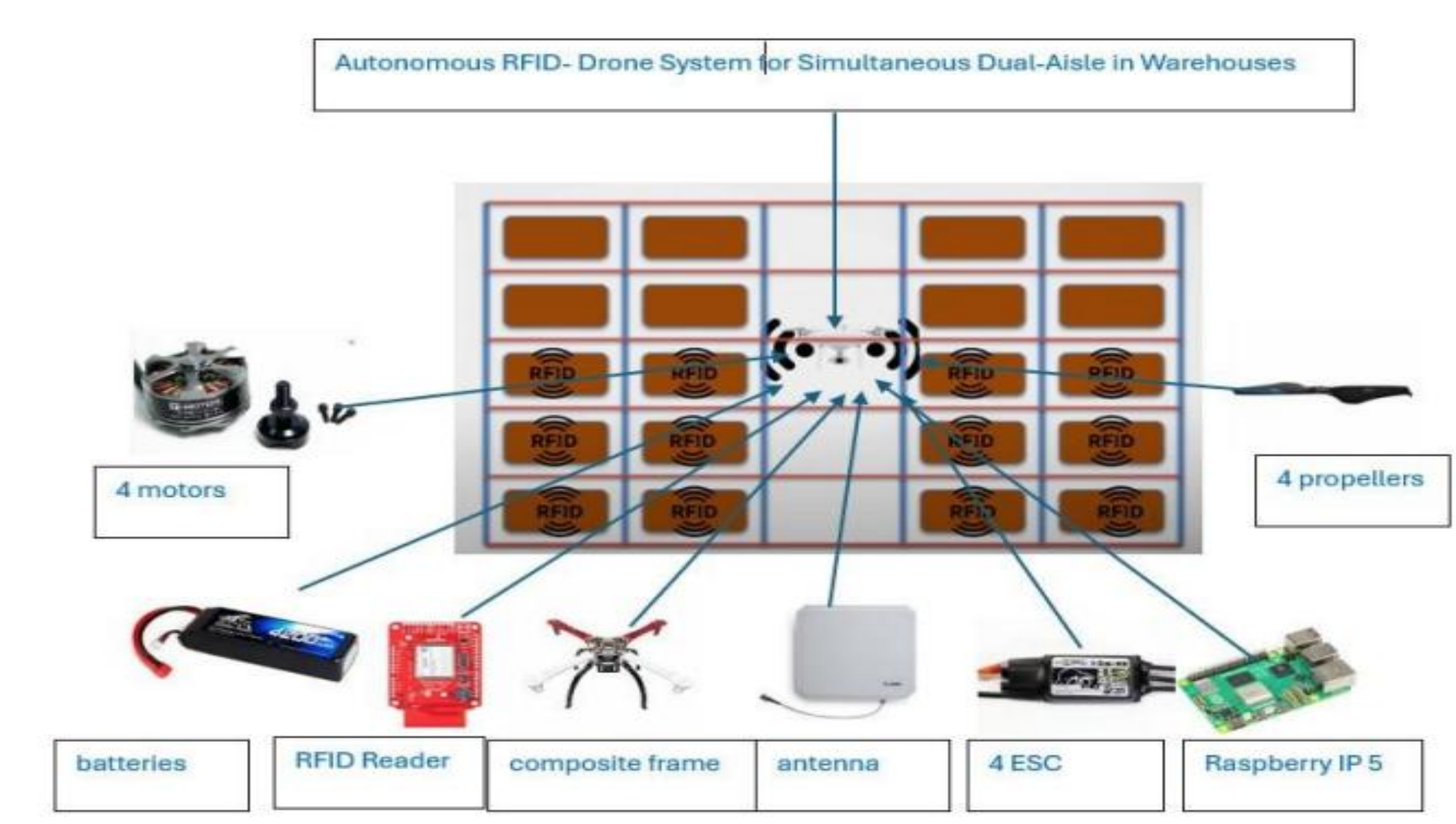
- Warehouses still rely heavily on manual inventory checks, causing 8–12% inaccuracies and over \$1.1T in annual losses.
- Fixed RFID systems leave blind spots in upper racks and metal-dense aisles, resulting in missed reads and frequent manual rechecks.
- Current inventory methods are inefficient, labor-intensive, and unsafe for workers at height.

Constraint	Achieved
RFID system must keep signal loss ≤ 6 dB in metal-rich environments (ISO/IEC 18000-63).	✓
Drone must meet OSHA 1910.178: no exposed moving parts.	✓
Must operate from 0°C to 50°C at 85% humidity.	✓
Drone must localize within ± 10 cm in GPS-denied areas.	✓
Drone must carry ≥ 2 kg while maintaining stable flight.	✓
Drone must localize within ± 10 cm accuracy in GPS-denied environments	✓

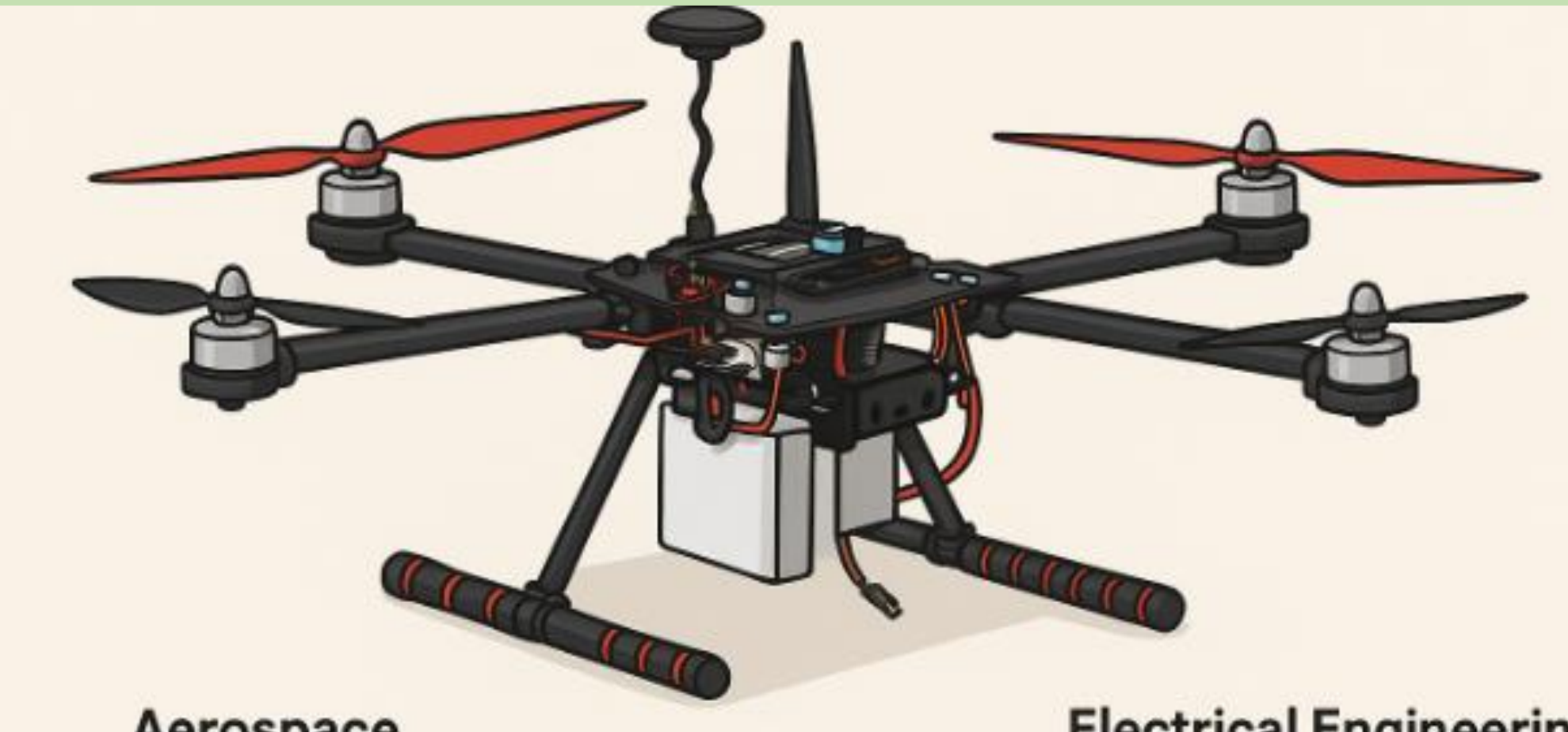
Specifications	Achieved
Achieve $\geq 95\%$ RFID tag detection accuracy in typical aisles.	99%
Scan ≥ 200 tags/min while moving through aisles.	700tags/m
Detect obstacles up to 3 m ahead.	>3.5 m
Provide UHF RFID reads through racks (3–10 m range).	1-11m
Maintain $\leq 3\%$ packet loss on Wi-Fi	$\leq 2.5\%$
Must carry a 1.4 kg RFID payload (reader, antennas, autopilot, etc.).	>1.4 KG
Support 8-hour operation with hot-swap batteries	>8 h
Maintain ≥ 15 minutes of scanning	>30 min



System Design



Prototype Development

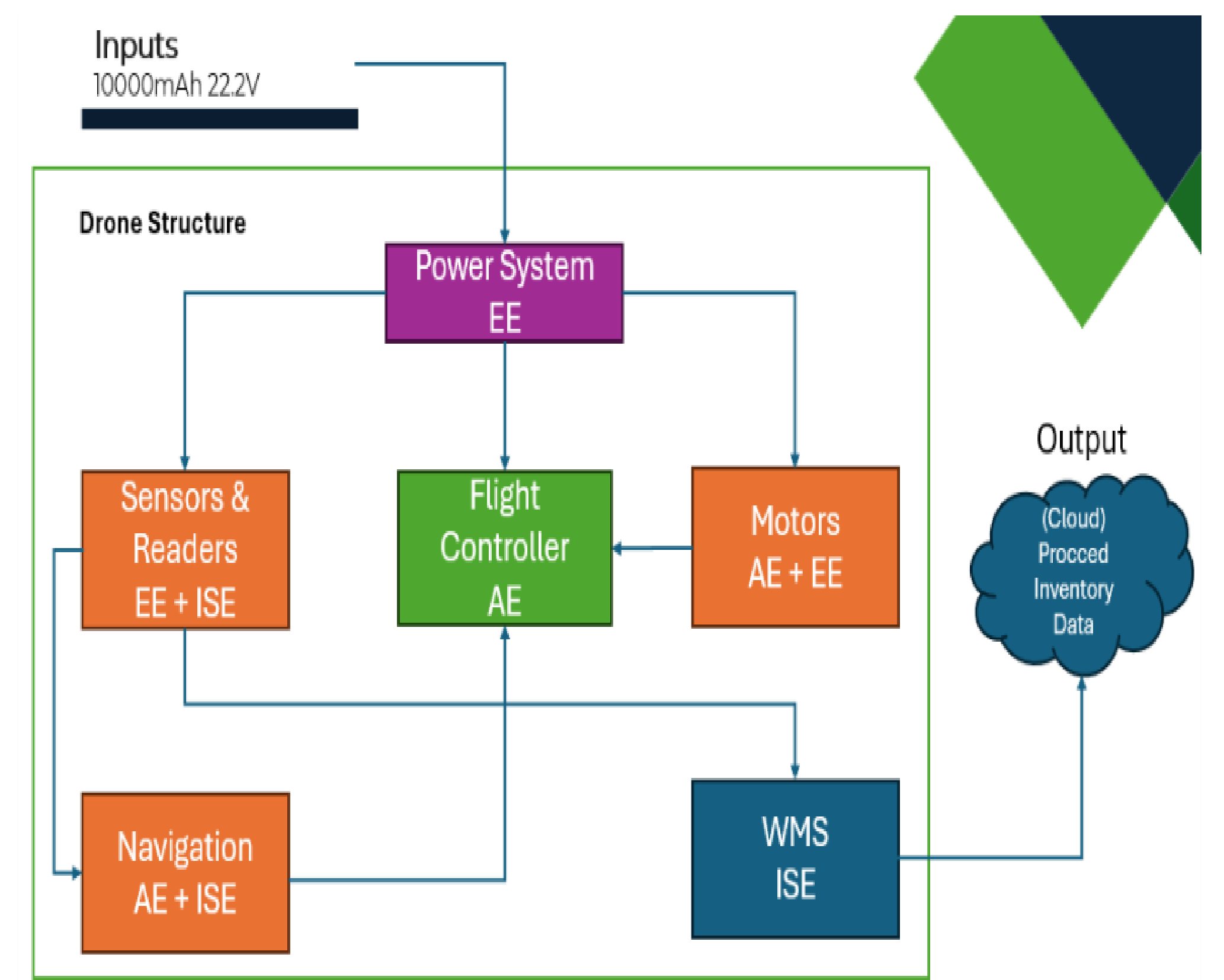


- | | |
|---|---|
| <p>Aerospace
Turki Alghamdi & Hasan Hawsawi</p> <ul style="list-style-type: none"> • Motor • Propellers • Frame • Pixhawk • Telemetry | <p>Electrical Engineering
Ali Alhajouj</p> <ul style="list-style-type: none"> • Batteries • Wires • ESCs • Antenna |
|---|---|

Validation & Verification

- System validation is performed by confirming that the drone meets key customer needs through analysis, simulation, and prototype testing.
- System verification is achieved by testing the prototype against all measurable specifications to ensure it meets the defined technical requirements.

System Architecture



Results & Conclusion



The prototype achieved stable autonomous flight, accurate RFID scanning, and real-time WMS updates, confirming the feasibility of using an autonomous drone to improve warehouse inventory accuracy and reduce manual effort.