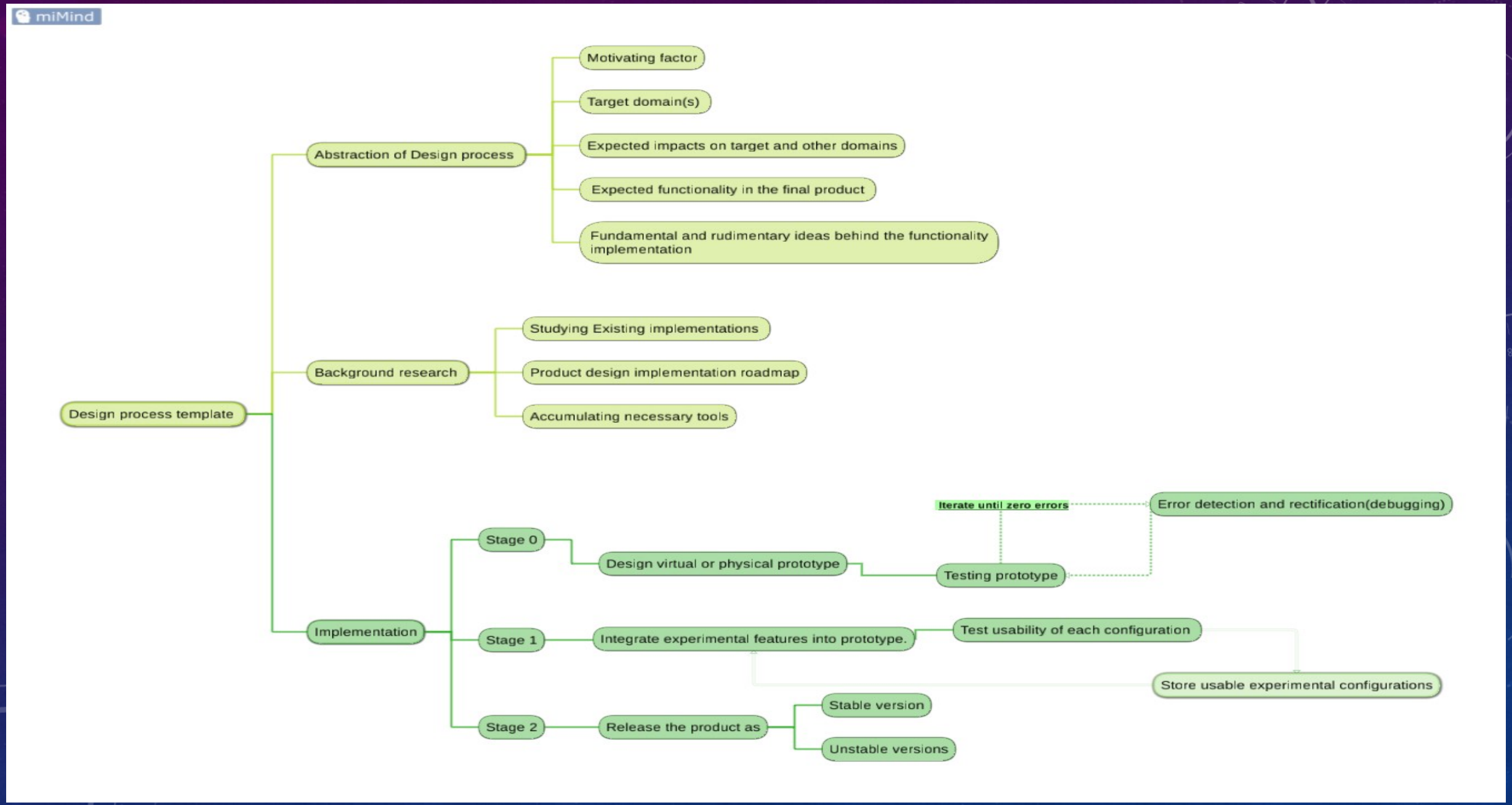
PRODUCT DESIGN AND FUNCTION OVERVIEW

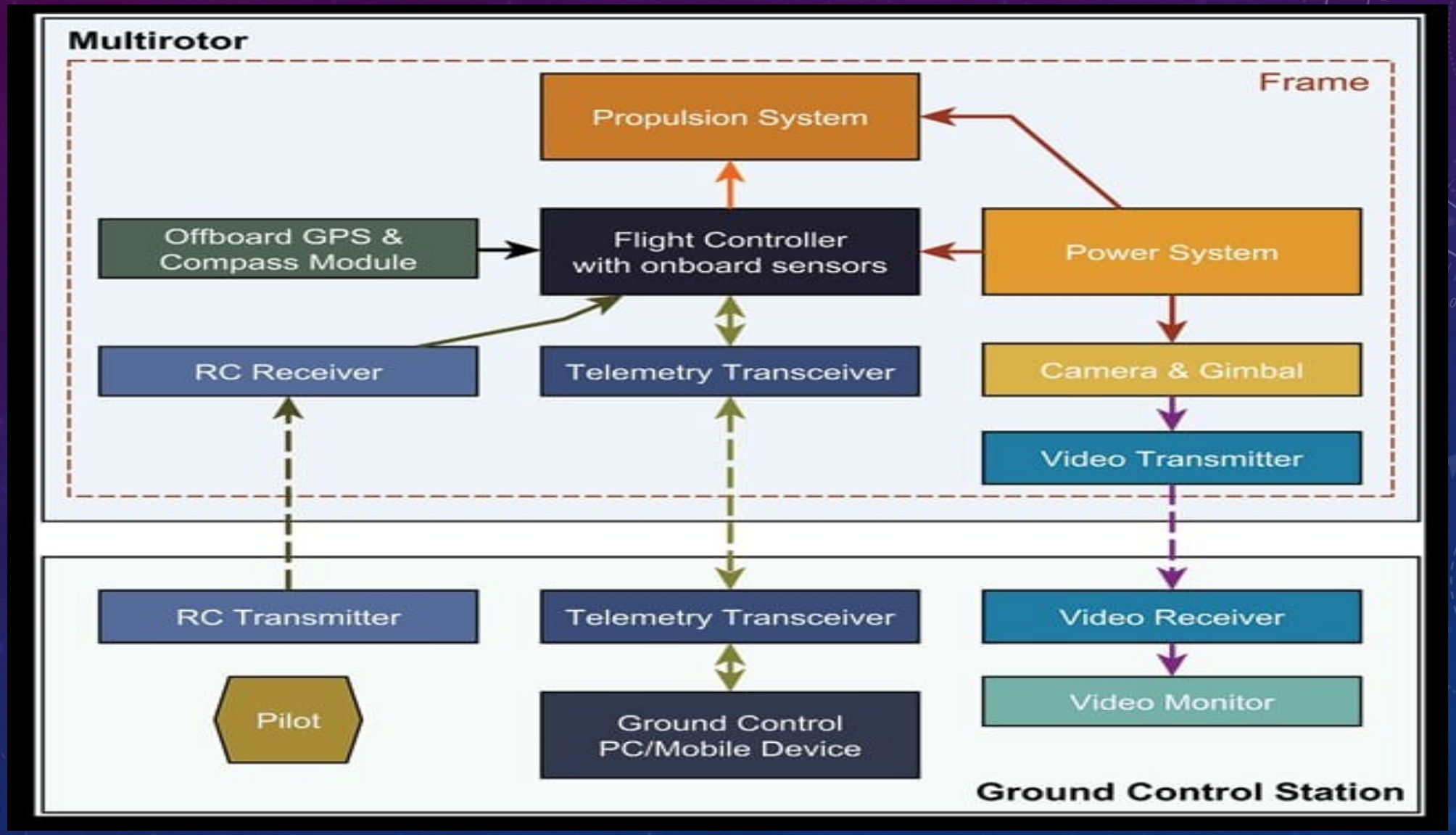
PRIMARY OBJECTIVES OF THIS PRESENTATION

1. Overview of the drone design cycle
2. Defining abstraction layers in a drone
3. Discussing and Comparing possible design Approaches
4. Short term and long term consequences of each design.

MIND MAP OF DRONE DESIGN LIFE CYCLE



ABSTRACTION LAYERS IN DRONE DESIGN



DESIGN CHOICES

Propulsion design choices – ok (Quad rotor) Prototype

Power supply and management – ok

Radio flight Control -ok

Telemetry and video feed transmission - TS832

Navigation and mission planning system - PIXHAWK

Collision avoidance system. -OPTICAL FLOW , ???

PROPULSION DESIGN CHOICES

Available options

- 1. Quad rotor design
- 2. Hex rotor design
- 3. Single rotor design

COMPARISON OF PROPULSION SYSTEMS

Single rotor design	Multi rotor design
1. Higher lift efficiency 2. Inherent flight stability (Doesnt Require complex and continous Flight adjustments). 3. Large payload capacity per watt 4. Requires larger blades 5. Larger blades can cause high damage on impact but can be mitigated by mesh shielding. 6. Longer ranges and stable operation winds. 7. Lower maneuverability compared to multi rotor design. 2 + 0.5 + 0.5 + 0.5 8. Good for larger capacities	1. Lower Efficiency 2. Requires active fly-by control System 3. Lower payload capacity per-watt 4. Requires smaller blades 5. Smaller Blades are safer and Cheaper to use 6. Short range and relatively unstable in strong winds compared to large single rotor design 7. High Maneuverable design with 3(TRUE) + 3(PSEUDO (0.5)) degrees of freedom 8. Good for payloads smaller than 15 kg and for surveillence drones

WHY SINGLE ROTOR PROPULSION IS BETTER IN FUTURE DESIGN?

- **<u>Advantages</u>**
- Higher lift efficiency (due to increased thrust per watt)
- Longer range
- Higher payload capacity
- Reduced cost (due to less rotors and energy required)

SINGLE ROTOR DESIGN CURRENTLY IN MARKET

YAMAHA RMAX SERIES FARMING DRONES

SINGLE ROTOR DESIGN CURRENTLY IN MARKET

R22-UV

PRECISION FARMING DEMONSTRATION

BY UAVOS COMPANY

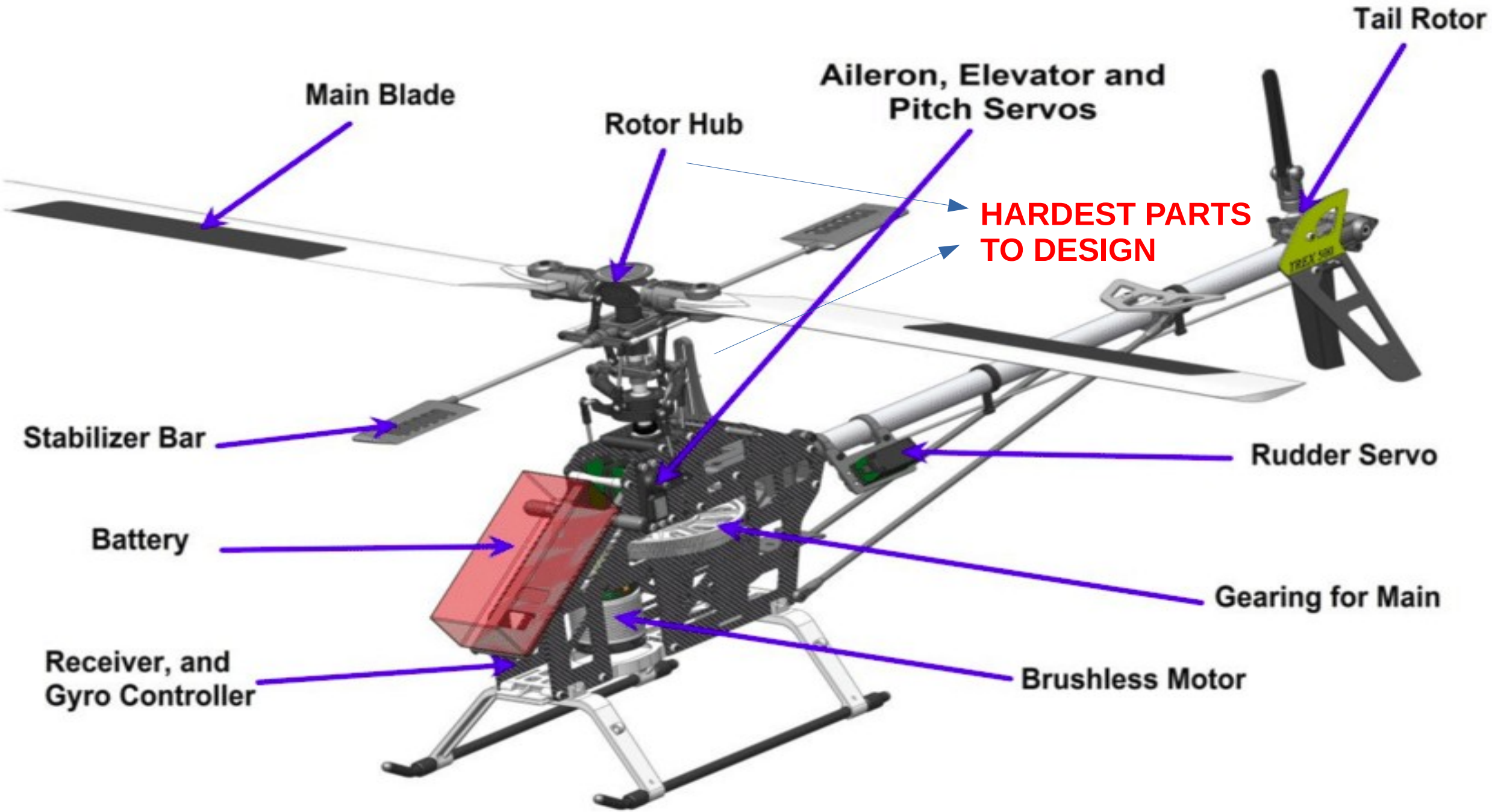
CHALLENGES IN SINGLE ROTOR PROPULSION FEATURES

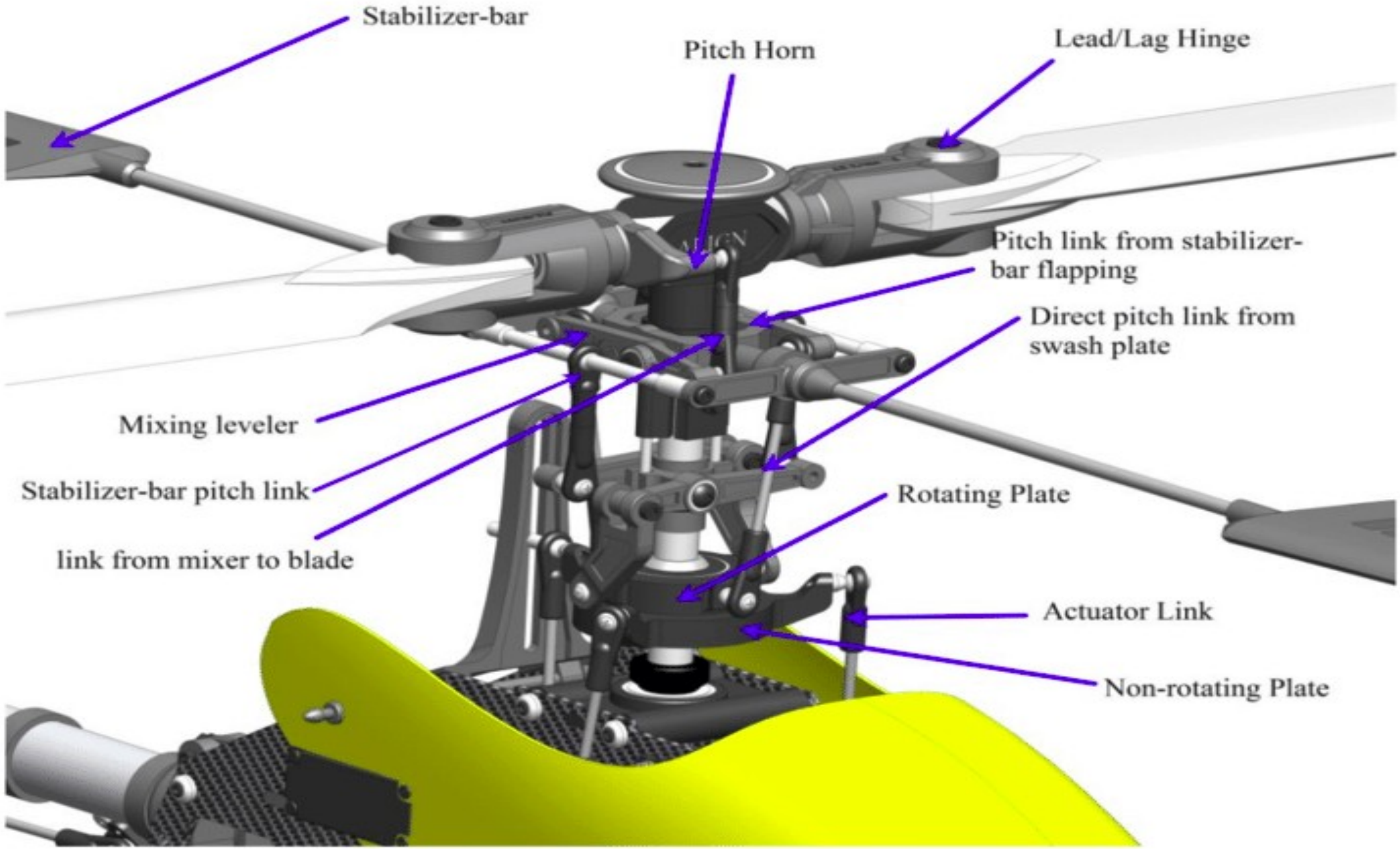
- Requires mechanically complex hub design

  → MITIGATION == ??

  RESEARCH ON HUB DESIGN --- in future ??

- → (Requires mechanical engineering expertise in transmission design systems and machining techniques.


Tail Rotor
Main Blade
Aileron, Elevator and
Pitch Servos
Rotor Hub
HARDEST PARTS
TO DESIGN
Stabilizer Bar
Rudder Servo
Battery
Gearing for Main
Receiver, and
Gyro Controller
Brushless Motor

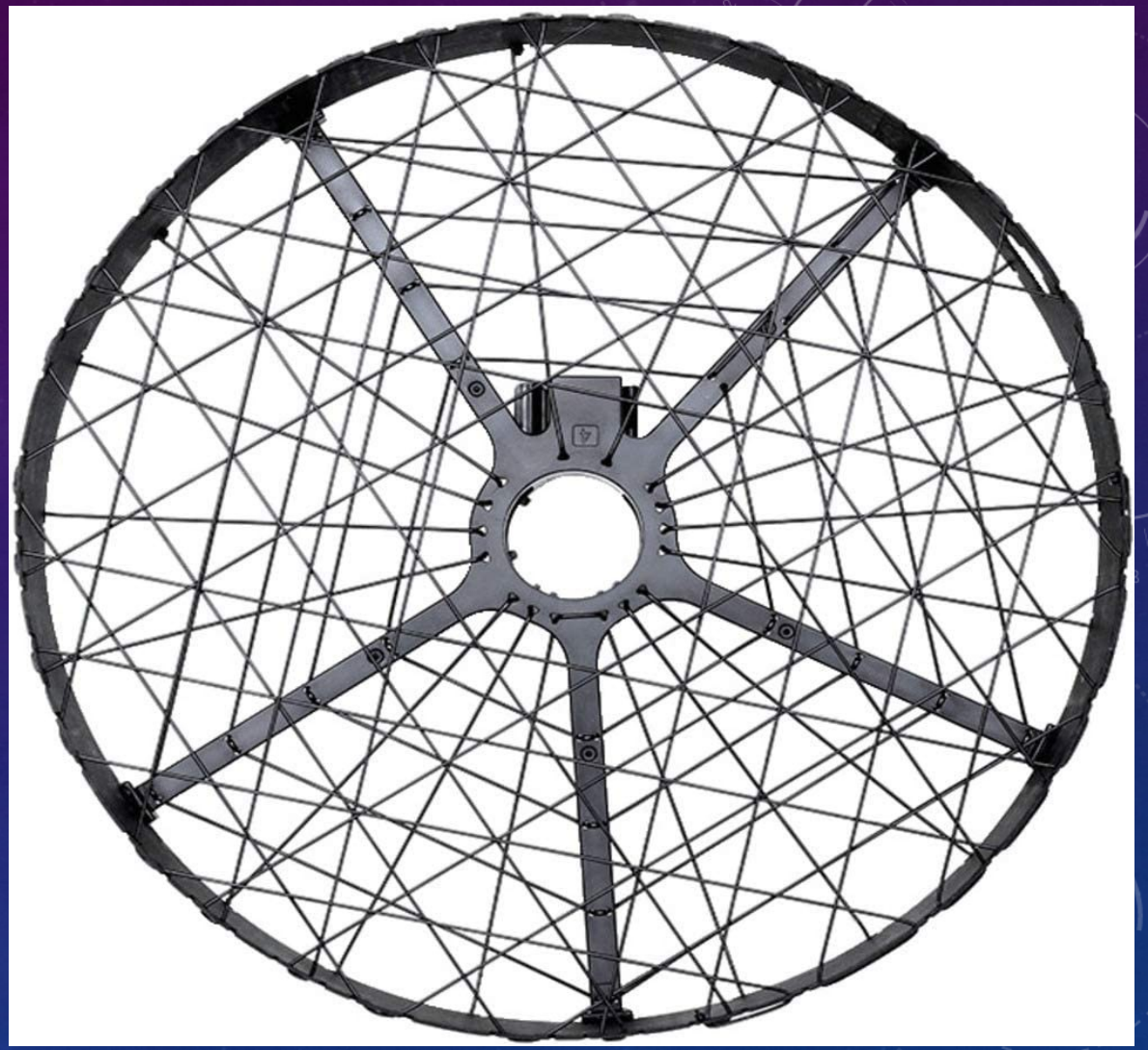

Stabilizer-bar
Pitch Horn
Lead/Lag Hinge
Pitch link from stabilizer-bar flapping
Direct pitch link from swash plate
Mixing leveler
Stabilizer-bar pitch link
link from mixer to blade
Rotating Plate
Actuator Link
Non-rotating Plate

CHALLENGES IN SINGLE ROTOR PROPULSION FEATURES

→ Larger blades are dangerous to operate
→ MITIGATION --- MESH SHIELDING ???

→ High drift in air flow during spray
→ MITIGATION == Change orientation and position of sprayer

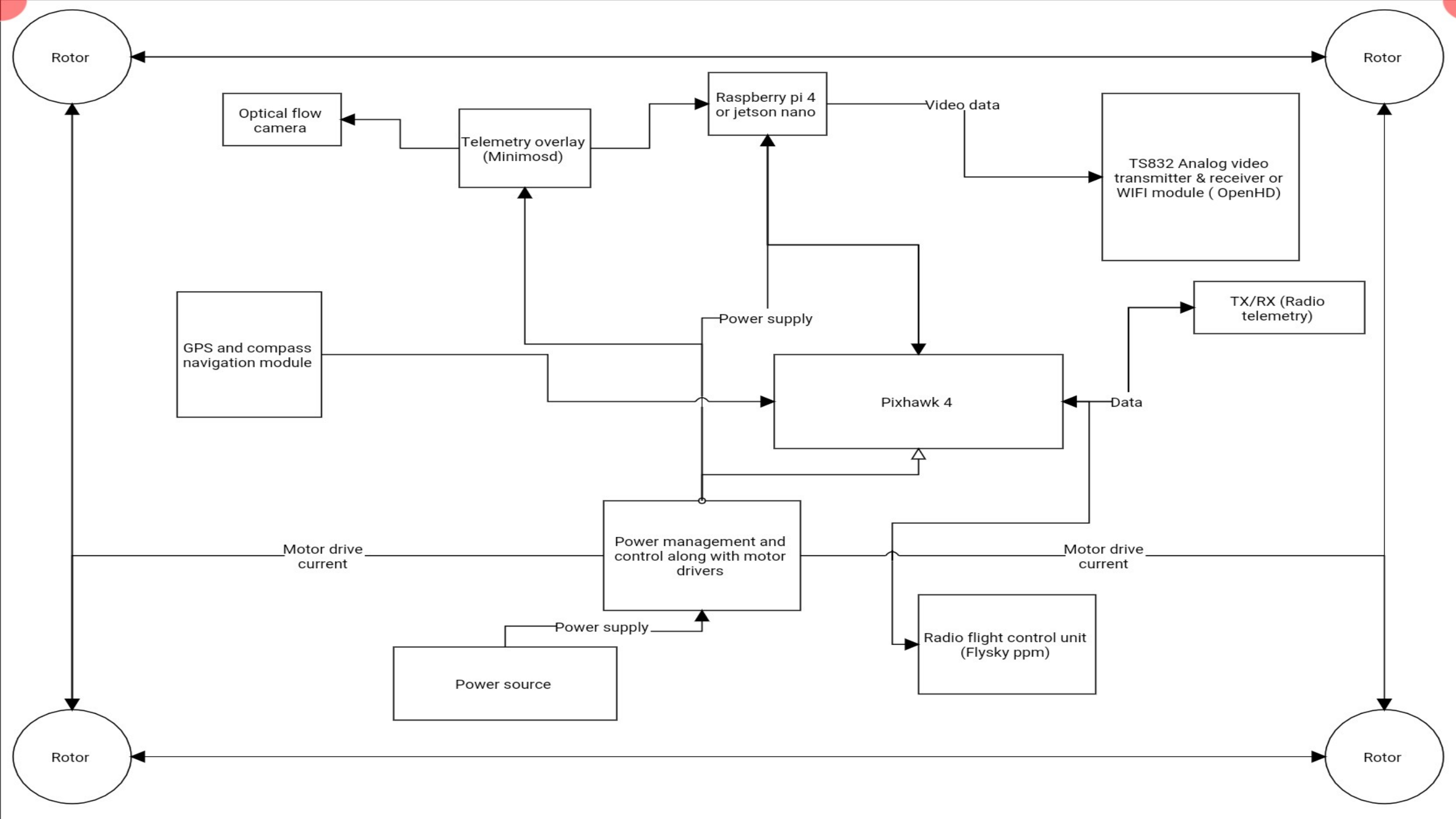
→ Larger blades are dangerous to operate
→ MITIGATION --- MESH SHIELDING ???



PROPULSION CHOICES SUMMARY

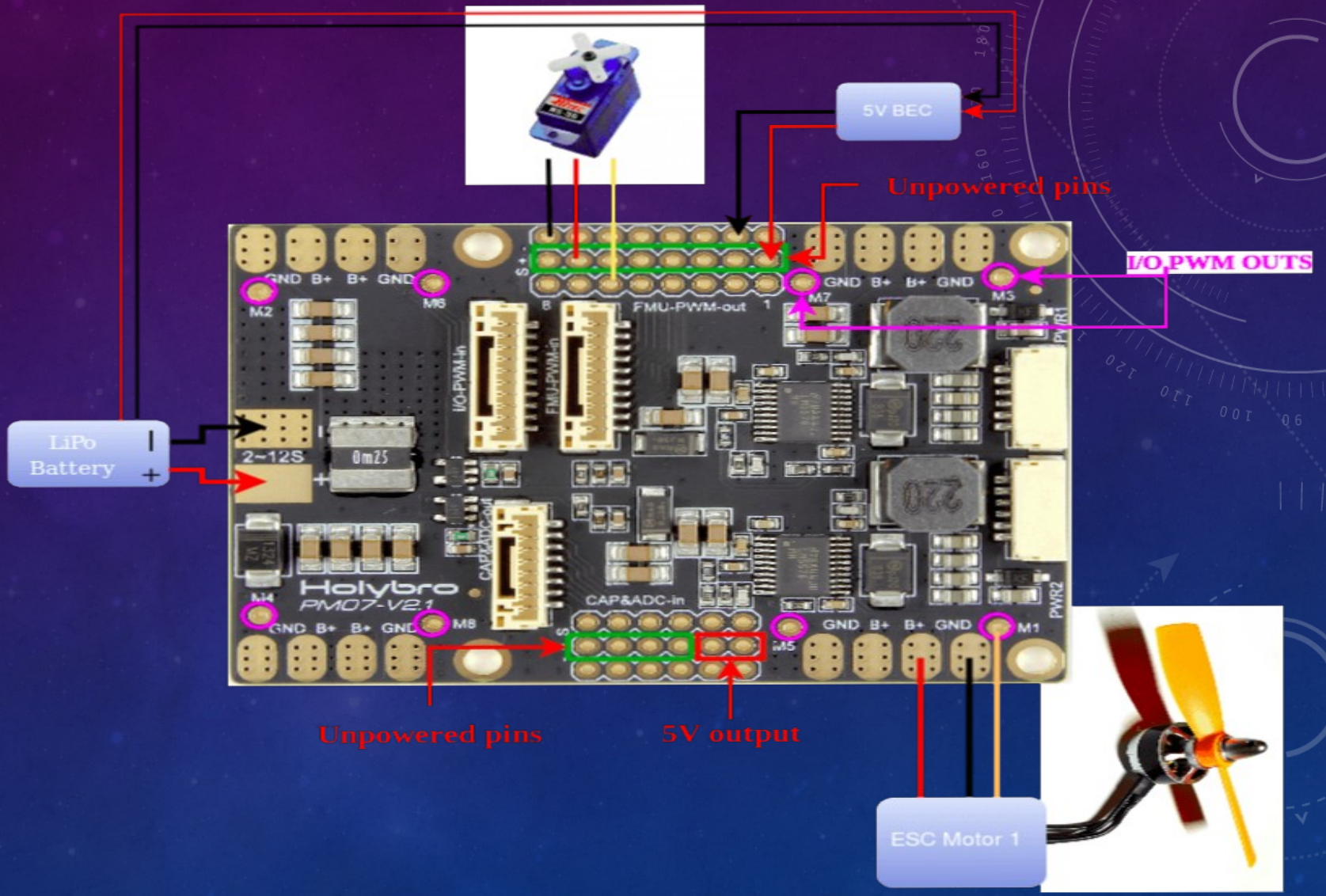
- ALTHOUGH SINGLE ROTOR DESIGN IS AN EFFICIENT DESIGN COMPARED MULTI ROTOR DESIGN IN BOTH ECONOMICS , OPERATIONAL RANGES AND CAPABILITIES, IT REQUIRES A LOT OF MECHANICAL EXPERTISE AND WORK (NOT IMPOSSIBLE THOUGH) .
- DUE TO THIS ITS BETTER TO SLOWLY DO THE RESEARCH & DEVELOPMENTS DURING THE COURSE OF THE STARTUP
- RESEARCH AND DESIGN ON COAXIAL ROTORS DESIGN (Sikorsky S-97 Raider), DUAL ROTOR DESIGN (CHINOOK) FOR INCREASED PAYLOAD REQUIREMENTS

SCHEMATIC DIAGRAM OF THE PROTOTYPE


Rotor
Rotor
Optical flow camera
Telemetry overlay (Minimosd)
Raspberry pi 4 or jetson nano
Video data
TS832 Analog video transmitter & receiver or WIFI module (OpenHD)
GPS and compass navigation module
Power supply
TX/RX (Radio telemetry)
Pixhawk 4
Data
Motor drive current
Power management and control along with motor drivers
Motor drive current
Power supply
Power source
Radio flight control unit (Flysky ppm)
Rotor
Rotor

POWER MANAGEMENT UNIT:-

(Pixhawk 4 Power Module (PM07))



FLIGHT CONTROLLER RADIO TRANSMITTER AND RECEIVER

Fly Sky FS-i6X 2.4GHz 6CH AFHDS 2A RC Transmitter With FS-iA10B 2.4GHz 10CH Receiver

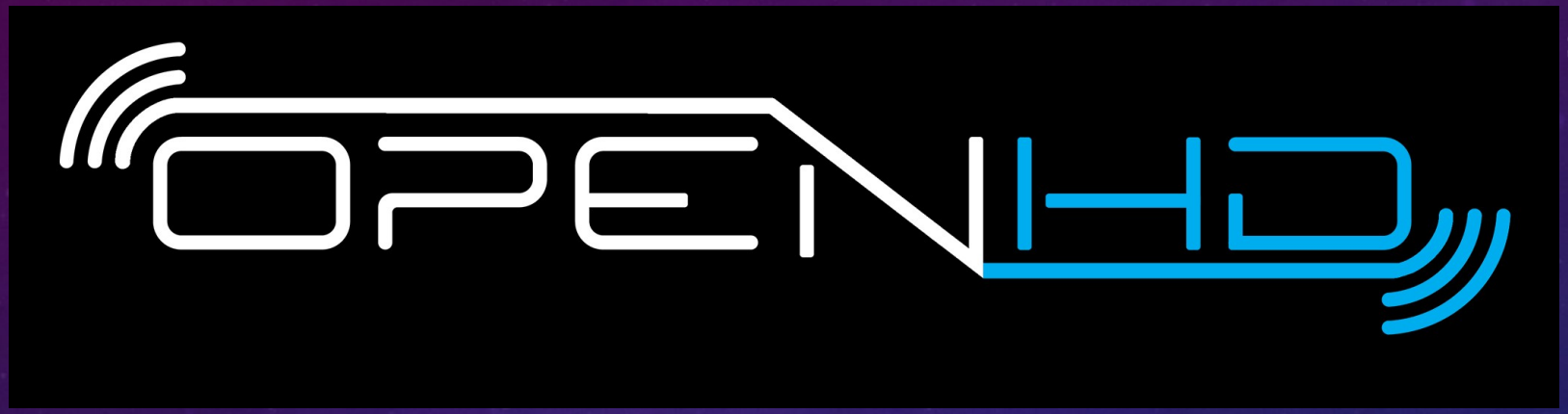
FOR CONTROLLING THE FLIGHT

TELEMETRY RADIOS

SiK Telemetry Radio

USED FOR RELAYING TELEMETRY DATA OVER ONG RANGES

VIDEO TRANSMISSION



USING OPENHD FRAMEWORK TO USE WIFI ADAPTER FOR VERY LONG RANGE VIDEO TRANSMISSION.

(ADVANTAGES) : CHEAPER & ADVANCED FEATURES CAN BE ADDED (LIKE FUSED DATA LINKS , WIFI TETHERING , CONFIG FLEXIBILITY)

(DISAVANTAGES) : HARDER IN SOFTWARE COMPLEXITY

ALTERNATIVE :

TS832 Analogue video transmitter

ADVANTAGES :
1. PLUG AND PLAY
2. GOOD OUT OF THE BOX EXPERIENCE
3. INDEPENDENT OF PIXHAWK FLIGHT CONTROLLER
4. GOOD RANGE
5. CAN BE USED WITHOUT ANY SBC(RASPBERRY PI)

DISADVANTAGES :
1. HIGHER COST
2. CAN ONLY TRANSMIT VIDEO DATA
3. ITS A DUMB TX/RX MODULE (MEANING HARDER TO MODIFY AND ADD NEW FEATURES)

_0___CAMERA ??!!__0_/

ANYTHING IS OK !!!
As “LONG AS THEY HAVE A CSI OR USB OUTPUT”

SUMMARY

1. SINGLE ROTOR PROPULSION IS TECHNICALLY BETTER BUT FOR INITIAL DESIGN STAGE MULTIROTOR DESIGN IS BETTER DUE TO LACK OF MECHANICAL ENGINEERING EXPERTISE , DESIGN TIME , CONSTRUCTION CONSTRAINTS.

2. MINIMUM HARDWARE COMPONENTS REQUIRED FOR THE MINIMUM FUNCTIONALITY HAVE BEEN PRESENTED IN THIS PRESENTATION

3. THERE IS A TRADE OFF BETWEEN SOFTWARE ,HARDWARE COMPLEXITIES AND ECONOMICS , TIME FOR CONSTRUCTION AND MAINTAINANCE && FEATURES