EE344 : ELECTRONIC DESIGN LAB

WINDOW CLEANING DRONE

TEAM ID : MON-13

AAGAM SHAH
JAY MEHTA
JAINAM RAVANI
KSHITIJ VAIDYA
ADIT SRIVASTAVA

MILESTONE 1

CHALLENGES IN CLEANING HIGH-RISE WINDOWS

- **Manual Effort and Risks**: Cleaning windows of high-rise buildings is labor-intensive and involves significant safety risks for workers

- **Inefficiency**: Traditional methods are time-consuming and require specialized equipment like scaffolding or suspended platforms

- **High Costs**: Employing skilled labor and safety measures increases operational expenses for building maintenance.

- **Environmental Challenges**: Cleaning in adverse weather conditions or accessing hard-to-reach windows poses additional difficulties.

PROPOSED SOLUTION

A specially designed hexacopter drone equipped with a sprayer and a continuous water supply.

VALUE PROPOSITION

Enhanced Safety

Reduces the need for human labor in high-risk environments.

Cost Effective

Minimizes labor costs and reduces reliance on heavy equipment

Time Efficiency

Cleans large glass surfaces in significantly less time.

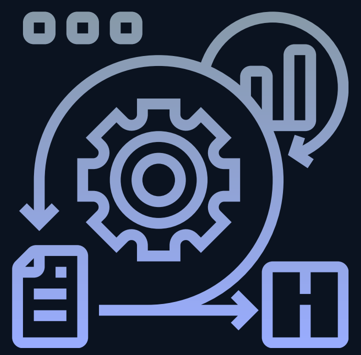
Adaptability

Operates efficiently in challenging conditions, efficiently reaching hard to access areas.

PRINCIPLE OF OPERATION

Designing a hexacopter equipped with window cleaning spray and a wiping mechanism involves integration of multiple modules and components. The exact methodology adopted by us to achieve the same is explained in the next slides.

METHODOLOGY



The solution includes a Hexacopter with a continuous water supply. The water is sprayed at a high pressure which would result in cleaning of the windows. Key decisions were made in choice of the mechanisms which are detailed in the following slides

QUAD VS HEXA COPTER

- Making a Quad-copter is easier compared to a Hexa-copter due to easier control over the Roll-Pitch-Yaw movements.
- But a Hexa-copter increases the payload capacity due to a higher available thrust which is crucial since we need to house a motor and various transmitters on the drone.
- For these reasons, a Hexa-copter was chosen over a Quad-copter despite the possible complexities

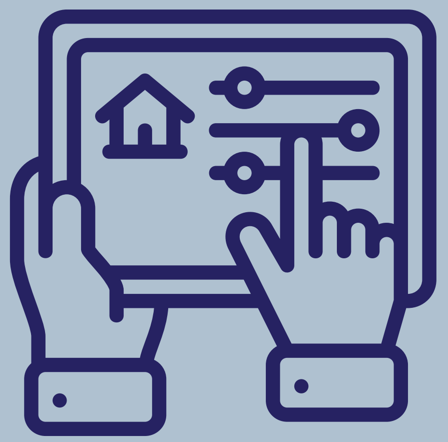
WATER SUPPLY VS STORAGE

- Housing a water storage on the drone would be make the spraying mechanism lot simpler and also reduce risks due to water leakage onto electronic components.
- But storing water is not feasible taking the payload constraints into consideration.
- For these reasons, a continuous water supply through a pipe from ground was chosen.

GROUND MOTOR VS ON-BOARD

- For transferring water to the drone, we need a ground motor which can pump water till the drone's height.
- But the pressure due to this motor won't be significant enough to expel water at a high speed which is required for cleaning.
- To tackle this we have installed a small DC motor on the drone which will increase the speed of the water before expulsion.

TECHNICAL DETAILS

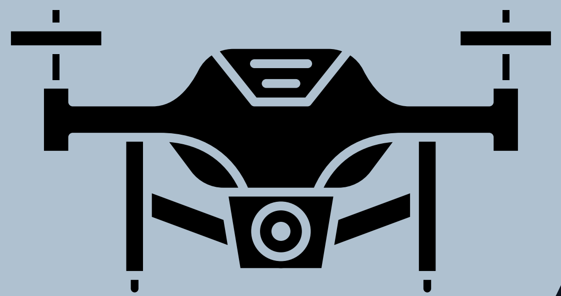


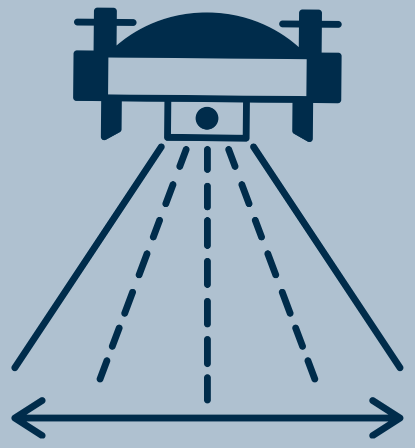
Controls

The drone is operated via Remote Control with a real time video feedback for precise maneuvering

Mechatronics

Six brushless motors provide life and stability, while servos and DC motors control the cleaning mechanism



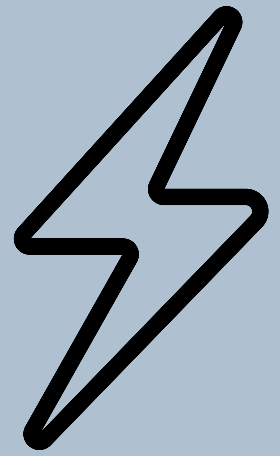


Sensors

Onboard cameras, IMU and Barometers ensure accurate navigation and obstacle avoidance

Power

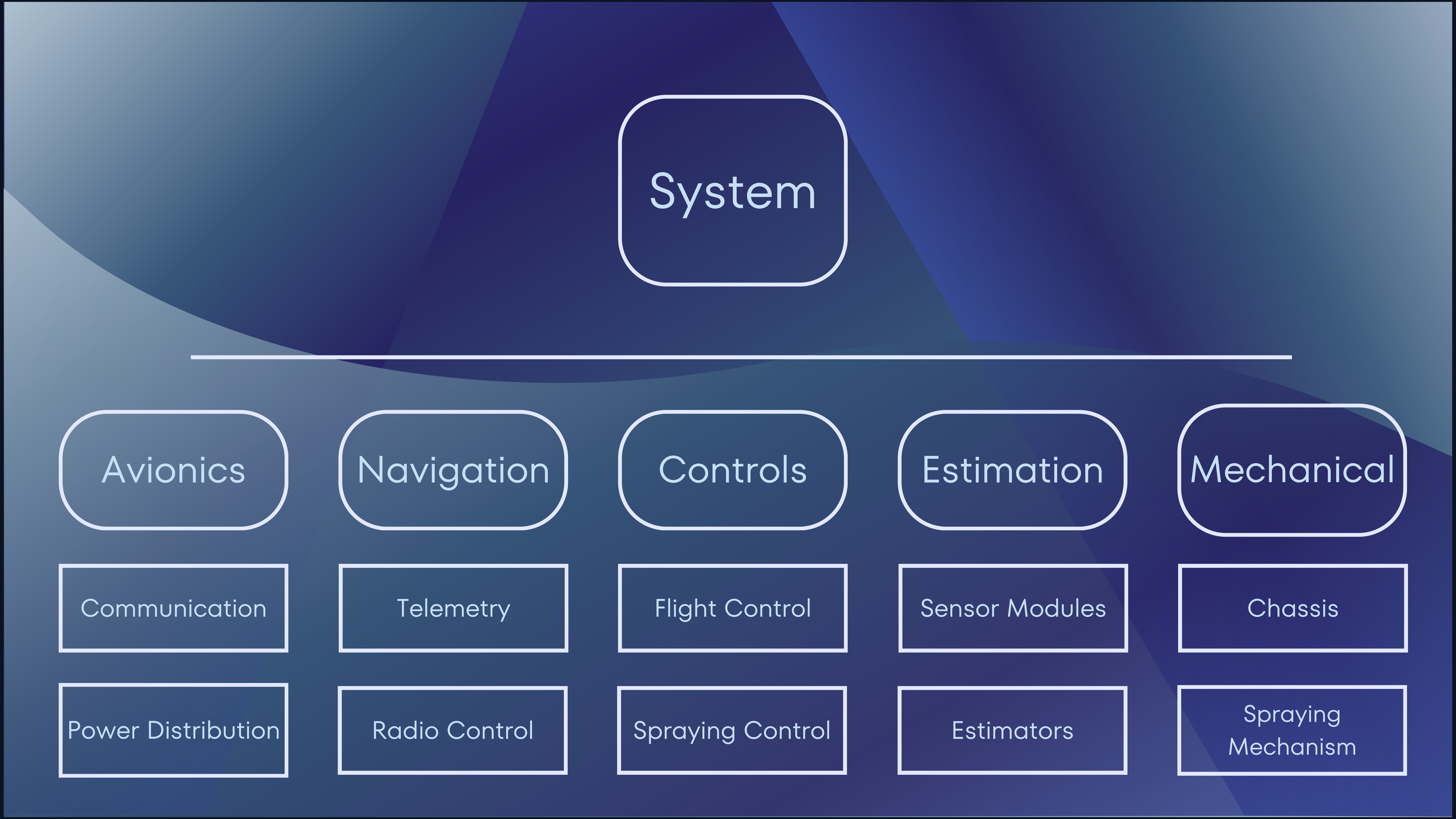
High capacity LiPo batteries support extended flight times



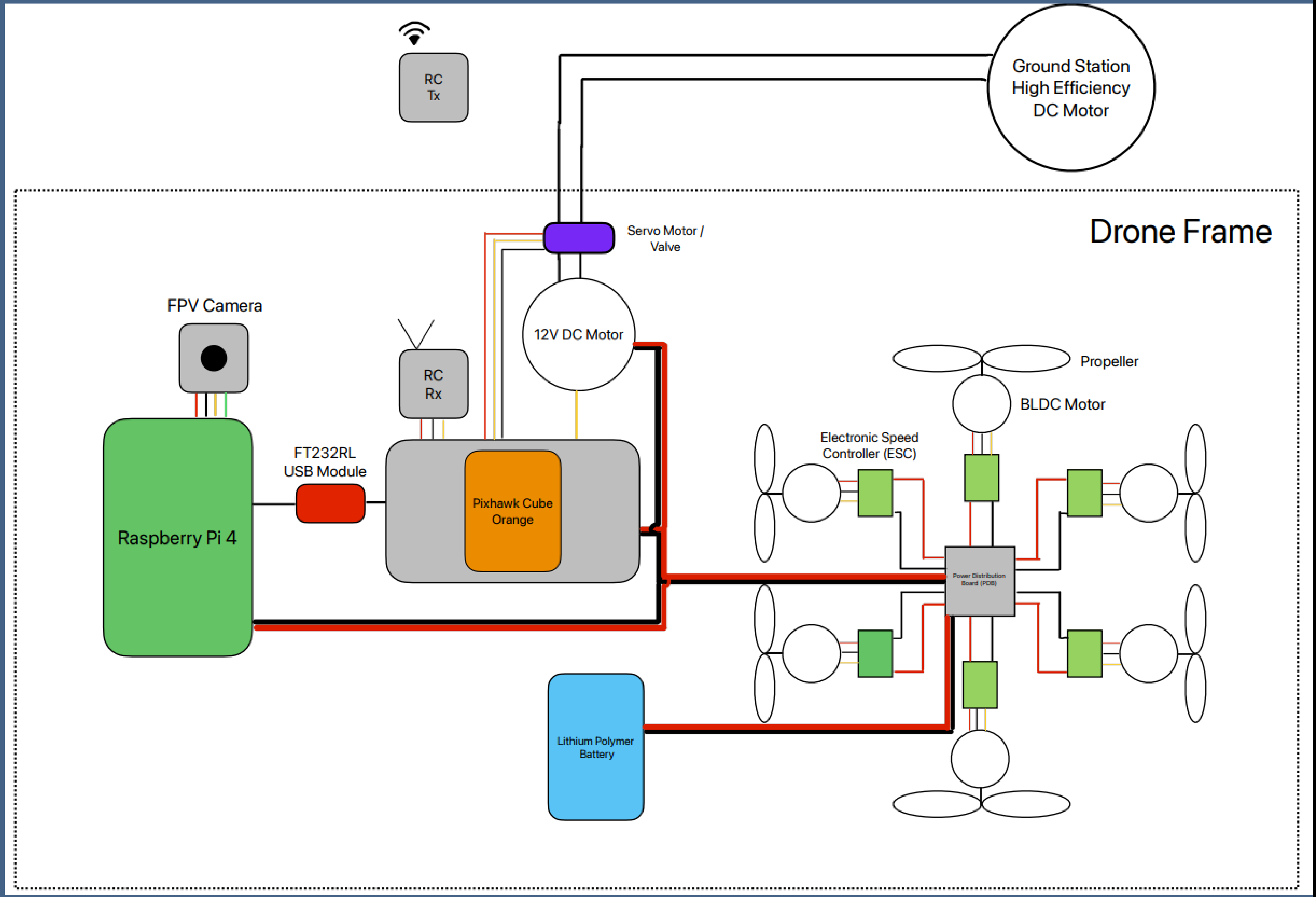
TARGET SPECIFICATIONS

Parameter	Specifications
Payload Capacity	Upto 2kg including the weight of the suspended water column, spraying mechanism and the sensors onboard
Cleaning Mechanism	Pressure spray nozzles and wiping microfiber brushes to result in streak free cleaning
Dimensions	Compact drone design with a diagonal motor-to-motor wingspan of 600-650mm
Operating Range	Upto 100m from the operator provided line-of-sight

BLOCK DIAGRAM



CIRCUIT/DATA FLOW DIAGRAM

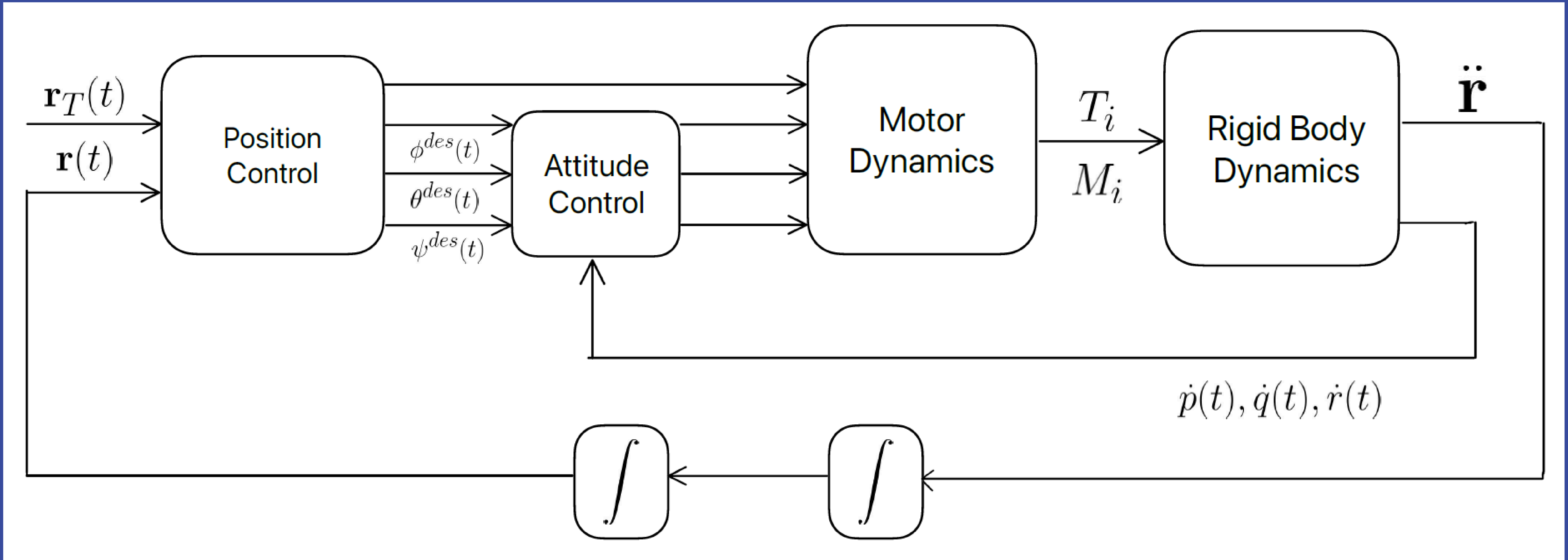


BILL OF MATERIALS

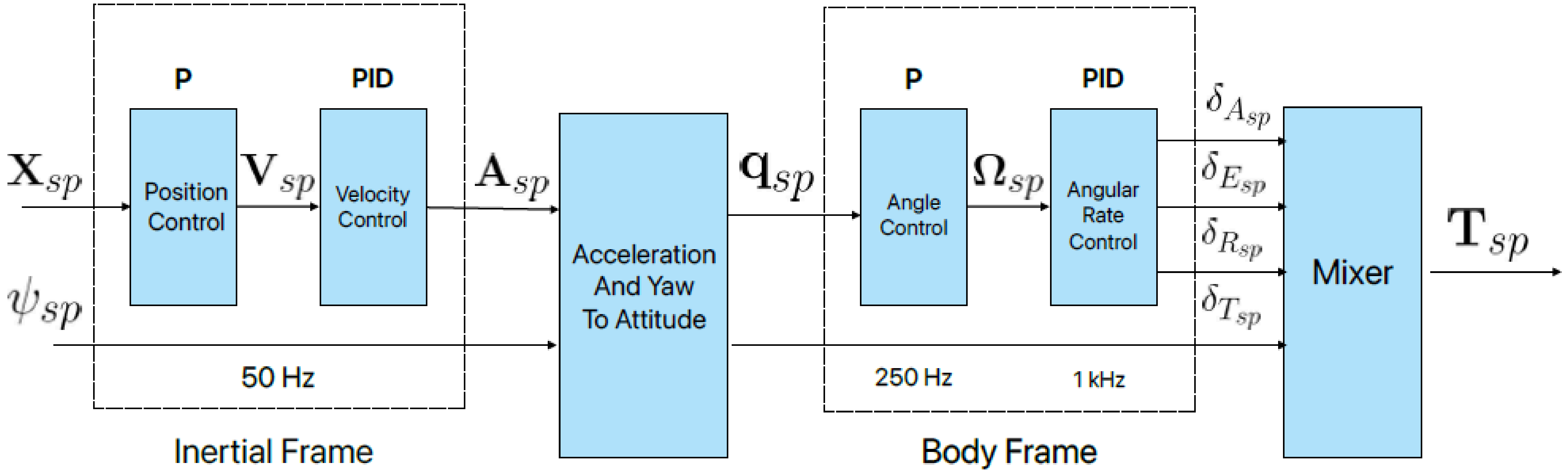
Component	Justification	Cost (₹)
S550 Hexacopter Frame	Hardware Main Body	4499
Brushless DC motors (6)	Propulsion System	3962
Pixhawk cube	Control System	Not to be purchased immediately
LiPo Battery (2)	Power sytem	4598
High Efficiency motor	Pumping Mechanism - Ground Supply	Not to be purchased immediately
Flexible Pipe	Pumping Mechanism - Water Carrier	343
12V DC Motor	Pumping Mechanism - Flow Controller	374

Raspberry Pi NoIR Camera Board	Camera for First Person View	In the EDL Inventory
Servo Motors	Pumping Mechanism - Nozzle Valve	In the EDL Inventory
RASPBERRY-PI SBC, Raspberry Pi4 B 8GB, BCM2711	Onboard Computing Module	In the EDL Inventory
FT232RL USB Module - RPi to Pixhawk Connection	Communications	319
FlySky FS-i6	Remote Control Module	4325
Propeller Blades (6)	Hardware Component	1794
	Total Cost :-	**26713**

GENERAL CONTROL FLOW

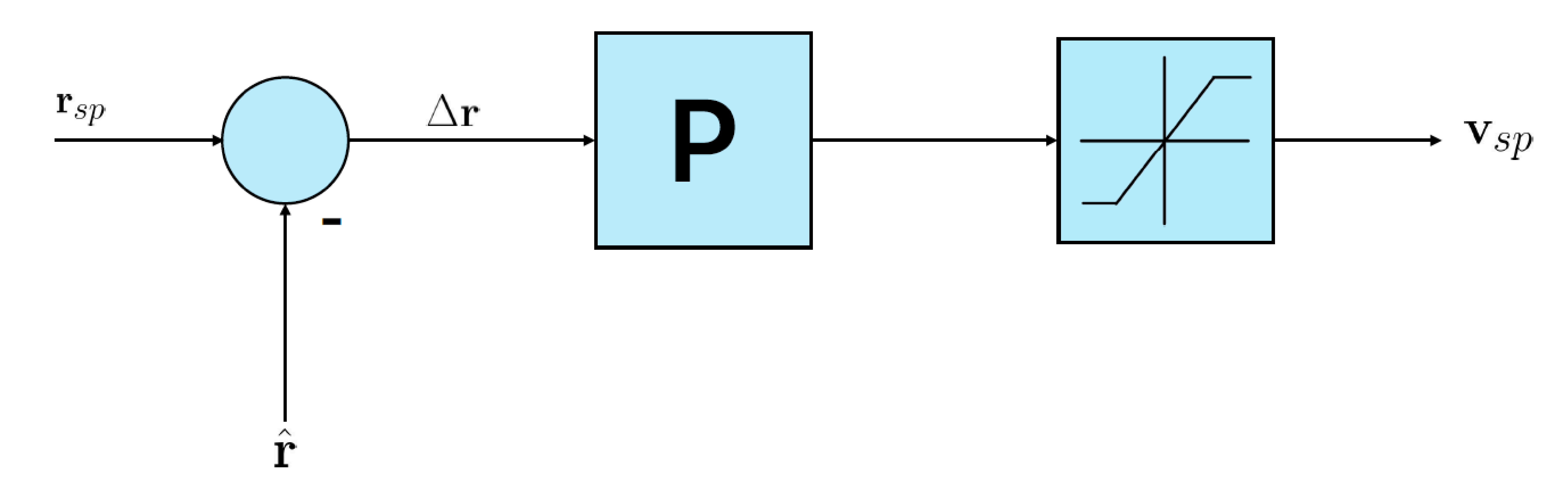


MULTICOPTER CONTROL ARCHITECTURE

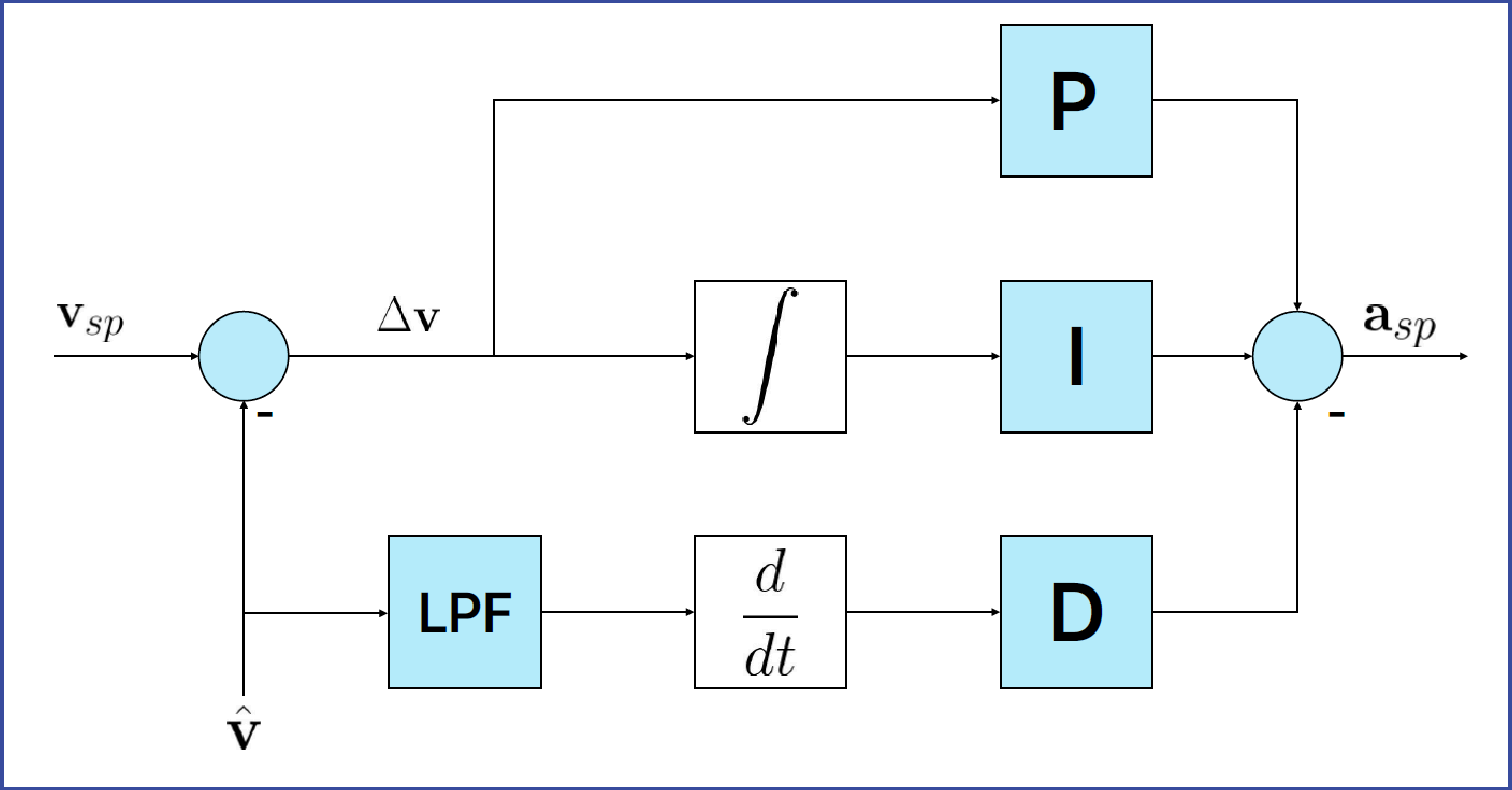


Multicopter Control Architecture

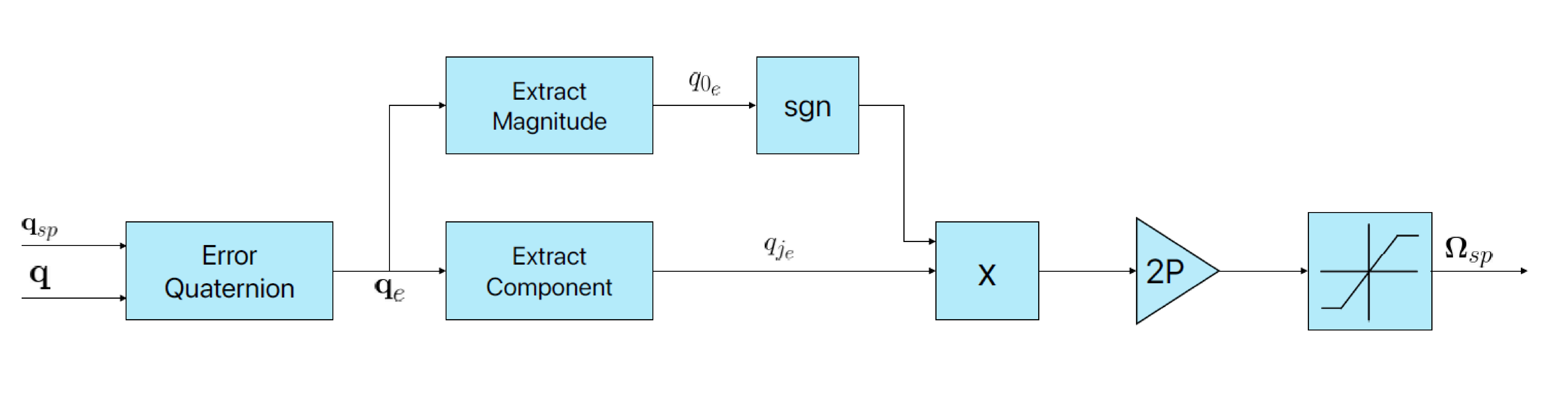
POSITION CONTROLLLER



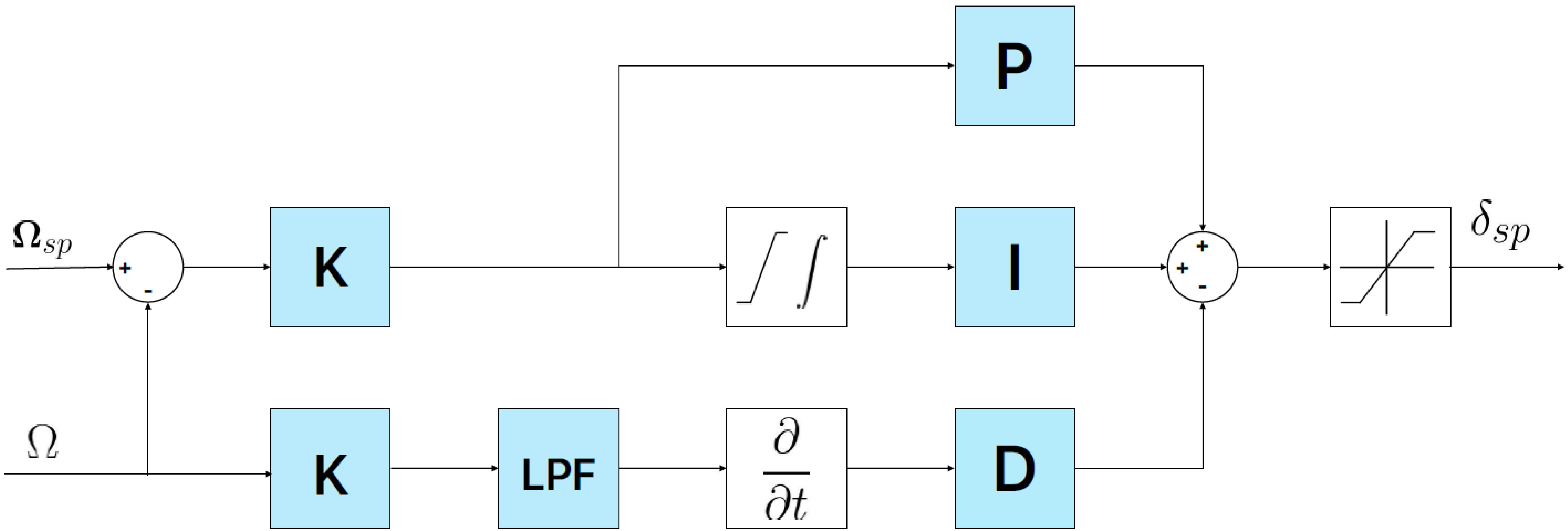
VELOCITY CONTROLLLER



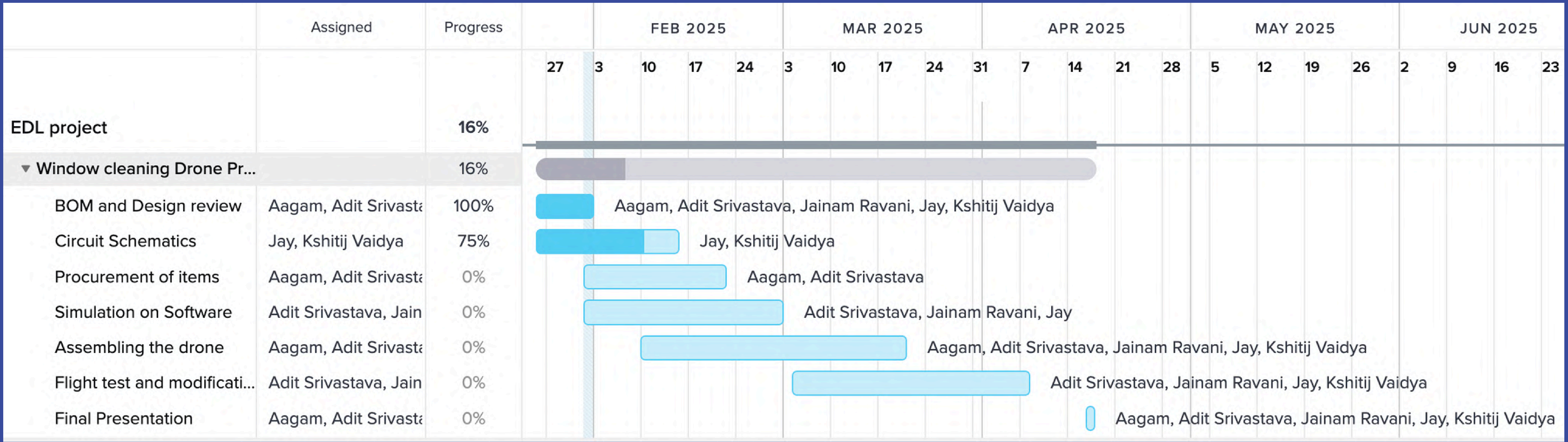
ATTITUDE CONTROLLLER



ANGULAR RATE CONTROLLLER



GANTT CHART


Assigned
Progress
FEB 2025
MAR 2025
APR 2025
MAY 2025
JUN 2025
27
3
10
17
24
3
10
17
24
31
7
14
21
28
5
12
19
26
2
9
16
23
EDL project
16%
Window cleaning Drone Pr...
16%
BOM and Design review
Aagam, Adit Srivasta
100%
Aagam, Adit Srivastava, Jainam Ravani, Jay, Kshitij Vaidya
Circuit Schematics
Jay, Kshitij Vaidya
75%
Jay, Kshitij Vaidya
Procurement of items
Aagam, Adit Srivasta
0%
Aagam, Adit Srivastava
Simulation on Software
Adit Srivastava, Jain
0%
Adit Srivastava, Jainam Ravani, Jay
Assembling the drone
Aagam, Adit Srivasta
0%
Aagam, Adit Srivastava, Jainam Ravani, Jay, Kshitij Vaidya
Flight test and modificati...
Adit Srivastava, Jain
0%
Adit Srivastava, Jainam Ravani, Jay, Kshitij Vaidya
Final Presentation
Aagam, Adit Srivasta
0%
Aagam, Adit Srivastava, Jainam Ravani, Jay, Kshitij Vaidya

KEY RISKS AND MITIGATION MEASURES

Water leakage
Prevent water leakage onto electrical equipment by proper coverage and insulation to prevent shocks

Fall safe
Emergency protocols in case of failure of flight mechanism or hardware. Landing gear will have shock absorbers to prevent damage due to impact

DELIVERABLES

Hexacopter

Fully functional hexacopter drone with a spraying and cleaning mechanism equipped with sensors, motors, LiPo battery and a landing gear

Software Stack

Code and Controller software designs for operating the drone using the on-boad Pixhawk Cube

Ground Control

Drone can be operated using telemetry module or radio control with a First Person View (FPV) Camera for enhanced navigation

Water Supply Mechanism

Ground station has a high efficiency motor used to pump water upto the drone to ensure a continuous water supply for cleaning purposes

THANK YOU !