Concept: Firefighting Assistant Drone

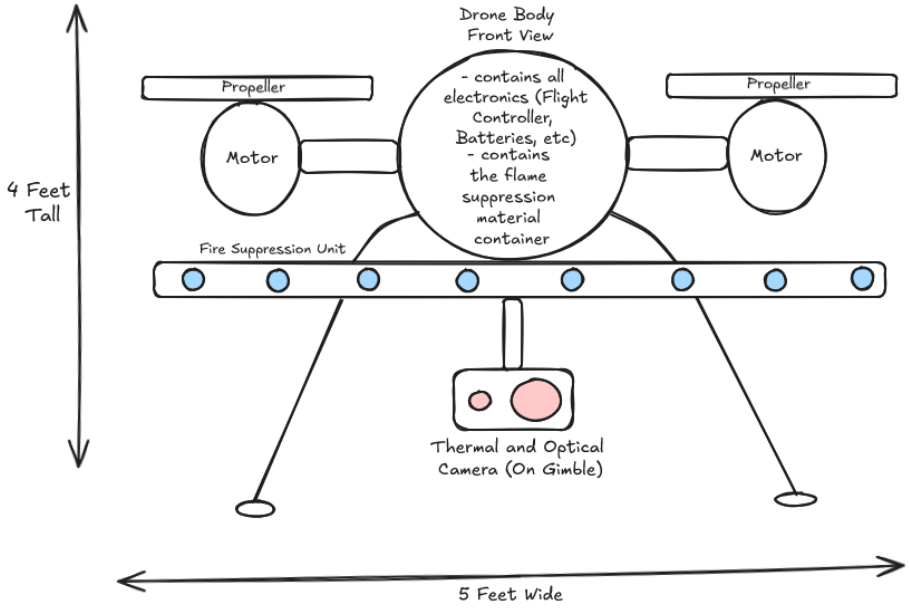
Firefighting Drone that assists firefighters with real-time analysis and fire suppression features. The drone can use its extensive sensor suite to gather data for ongoing fire conditions and can also suppress flare ups. This is useful for firefighters and emergency response teams.

1. Allows firefighters to monitor and understand fire conditions from a safe distance
2. Can **quickly suppress small fires** to prevent them from spreading
3. Provides **real-time data on fire dynamics** to aid high-level decision making

Included Functionality:

1. Thermal Camera – **detects hotspots** and tracks fire intensity
2. Optical Camera – provides **clear visual image and video feeds**
3. Fire Suppression – small unit that can **dispense fire-retardant foam/powder to extinguish small fires**
4. GPS/IMU Navigation – provides **accurate location tracking** and stable flight/orientation control
5. Obstacle Avoidance – uses ultrasonic sensors to **detect and avoid obstacles** such as trees, walls, debris, etc.

Throttle %	25%	50% Hovering	75%	100% Full Control
Total Thrust kg	6 kg	12 kg	18 kg	24 kg
Estimated Flight Time	~ 20 minutes with a 10S 14Ah battery			
Total Weight	7-9 kg (depends on battery and fire suppression type/level)			



Propulsion System

1. Battery (10S 12Ah 37V) – 2.5 kg, provides **~ 20 minutes of flight time** at general load
2. T-Motor U8 170kV with 26-inch props – provides efficient thrust for heavy lifting

- The U8 K170kV motors are optimized for heavy lifting operations with low kV
- **Running at 50-75% throttle optimizes battery life,** providing the longest flight duration (20 mins) while maintaining good control
- Thrust-to-Weight ratio is **sufficient for lifting a 7-9 kg drone** comfortably

Component	Weight (kg)
Propulsion System	1.4 kg
Battery System	2.5 kg
Fire Suppression System	2-3 kg
Sensor Suite	0.75 kg
Control System	0.35 kg
Total	7-9 kg

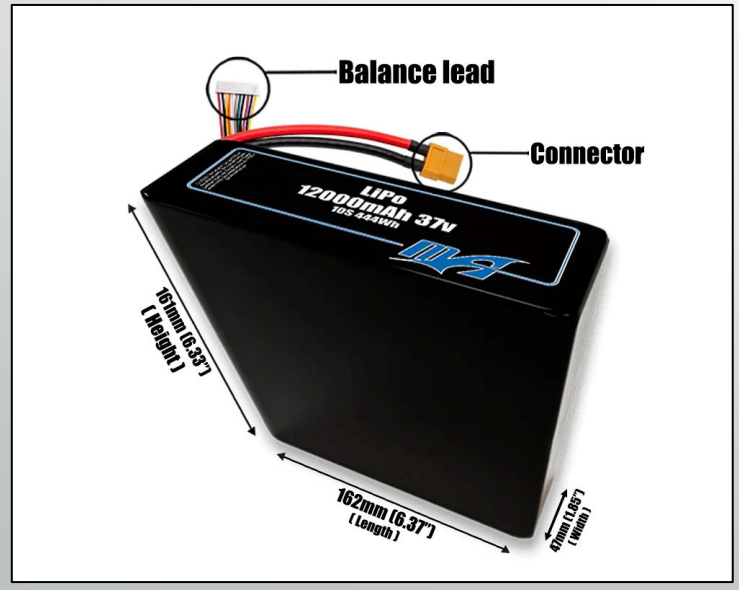
Throttle (%)	Power (W)	Current (A)	Thrust per Motor (kg)	Total Thrust (4 Motors, kg)	Thrust-to-Weight Ratio (max weight)
25%	325	8.75	1.5	6	0.77 : 1
50%	650	17.5	3.0	12	1.33 : 1
75%	975	26.25	4.5	18	2 : 1
100%	1300	35	6.0	24	2.67 : 1

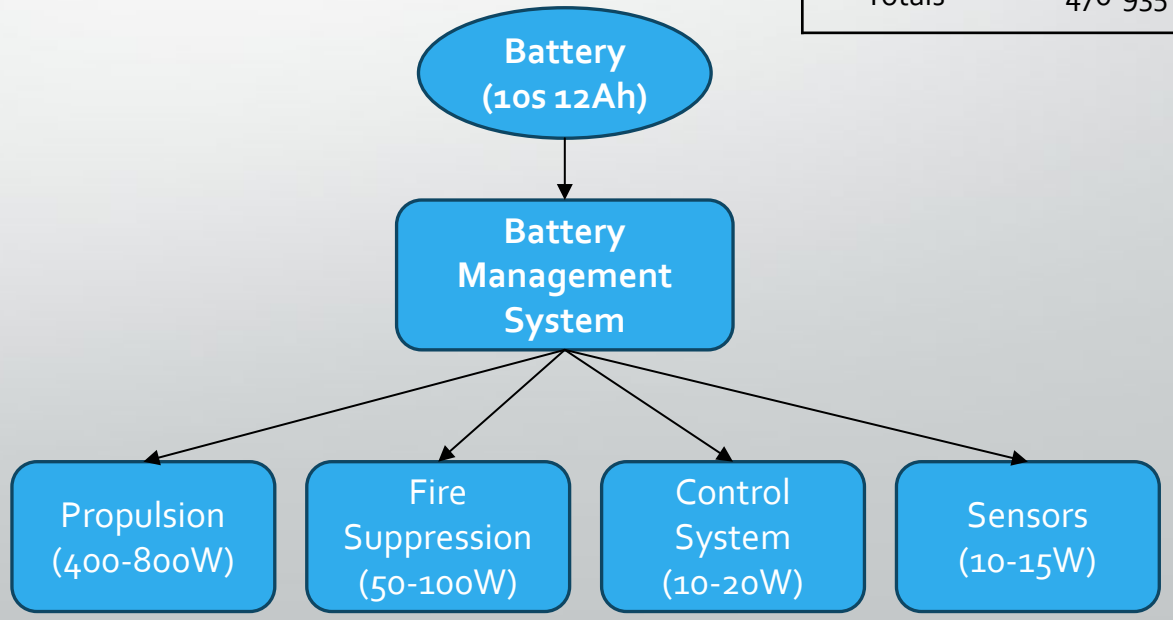
Power and Battery System

- Battery: 10S 12Ah 37V (444 Wh capacity)
- Estimated Flight Time: **20 minutes at typical load (650-750W)**
- Battery Management System: optimizes battery usage and handles temperature and current monitoring

- **Battery can be swapped or charged during missions** to ensure minimal downtime between operations.
- Per 1 10S battery, ~20-minute flight time at typical use (data gathering, video analysis) or **~15 minutes at heavy use** (fire suppression unit)

Component	Power Consumption (W)
Propulsion System	400-800W
Fire Suppression System	50-100W
Sensor Suite	10-15W
Control System	10-20W
Totals	470-935W





Navigation System

Navigation Components:

1. GPS Module – Ublox M10
    1. **Horizontal Accuracy - $\pm 1.5m$**
    2. Multiple Concurrent GNSS
    3. 10 Hz Update Rate
2. IMU System – 3x ICM-45686
    1. **Triple** 6-axis MEMS IMU (Accel/Gyro)
    2. Gyro Range - $\pm 4000\ dps$
    3. Accel Range - $\pm 32g$
3. Ultrasonic Sensors - MB7040 I2CXL
    1. 8 sensors for **$360°$ spherical coverage**
    2. Range: $0.02m\ -\ 7.65m$
4. Flight Controller – Pixhawk Jetson Baseboard
    1. Utilize OOS hardware with integrated Jetson to run **machine learning tasks onboard**
    2. Use open-source autopilot software, **PX4,** able to implement firefighting specific tasks from base software

PX4 Navigation Features:

1. **Autonomous Functionality**
    1. Hold – Holds current position and altitude
    2. Return – Return and land at safe location
    3. Mission – Perform defined flight plan
2. **Safety**
    1. Geofencing – locks drone to specified area
    2. Emergency/Low-Battery
3. Firefighting Missions
    1. **Fire Perimeter Mapping**
    2. **Hotspot Tracking and Analysis**

Sensor System

Sensor Applications:

1. Environmental Analysis
    1. **Multi-Gas** concentration **monitoring**
    2. Oxygen and **combustible gas detection**
    3. Air quality assessments
2. Fire Scene Assessment
    1. Thermal **Hotspot Identification**
    2. Visual Overview Analysis
    3. Temperature Mapping
3. Navigation Support
    1. 360° spherical obstacle detection
    2. **Autonomous navigation** and position tracking
    3. Stabilized flight control

Sensor Components:

1. Vision System – 2-axis gimble stabilization
    1. **Thermal** Camera
    2. **Optical** Camera
2. Gas Detection System
    1. **CO Detection** - TGS5042
        1. $0 - 10{,}000 \pm 10\ ppm$ detection range
    2. **CO2 Detection** – SenseAir s8
        1. $400 - 10{,}000 \pm 40\ ppm$ detection range
    3. **Methane Detection** – TGS2611
        1. $500 - 10{,}000 \pm .60\ ppm$ detection range
    4. **Oxygen Detection** – AlphaSense O2-A2
        1. $0.1 - 20.9\%$ detection range
3. Navigation and Position
    1. GPS Module
    2. IMU System
    3. Ultrasonic Sensor