New Mexico MFG Directories

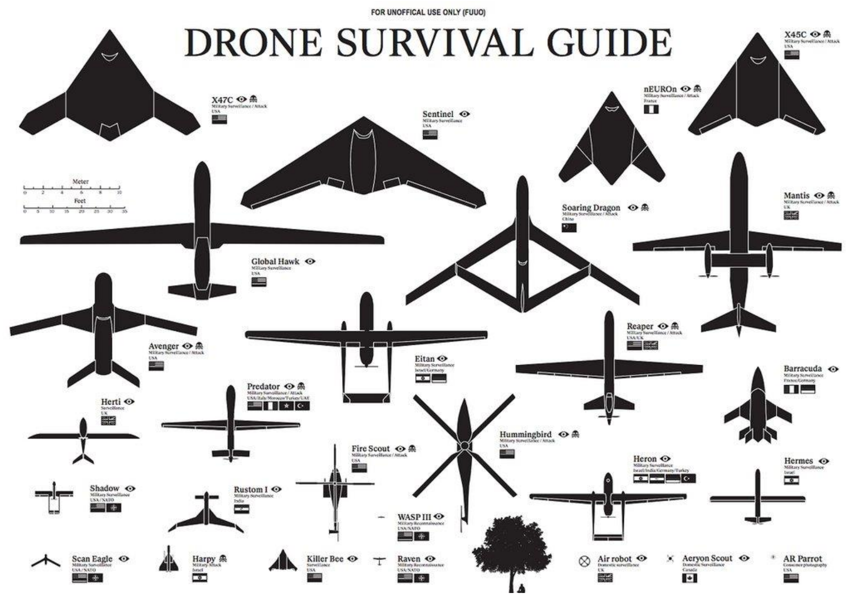
Drones Classification, Configurations, and applications

New Mexico MFG Directories

- MFG DAY Events
- New Mexico Made Companies (NM-MEP)
- New Mexico TRUE Certified Businesses (NMEDD)
- Aztec Chamber of Commerce Members
- Sandoval Economic Alliance Partners
- SkillsUSA New Mexico Partners
- WESST Client Directory
- Girl Scouts USA Partners
- Navajo Nation Manufacturing
- Manufacturers Marketplace (New Mexico Business Coalition)

Drones Classification and Configurations

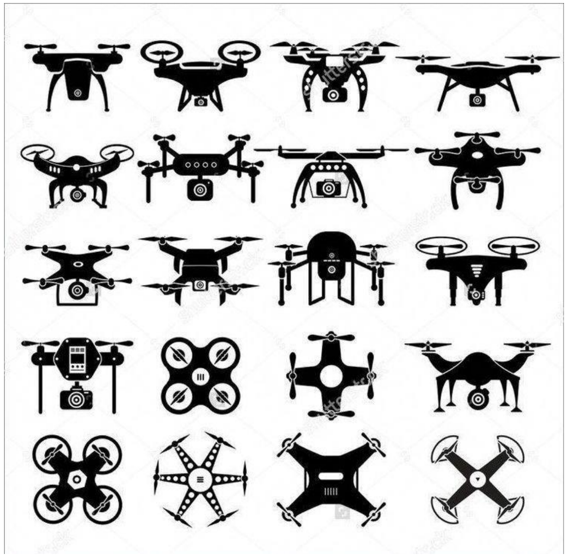
❖ Terminologies
- *Drones*
- *Unmanned Air/Aerial Vehicles (UAVs)*
- *Unmanned Air/Aerial Systems (UASs)*
- *Unmanned Aircraft System (UAS)*



➢ Unmanned Aerial Systems or drones that have many applications in both military and civilian sectors are attracting much attention.

➢ New unmanned vehicle concepts for different environments are being developed.

➢ Each of UASs exhibits certain advantages and disadvantages for deployment in particular missions and applications.

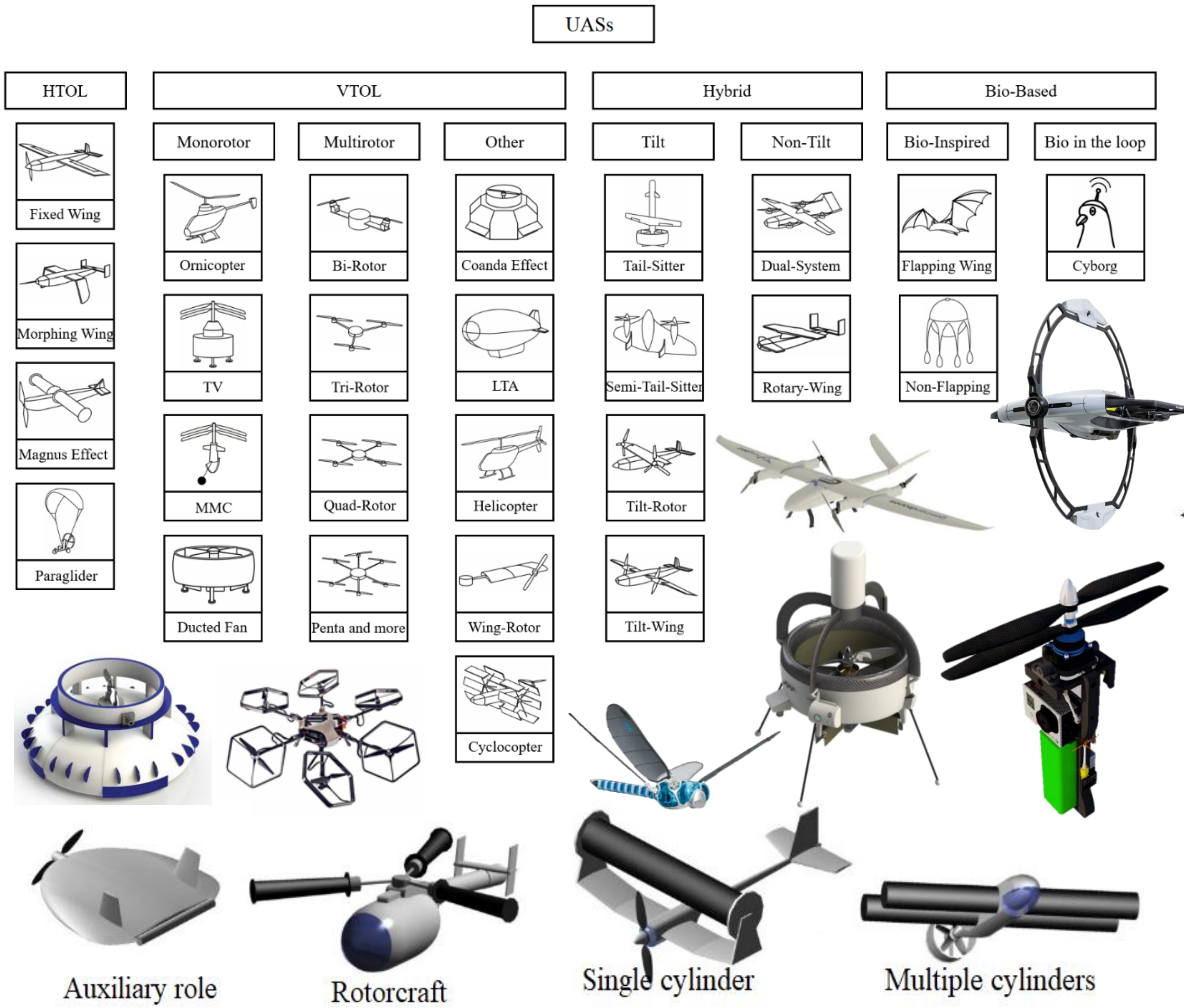


Advances in:
- Design process
- Manufacturing and materials
- Guidance, navigation, and control methods
- Power storage systems

→ **Development of a wide range of drones**

Background & motivation

❖ Classification of Drones

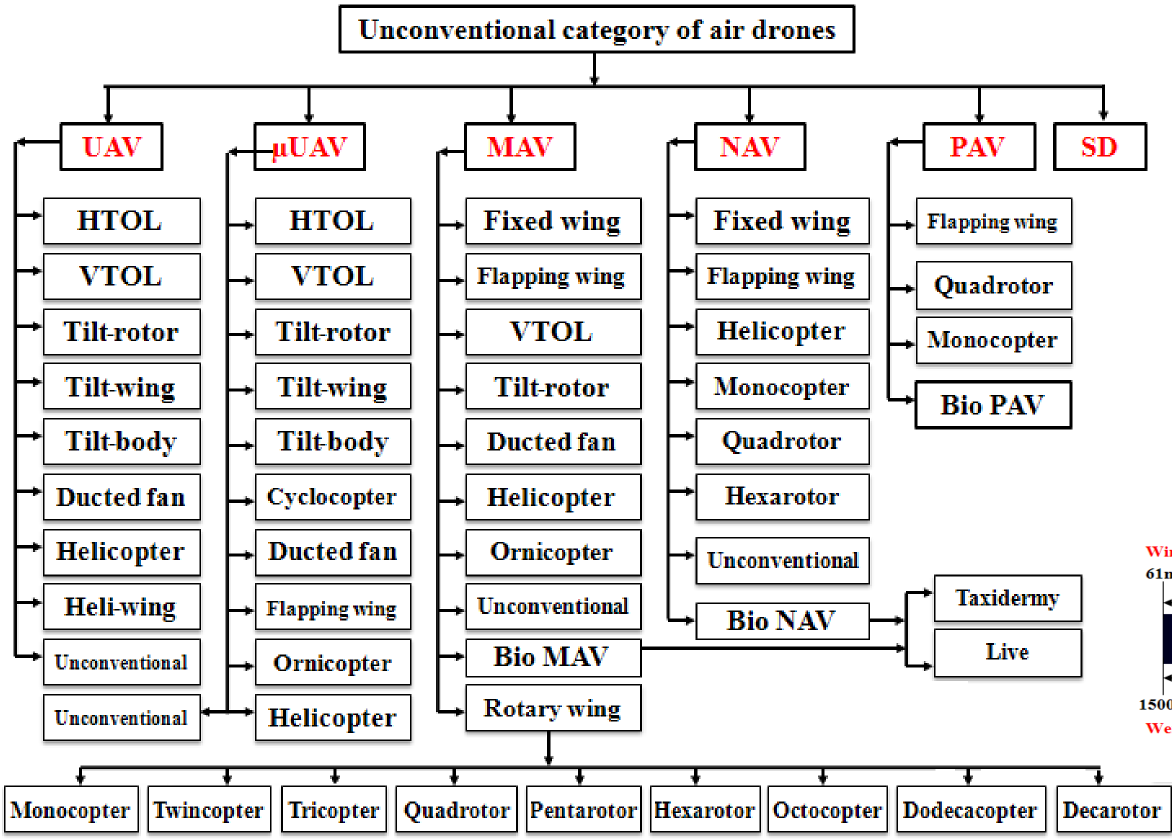


- HTOL
  - Fixed_wing
  - Morphing wing
  - Magnus_effect
  - Paraglider
- VTOL
  - Monorotor
    - Ornicopter
    - Thrust vectoring
    - Moving mass controlled
    - Ducted fan
  - Multirotor
    - Bi_rotor
    - Trirotor
    - Quadrotor
    - More than four rotors
  - Coanda_effect
  - Lighter than air
  - Helicopter
  - Wing_rotor
  - Cyclocopter
- Hybrid
  - Tilt
    - Tilt_body
      - Tail_sitter
      - Semi tail_sitter
    - Tilt_components
      - Tilt_rotor
      - Tilt_wing
  - Non_Tilt
    - Dual_system
    - Rotary_wing
- Bio_based
  - Bio_inspired
    - Flapping_wing
    - Non flapping_wing
  - Bio in the loop
    - Birds
    - Insects

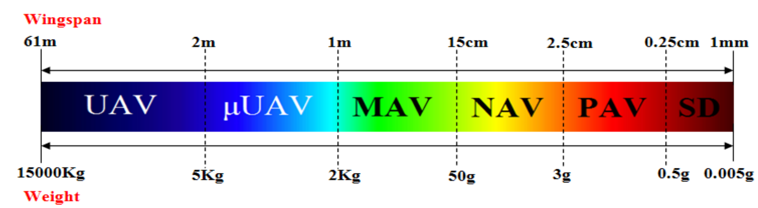
Darvishpoor, S., Roshanian, J., Raissi, A. and Hassanalian, M., 2020. Configurations, flight mechanisms, and applications of unmanned aerial systems: A review. *Progress in Aerospace Sciences*, 121, p.100694.

Drones Classification and Configurations

- Classification of Drones
  - New classification of drones based on weight

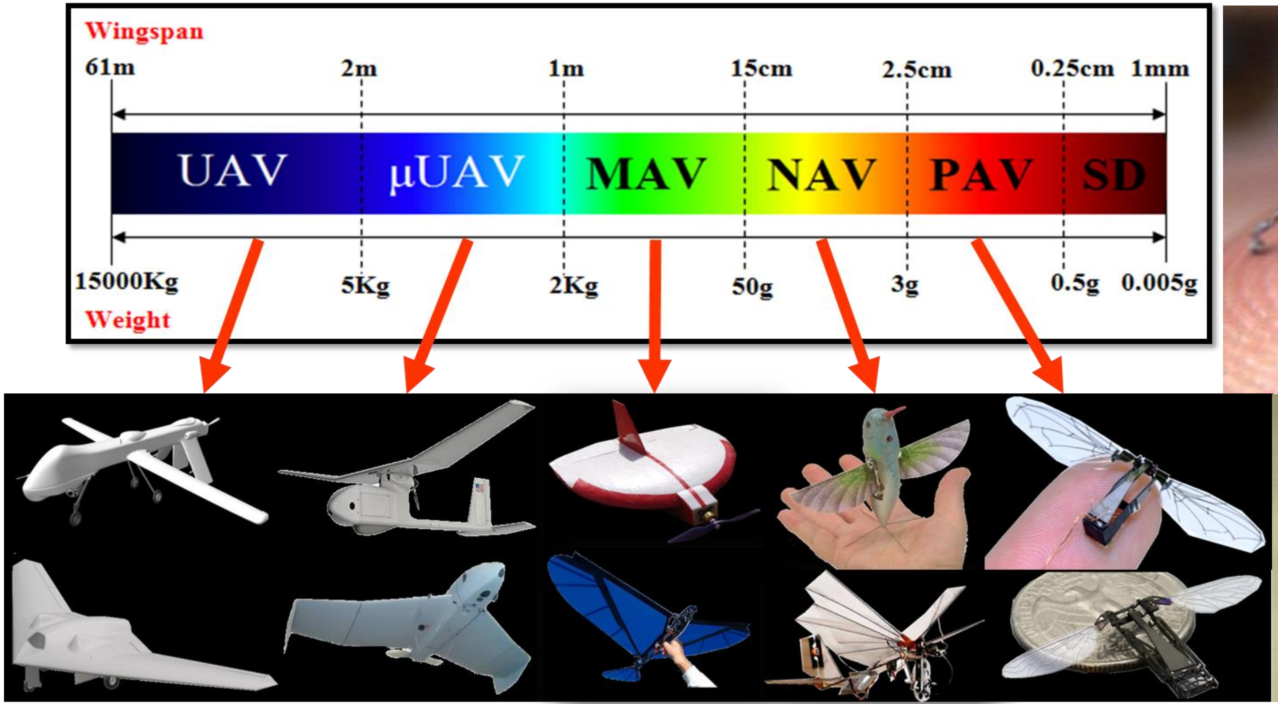


Class	Weight Range	Wing Span Range
UAV	5 - 1500 kg	**2 - 61 m**
UAVµ	2 - 5 kg	**1 - 2 m**
MAV	50 - 2000 g	**15 - 100 cm**
NAV	3 - 50 g	**2.5 - 15 cm**
PAV	0.5 - 3 g	**0.25 - 2.5 cm**
SD	0.005 - 0.5 g	**1 - 2 mm**



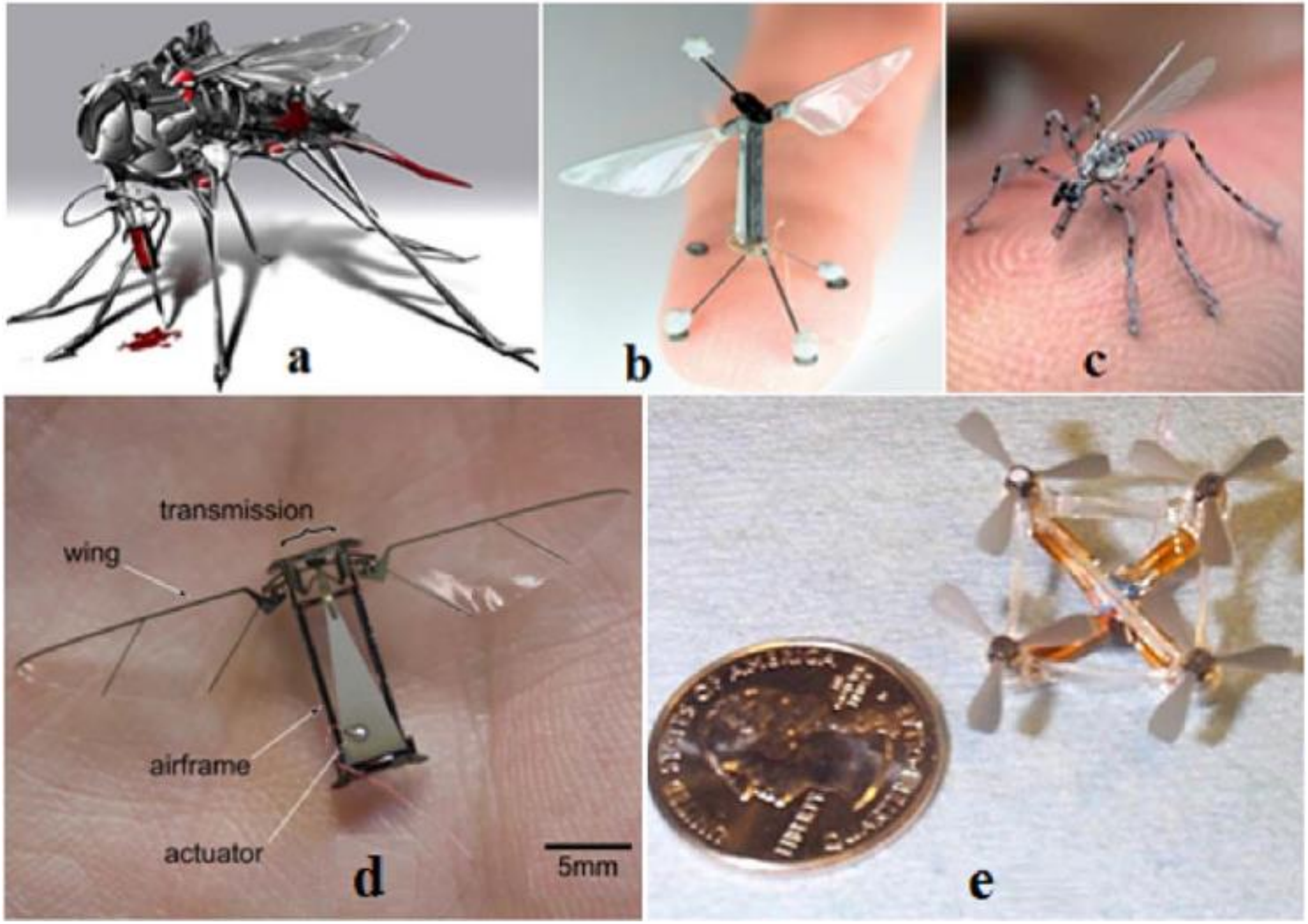
Drones Classification and Configurations

❖ Classification of drones

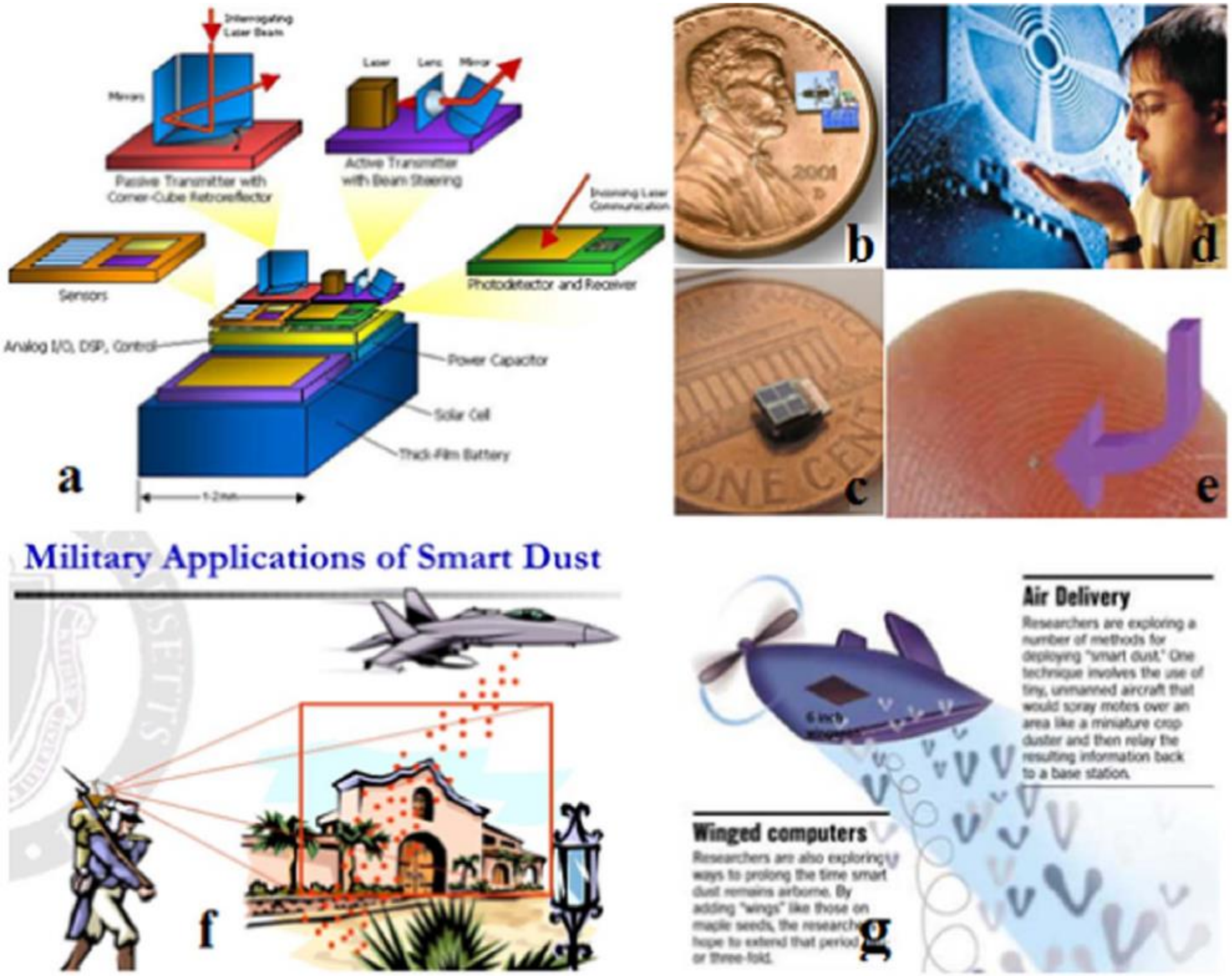


Drones Classification and Configurations

❖ **Different types of PAVs**



❖Smart dust


Passive Transmitter with Corner-Cube Retroreflector
Active Transmitter with Beam Steering
Sensors
Photodetector and Receiver
Analog I/O, DSP, Control
Power Capacitor
Solar Cell
Thick-Film Battery
a
b
c
d
e
Military Applications of Smart Dust
f
Air Delivery
Researchers are exploring a number of methods for deploying "smart dust." One technique involves the use of tiny, unmanned aircraft that would spray motes over an area like a miniature crop duster and then relay the resulting information back to a base station.
Winged computers
Researchers are also exploring ways to prolong the time smart dust remains airborne. By adding "wings" like those on maple seeds, the research hope to extend that period or three-fold.
g

Drones Classification and Configurations

❖ Horizontal Takeoff and Landing UASs

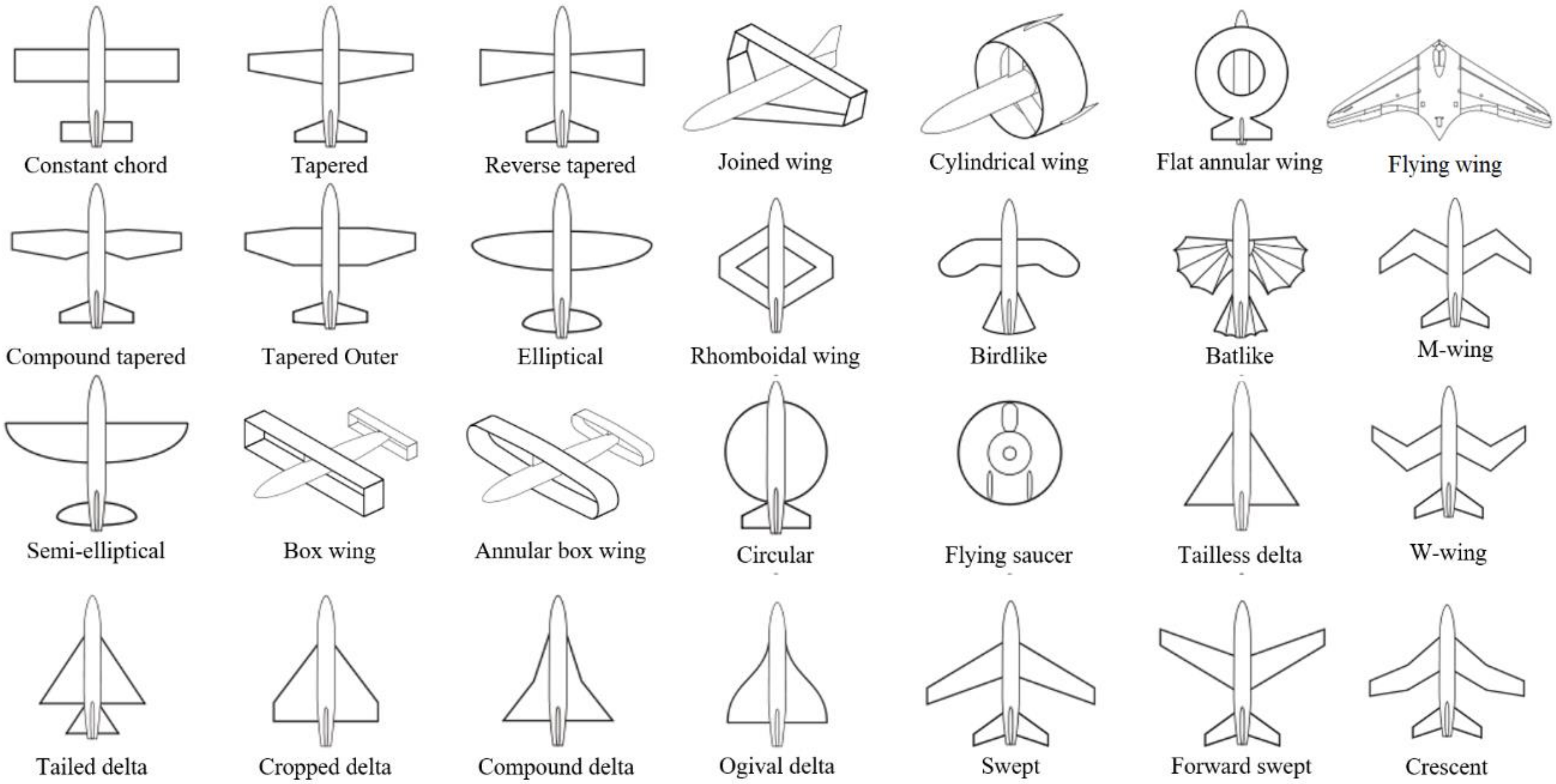
- Generally, the HTOL unmanned aerial systems need a runway to take off or require to travel a horizontal route to reach the necessary minimum takeoff speed.
- This requirement can be satisfied by utilizing engines and rotors or by employing an initial external thrust, such as catapult-launched UASs.
- Moreover, the landing maneuver for these UASs is often done horizontally.

Drones Classification and Configurations

❖ Horizontal Takeoff and Landing UASs

➢ **Fixed-wing UASs**

- Fixed-wing classification is applied to classical UASs that use their wings to generate lift.
- Fixed-wing drones can have different wing designs and even more than one pair of wings depending on the mission.



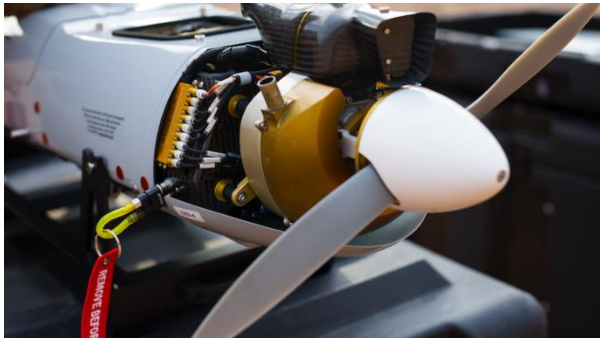
Drones Classification and Configurations

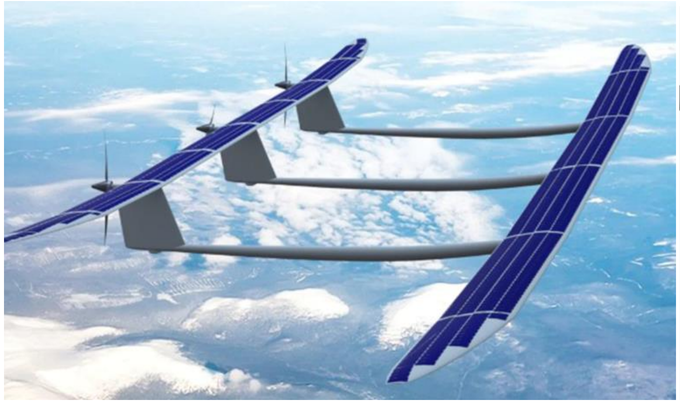
❖ Horizontal Takeoff and Landing UASs

➢ **Fixed-wing UASs**

Fixed-wing UASs are very simple structurally and able to use different propulsion systems:

- Fuel engines
- Solar and battery-powered electric motors





Drones Classification and Configurations

❖ Horizontal Takeoff and Landing UASs

➢ **Fixed-wing UASs**

Fixed-wing UASs can be designed in different sizes and classes:

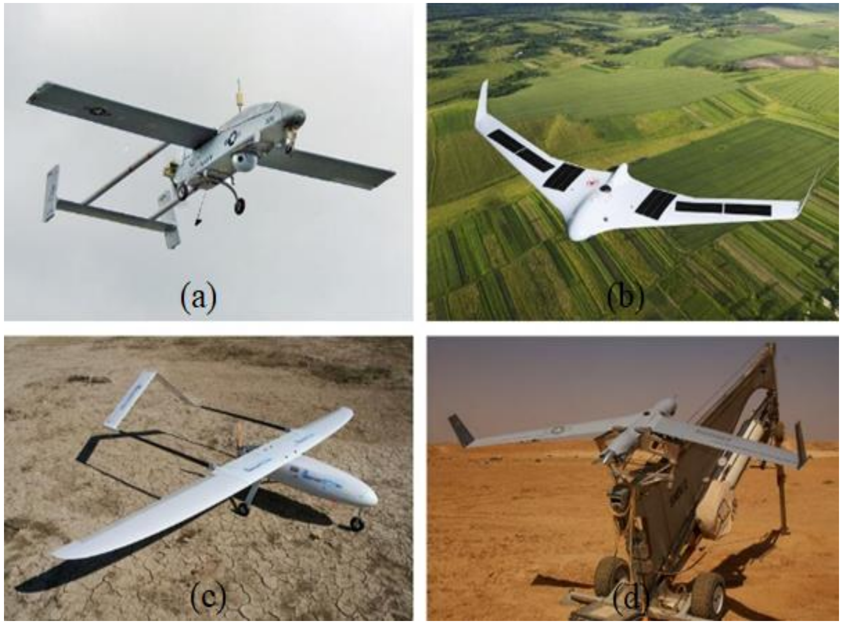
- Unmanned Air Vehicle (UAV)
- Micro Air Vehicle (MAV)
- Nano Air Vehicle (NAV)

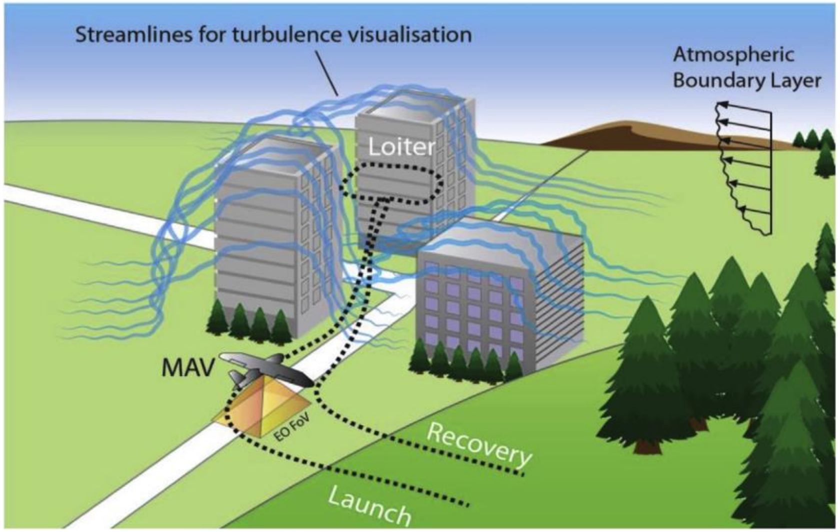
Drones Classification and Configurations

❖ Horizontal Takeoff and Landing UASs

➢ **Fixed-wing UASs**

- Fixed-wing UASs can fly over a wide range of altitudes and distances.
- They need a runway for taking off and landing, and unlike VTOLs, they usually cannot perform a hovering flight because of their low thrust to weight ratio.
- The way of hovering flight in fixed-wing UASs may not be so applicable due to the high pitch angle.
- Even with shortcomings, fixed-wing UASs are the most widely used drones, and several thousand of them have been built and flown around the world.





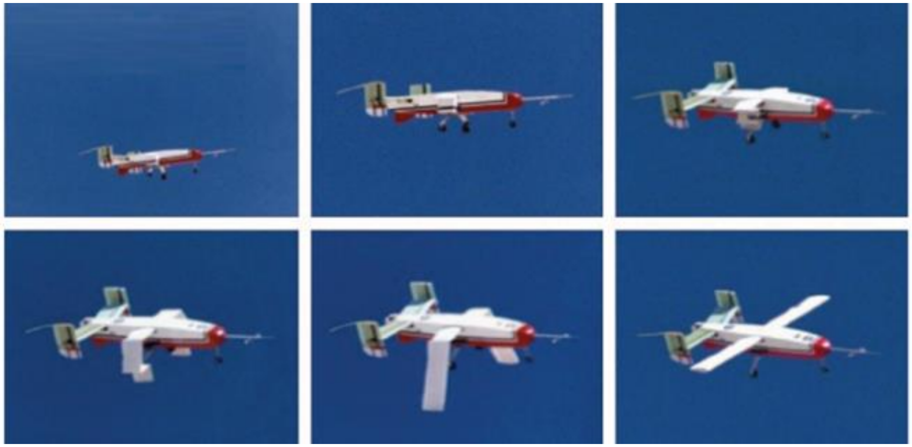
Drones Classification and Configurations

❖ Horizontal Takeoff and Landing UASs

➢ **Morphing-wing UASs**

- The Morphing-wing UASs use a similar flight mechanism to the fixed-wings, except that depending on the flying regime or other conditions, their wings can change to a different form.

- This change can occur in the wings' specifications:
  - ➢ Sweep-back
  - ➢ Sweep-forward angle
  - ➢ Changing the airfoil shape
  - ➢ Increase and decrease in the chord and wingspan



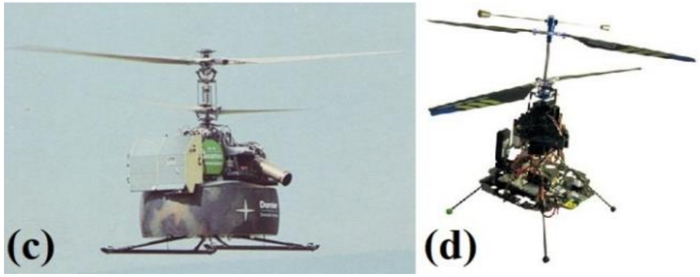
Drones Classification and Configurations

- Horizontal Takeoff and Landing UASs
  - **Magnus-effect UASs**

Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Thrust vectoring**



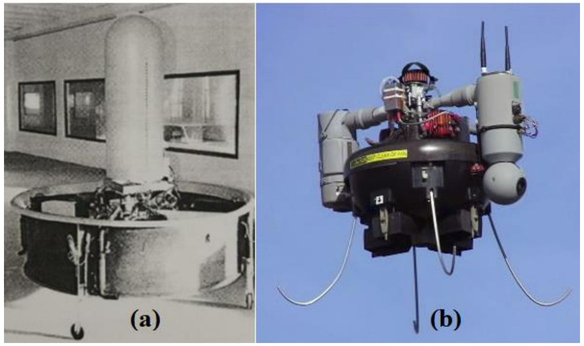
- This group of UASs often are made of a brushless motor, which is simultaneously able to produce clockwise (CW) and counter-clockwise (CCW) rotation.
- Two CW and CCW blades are used in this type of UASs to produce the required lift while do not generate any gyroscopic and reaction torque.
- In thrust vectoring drones, the motor is often mounted on a servo motor actuator, which can tilt it in different directions.
- The change in the thrust vector enables the longitudinal and lateral motion, and by changing the speed of the rotors, it is possible to have a motion in the yaw axis.
- It is also possible to use swash-plate instead of servo mechanism to build coaxial helicopters.

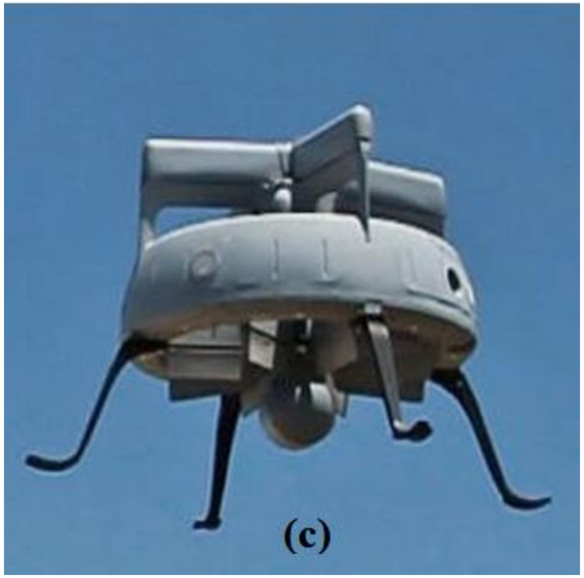
Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Ducted-fan UASs**

- This class of drones consists of a duct with a fan (or propeller) that controls the vehicle using control surfaces embedded at the end of the duct.
- This type of drone can also be categorized as tail-sitters; however, they are classified in this category since their flight relies on their propellers only, and they do not use wings or canards.
- The thrust required for these drones is provided by a fan or propeller and sometimes by a coaxial fan or propeller.
- Several fins are incorporated into the fan outlet that drives the vehicle by guiding the airflow.
- Landing and takeoff maneuvers are possible with an increase or decrease in fan or propeller speed.



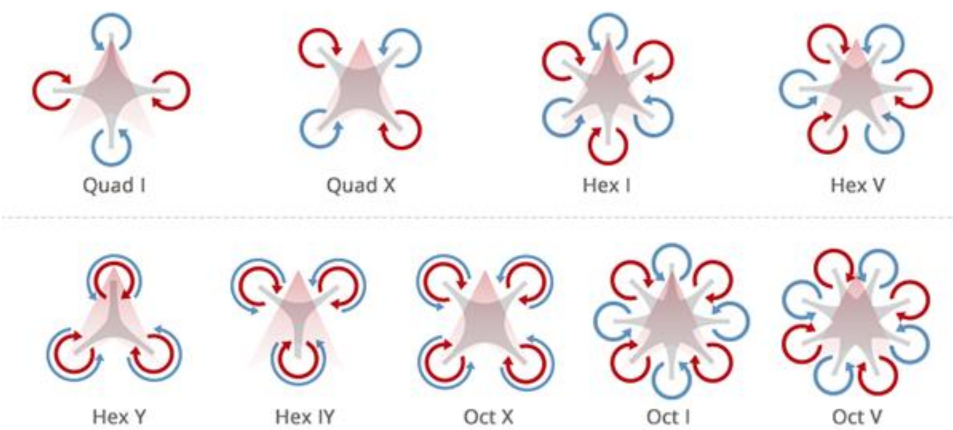


Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Multirotors UASs**

- Multirotors UASs consist of two or more rotors and propellers.
- The flight mechanism of these drones is based on the generation of lift by propellers.
- These drones are controlled by altering the speed of the rotors.
- Among multirotors drones, quadrotors are very popular, and over thousands of them have been built over the past few decades because of their ease of construction and control.



Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Quadrotors**

- Quadrotors have gained popularity among drones designers because of their ease of construction and control.
- A common set of quadrotors are made with fixed rotors.
- The motors in quadrotors rotate in pairs opposite to each other to counteract the reaction torque caused by the rotation of the motor and the propellers.
- This vehicle moves in such a way that the two propellers facing each other rotate in the same direction and opposite to the other couple propellers (their pitch is opposite to that of the other two propellers).

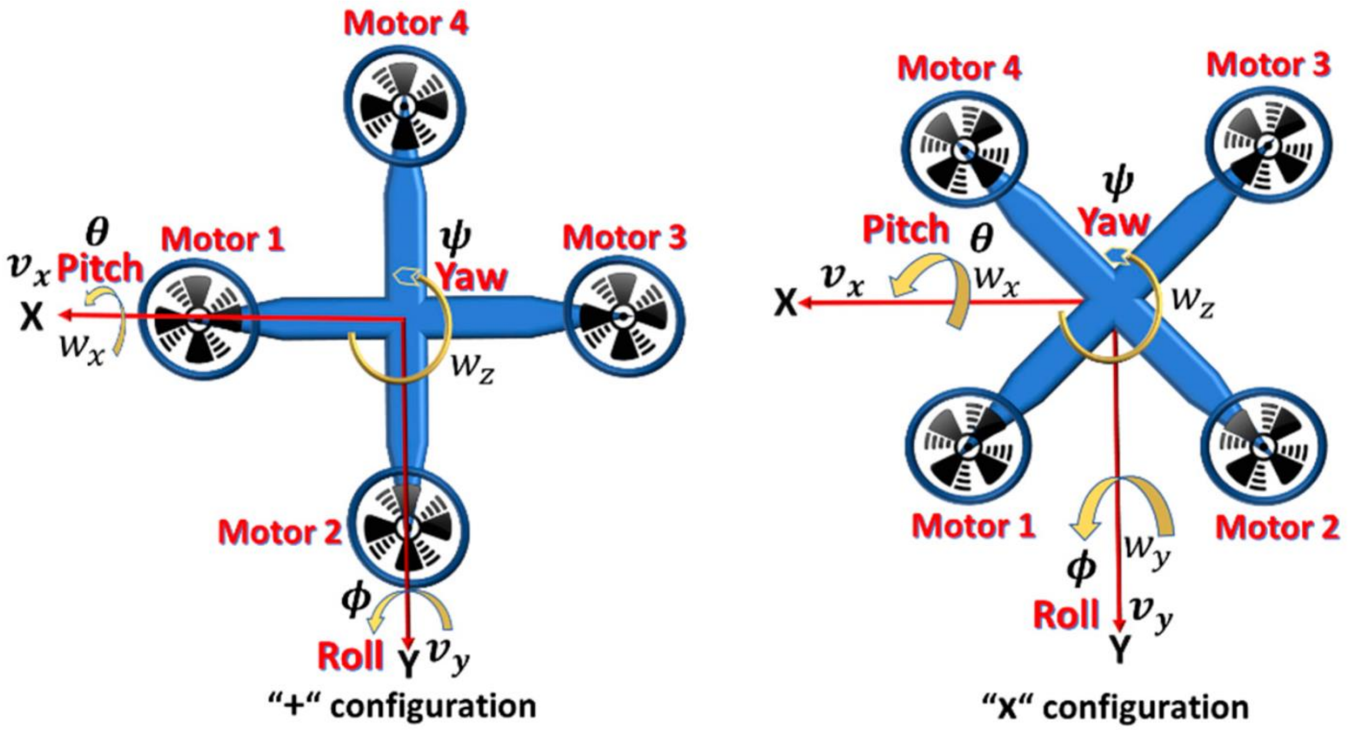
Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Quadrotors**

- 45-degree rotation of quadcopter around the z-axis creates another common structure of this type of drone, which is called X structure.

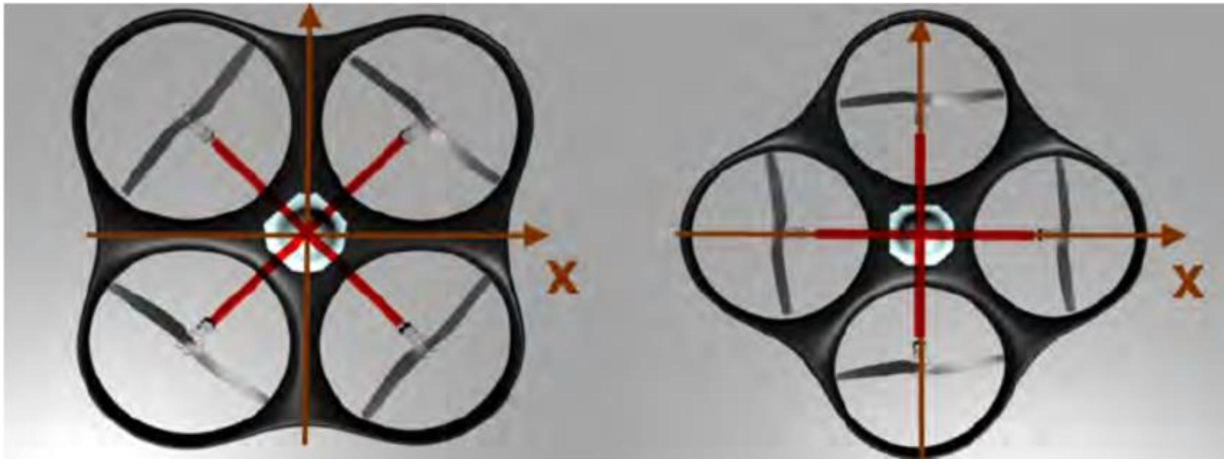
- X structure also flies in the similar way as the (+) structure.



Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Quadrotors**



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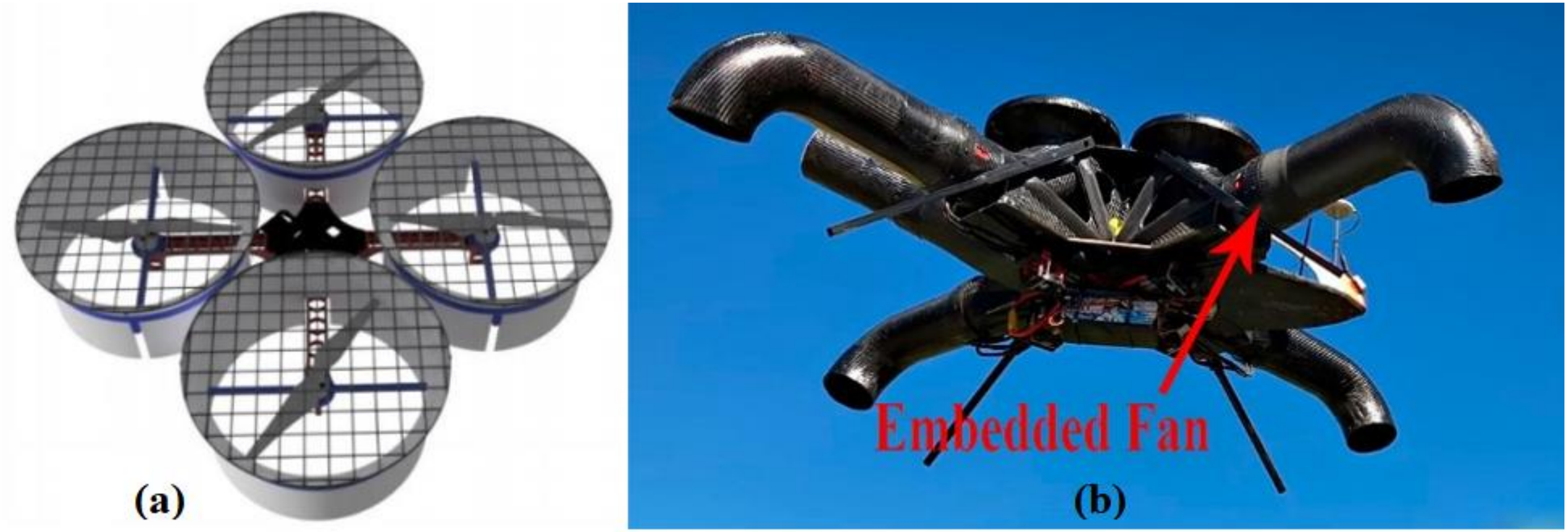
Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Quadrotors**

- Some researchers have developed a ducted quadrotor drone with embedded fans, which increases safety and makes it appropriate for daily use, specifically in urban environments.



Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Coaxial quadrotors**

- There are also some configurations of quadrotors that are made coaxially.
- In this type of drone, eight rotors are arranged coaxially coupled in the form of a quadrotor.

- The performance of this drone is similar to that of quadrotors, except that there must be a $\Delta\omega$ decrease or increase in rotational speed of coupled coaxial motors so that their rotation around their common axis generates torque.
- The flight mechanism and the dynamic modeling of this configuration of drones are similar to the quadrotors.

Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Tilt-rotor quadrotors**

- Like mono-rotors and other multirotors, quadrotors have also been developed with tilt-rotor structure. Unlike fixed-rotors, these types of quadrotors are mounted on a mechanism that enables them to be tilted.

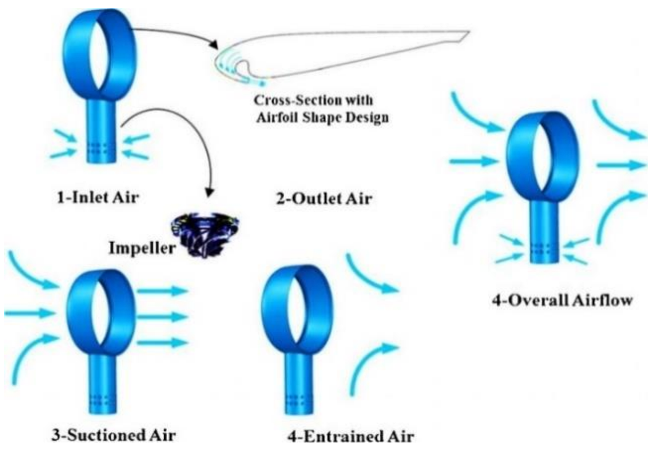
- The overall flight mechanism of this type of drone is generally similar to quadrotors; however, thrust vectoring may be used for pitch maneuver rather than an increase or decrease in motors speeds.

- In these drones, like other tilt-rotors, the motors are driven by servo motors. Generally, the tilt-rotor quadcopters have higher maneuverability and efficiency; however, they have more complex control and dynamics compared to quadrotors.

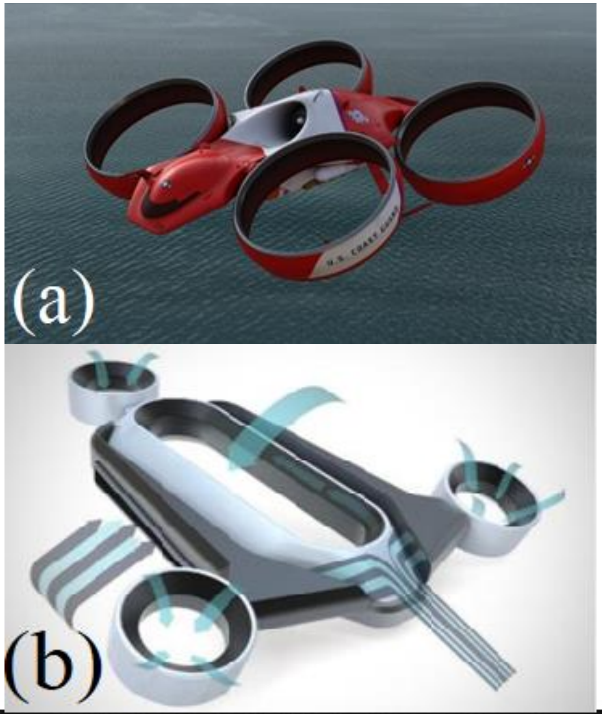
Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Quadrotors (Dyson fan)**



- For quadrotors, some unexplored ideas based on the use of the Dyson fan have been proposed by researchers.
- Dyson fan was patented in 2009 by a designer under the same name.
- In this type of fan, a compressor guides the air to a ring. The curve of the ring is designed in such a way that air flows over it and continues horizontally.
- Dyson fan has high noise pollution and low efficiency. For this reason, the idea of designing an unmanned aerial vehicle based on the Dyson fan has not yet materialized.
- Due to the increasing safety of UASs with removing the propellers and the proper maneuverability and hovering capability of quadrotors, combining a quadrotor with a Dyson fan can be very suitable for urban spaces.



Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Quadrotors (Dyson fan)**

Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Penta-rotor and Higher**

- The flight mechanism of multirotors having more than four rotors is similar to those of the previous four categories.

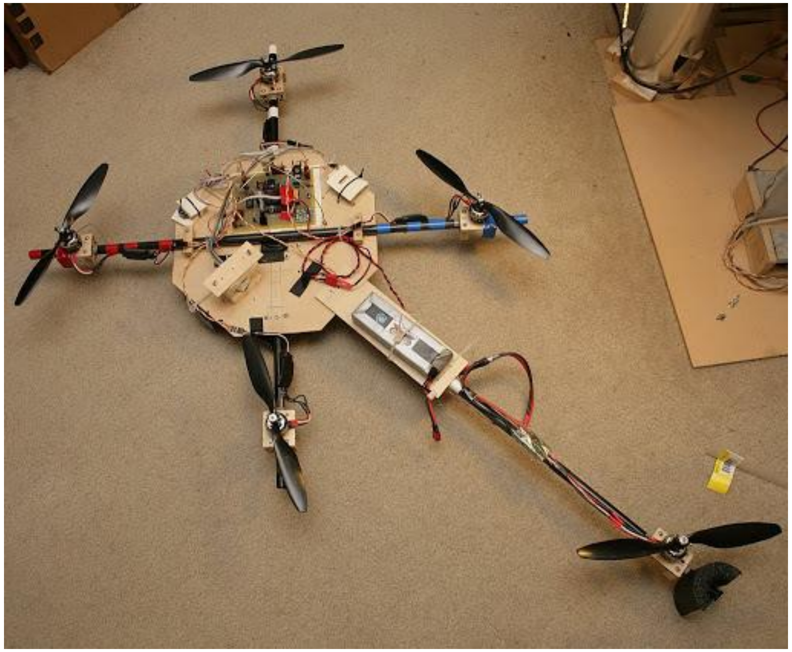
- Reaction torque is not considered a problem for drones with even rotors; however, a similar approach is used for drones with odd rotors as introduced for a mono-rotor or tri-rotor drone.

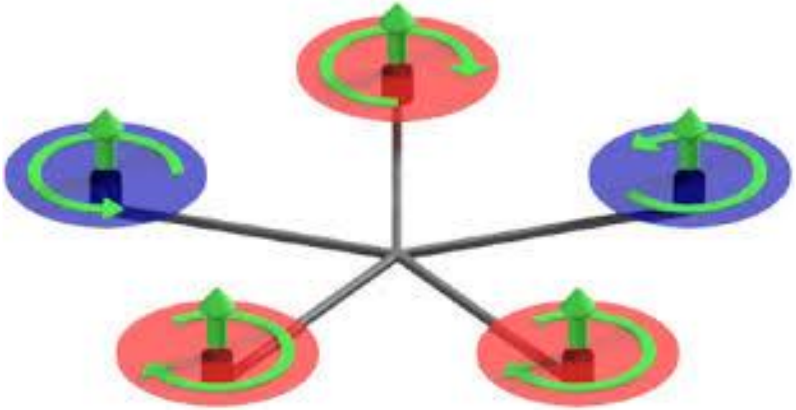
Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Penta-rotor and Higher**

- Compared to other multirotors, using more than four rotors increases the payload capacity, dynamics complexity, and energy consumption.
- Even though having multiple rotors increases drones' safety in the case of motor failure, they are less efficient compared to drones that use fewer rotors with equal propeller area.
- While UASs with an even number of rotors do not need any extra mechanism, the UASs with odd rotors may need additional mechanisms to counteract the sole rotor's reaction torque.
- Using more rotors makes the control algorithms more complex.

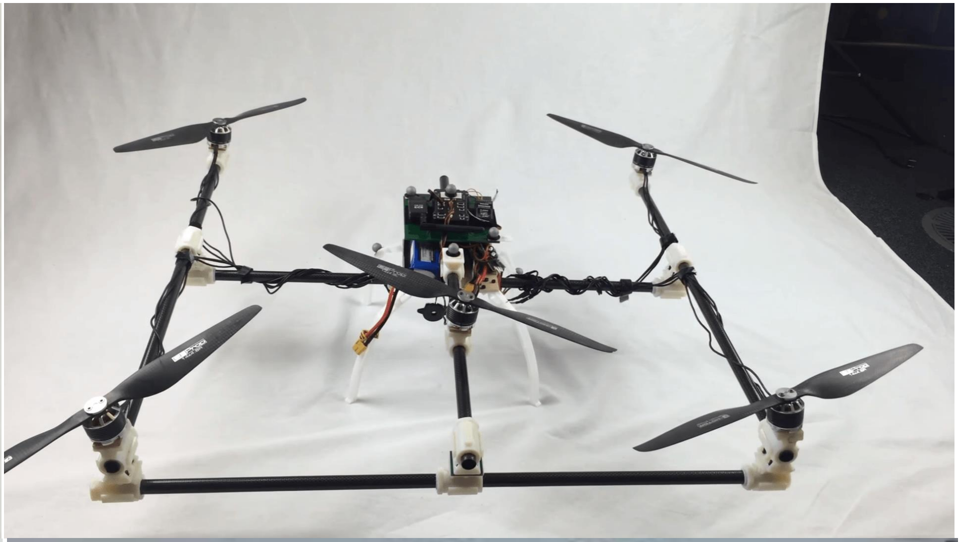




Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Penta-rotors**



Drones Classification and Configurations

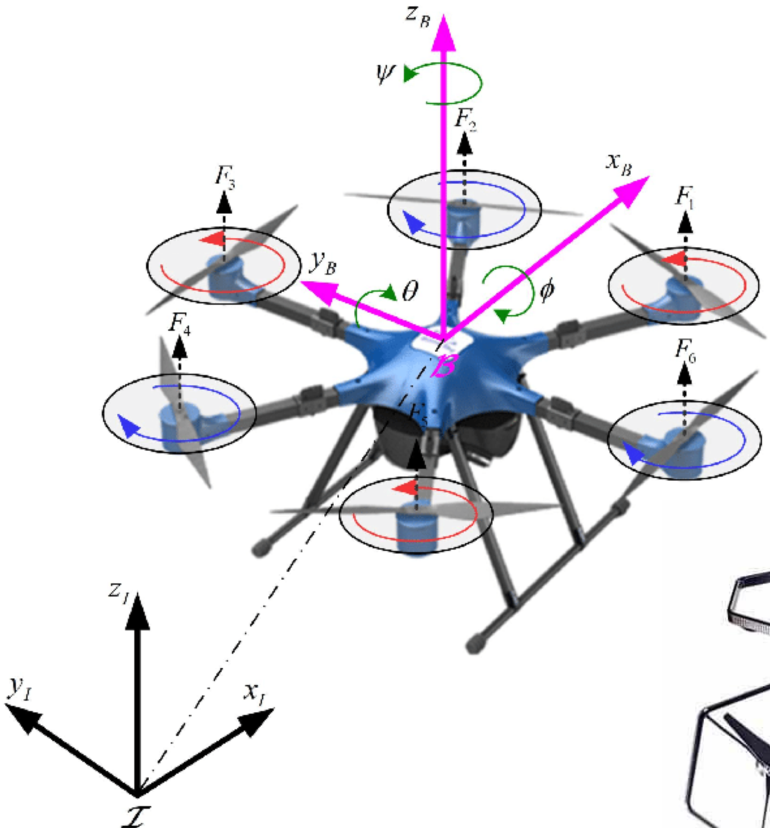
❖ Vertical Takeoff and Landing UASs

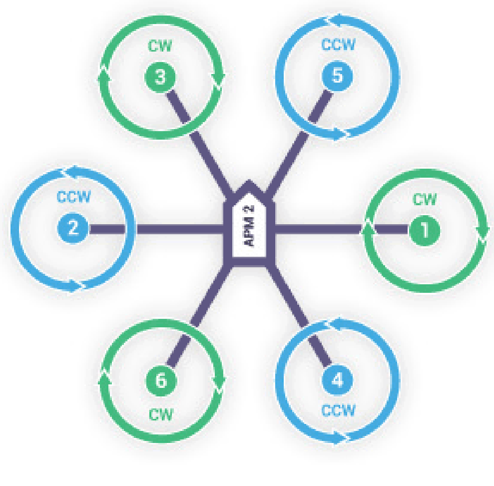
➢ **Penta-rotors**

Drones Classification and Configurations

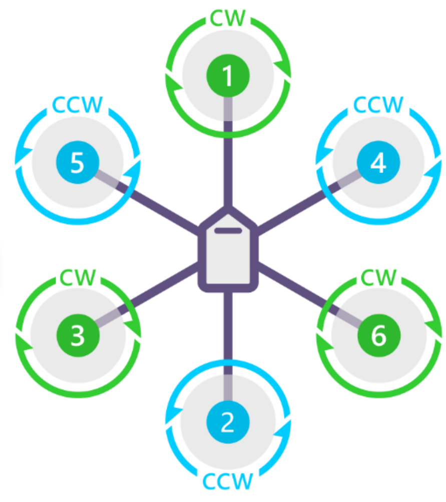
❖ Vertical Takeoff and Landing UASs

➢ **Hexa-copters**





HEXA X

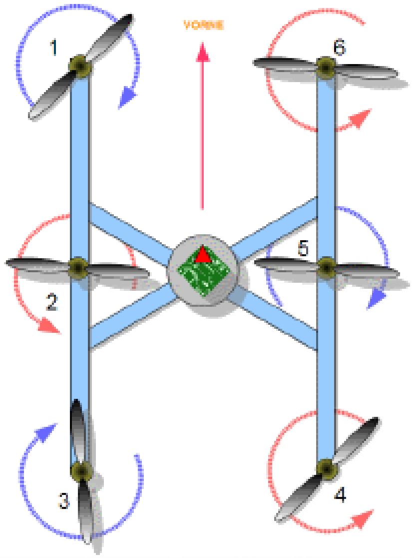


HEXA+

Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

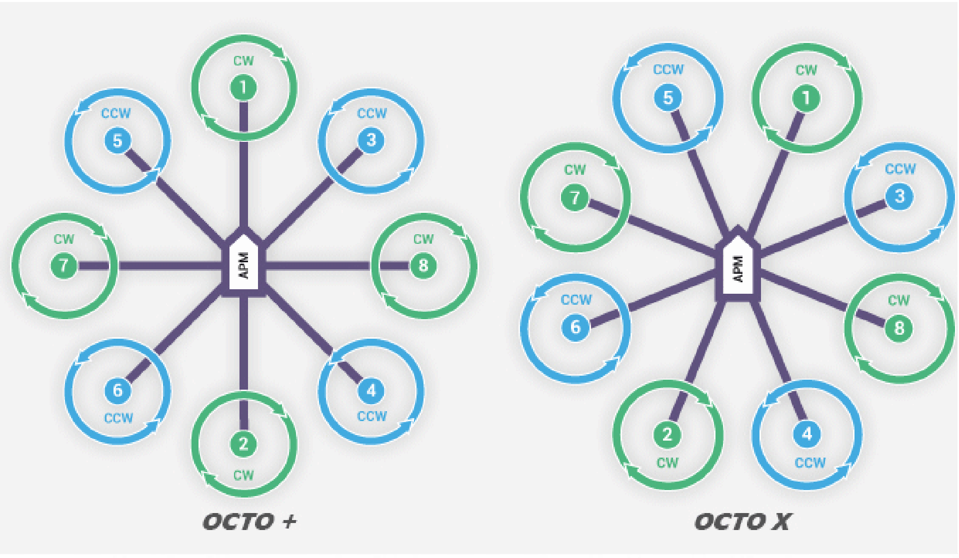
➢ **Hexa-copters**

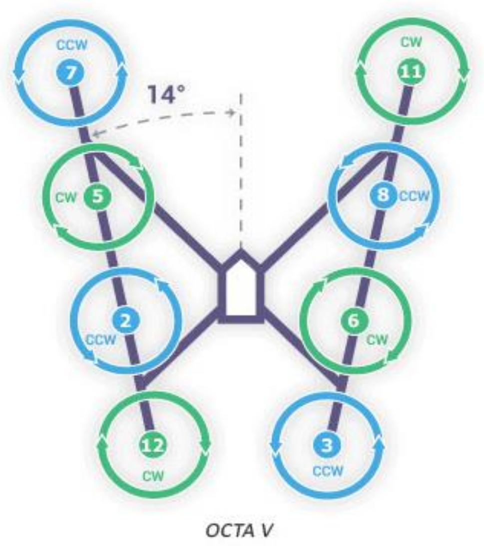


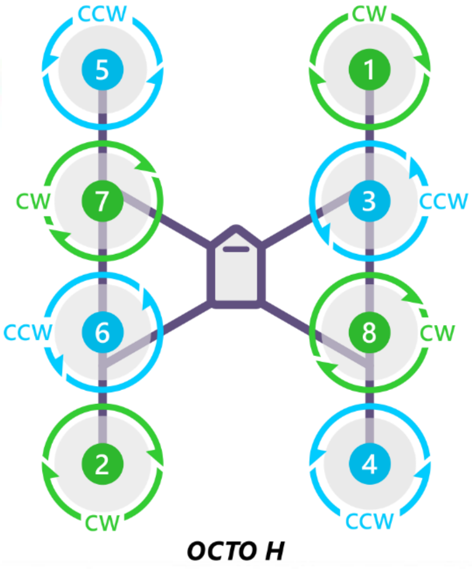
Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Octocopters**







Drones Classification and Configurations

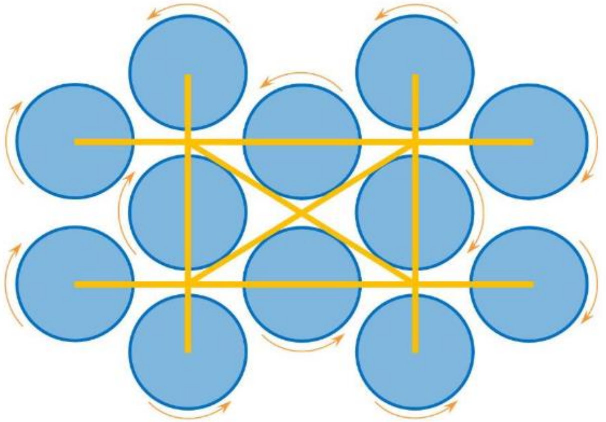
❖ Vertical Takeoff and Landing UASs

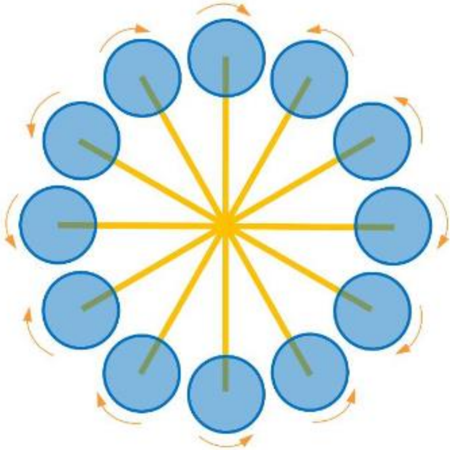
➢ **Octocopters**

Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Dodecacopter**

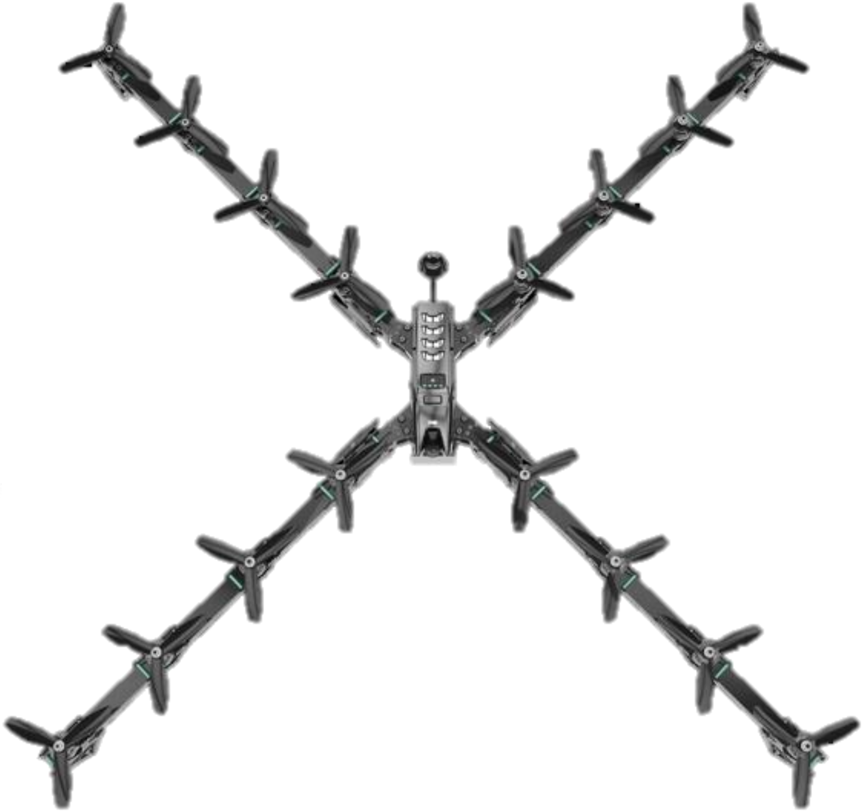




Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

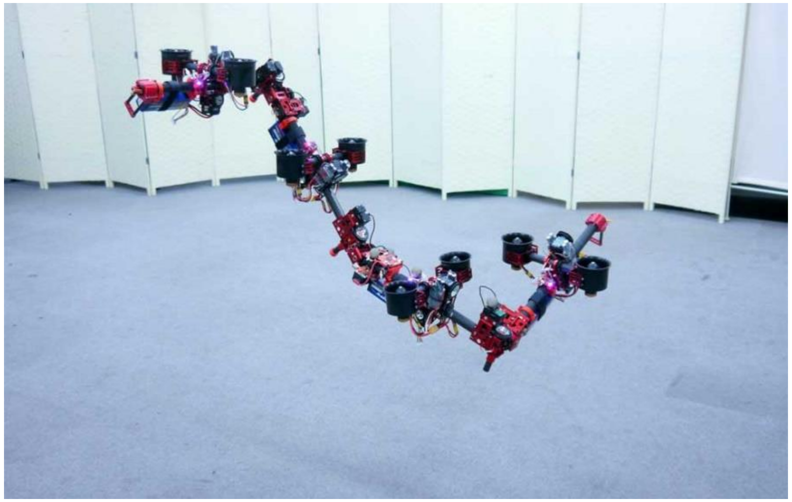
➢ **Multirotors**

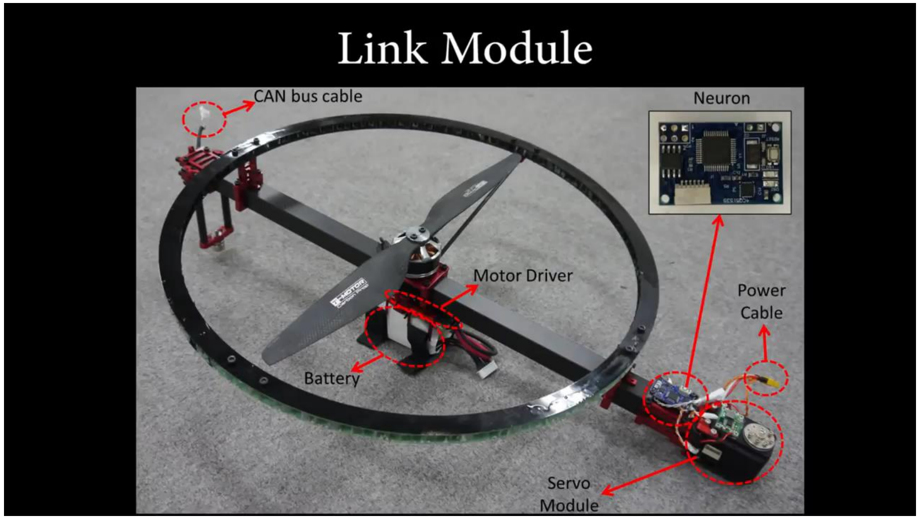


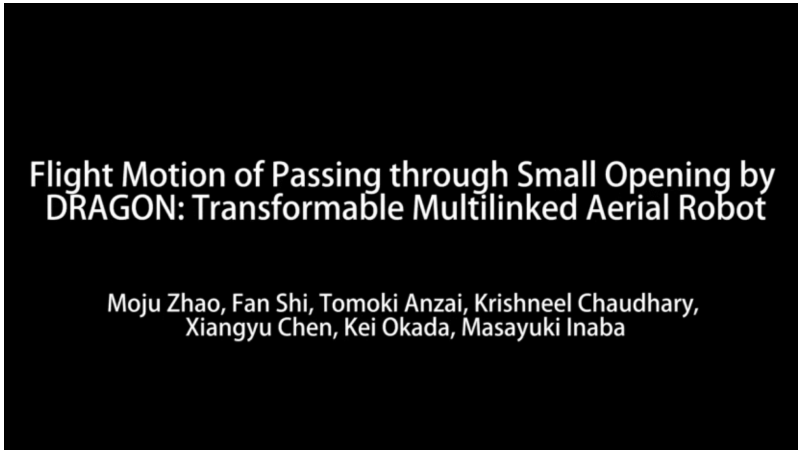
Drones Classification and Configurations

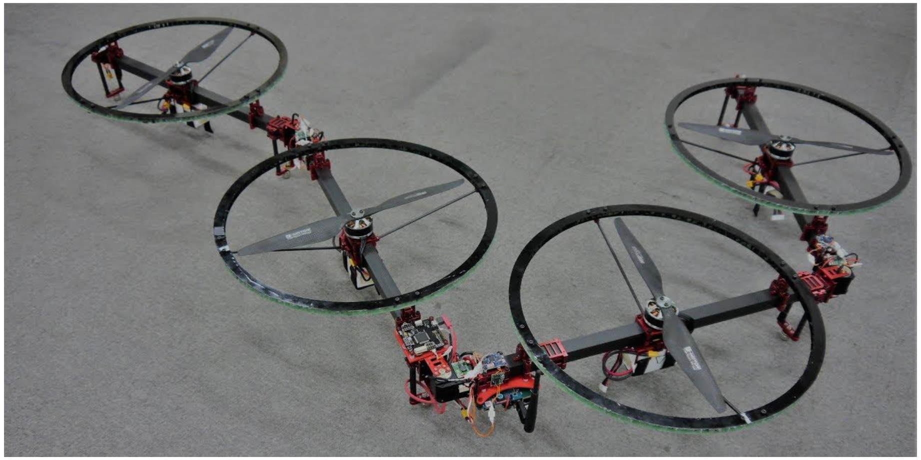
❖ Vertical Takeoff and Landing UASs

➢ **Transformable Multirotor**









Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ Coanda-effect UASs

- The Coanda effect that is described by Henri Coanda in 1932 is the tendency of flow to stay attached to a convex surface.

- In Coanda-effect UASs, passing flow through the surface leads to a static pressure drop that will create a lift force.

- The first dome-shaped UAS was developed by Collins in 2002 that was called Coanda UAV.

Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

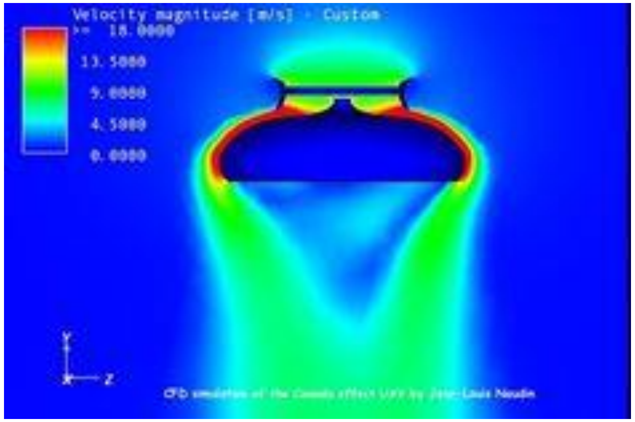
➢ **Coanda-effect UASs**

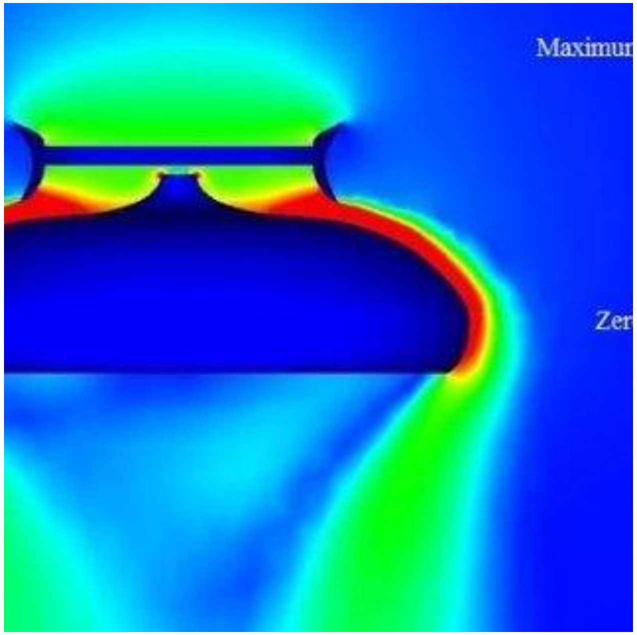
- In this kind of drone, generally, a propeller sucks the air into the duct installed on the upper part of UAS and then guides the high-speed airflow over its surface.

- This high-speed airflow through this convex surface is accelerated and causes a static pressure drop, which forms the major part of the lift force for flight.

- To avoid rotation of this UAS, some fixed fins are implemented on the outer surface of the body, which changes the airflow direction.

- This creates a torque that is in the opposite direction of the torque generated by blades.

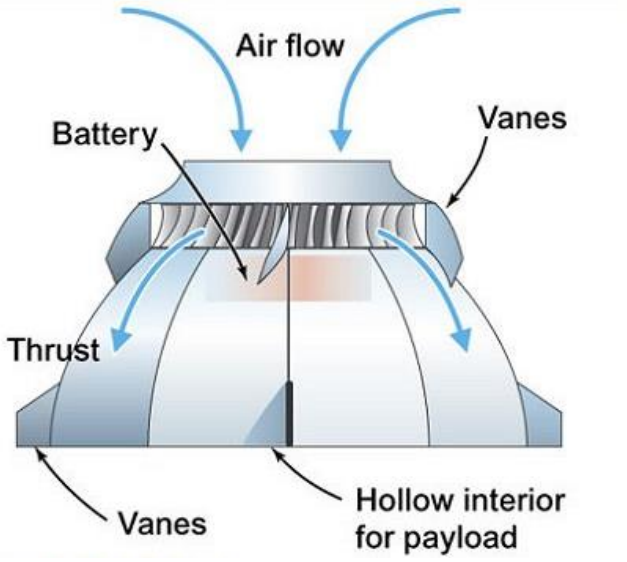


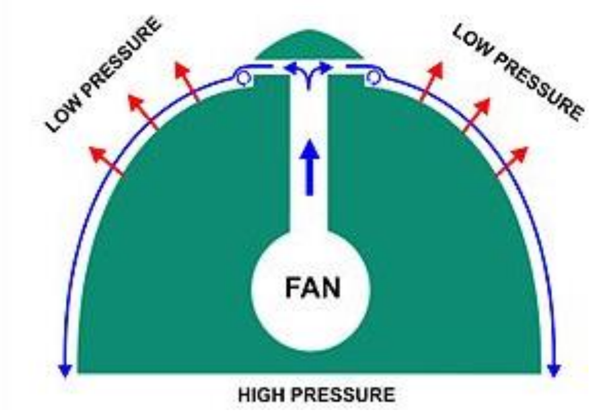


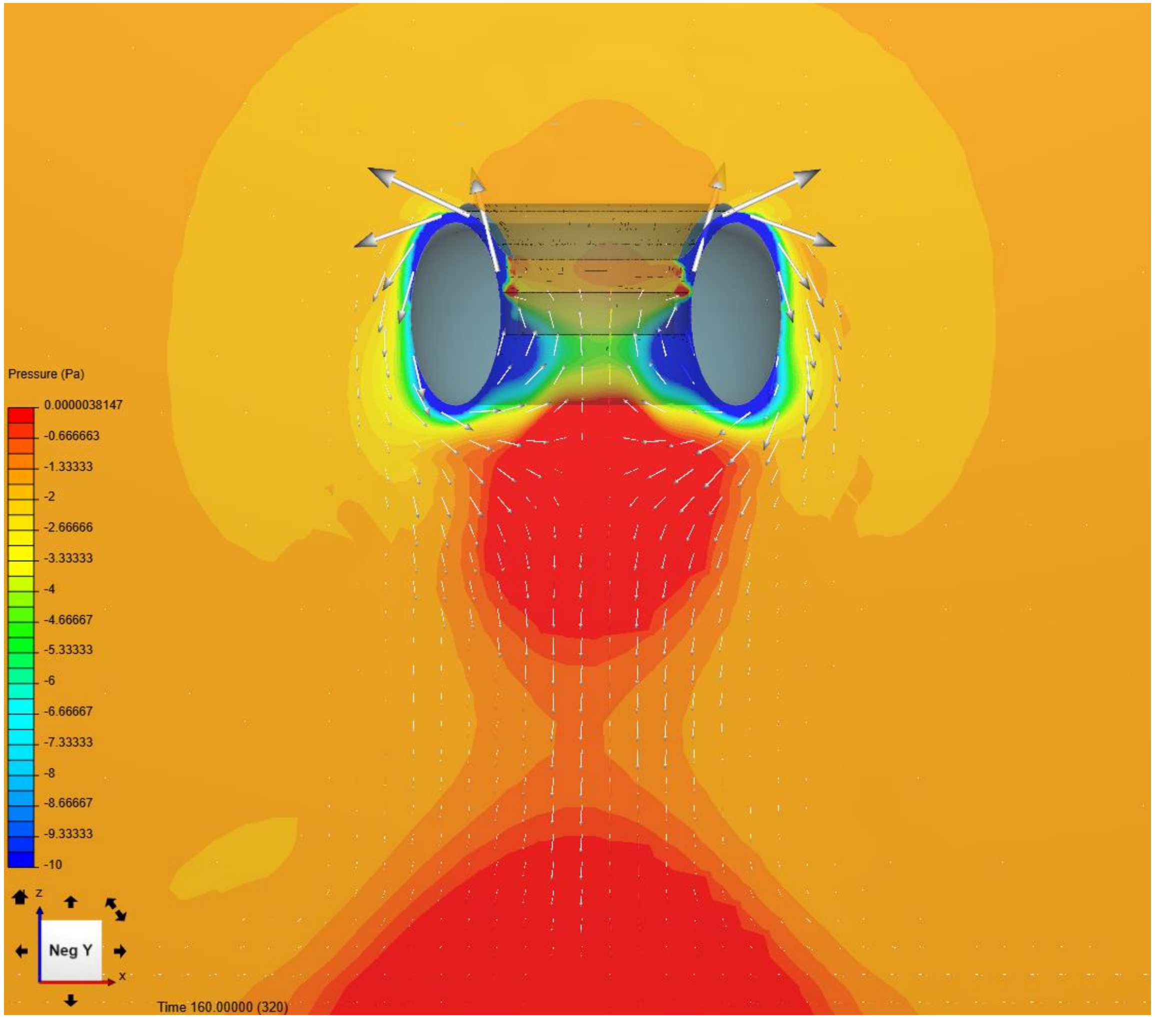
Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Coanda-effect UASs**







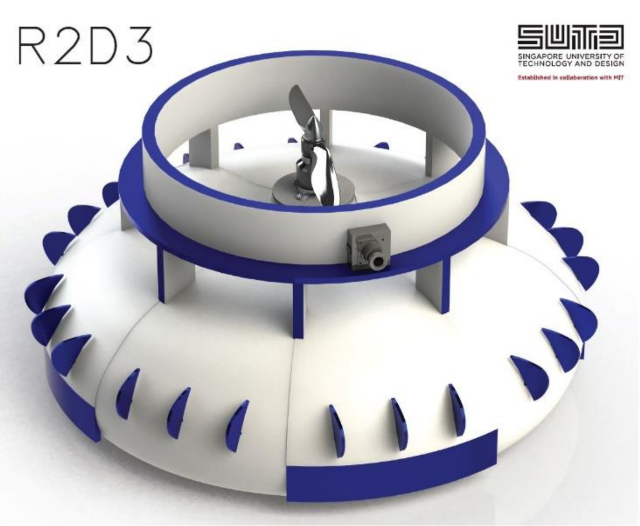
Drones Classification and Configurations

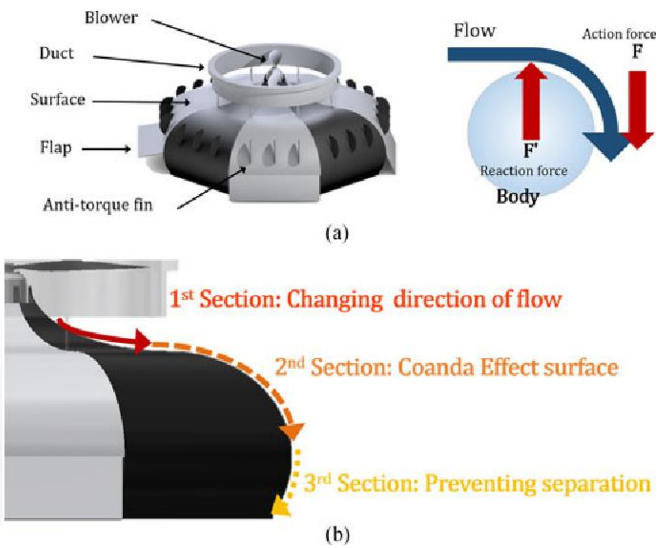
❖ Vertical Takeoff and Landing UASs

➢ **Coanda-effect UASs**

- In order to control the UAS, a number of moving control surfaces are added to its body that can be used for controlling the drone.

- In these UASs, there are some controllable stabilizing fins that can be used for directional control around the yaw axis.





Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Coanda-effect UASs**

Coanda-effect Drone Propulsion

Coanda-effect in hovercraft

Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Coanda-effect UASs**

- The lift force in the Coanda-effect UASs is produced by deflecting and guiding the generated airflow along the body's outer side. Therefore, the inside of the body would be appropriate for placing the cargo.

- In these UASs, the airflow necessary to create lift forces is not dependent on the altitude or the angle of attack, unlike fixed-wing UASs, which makes them more stable during the flight.

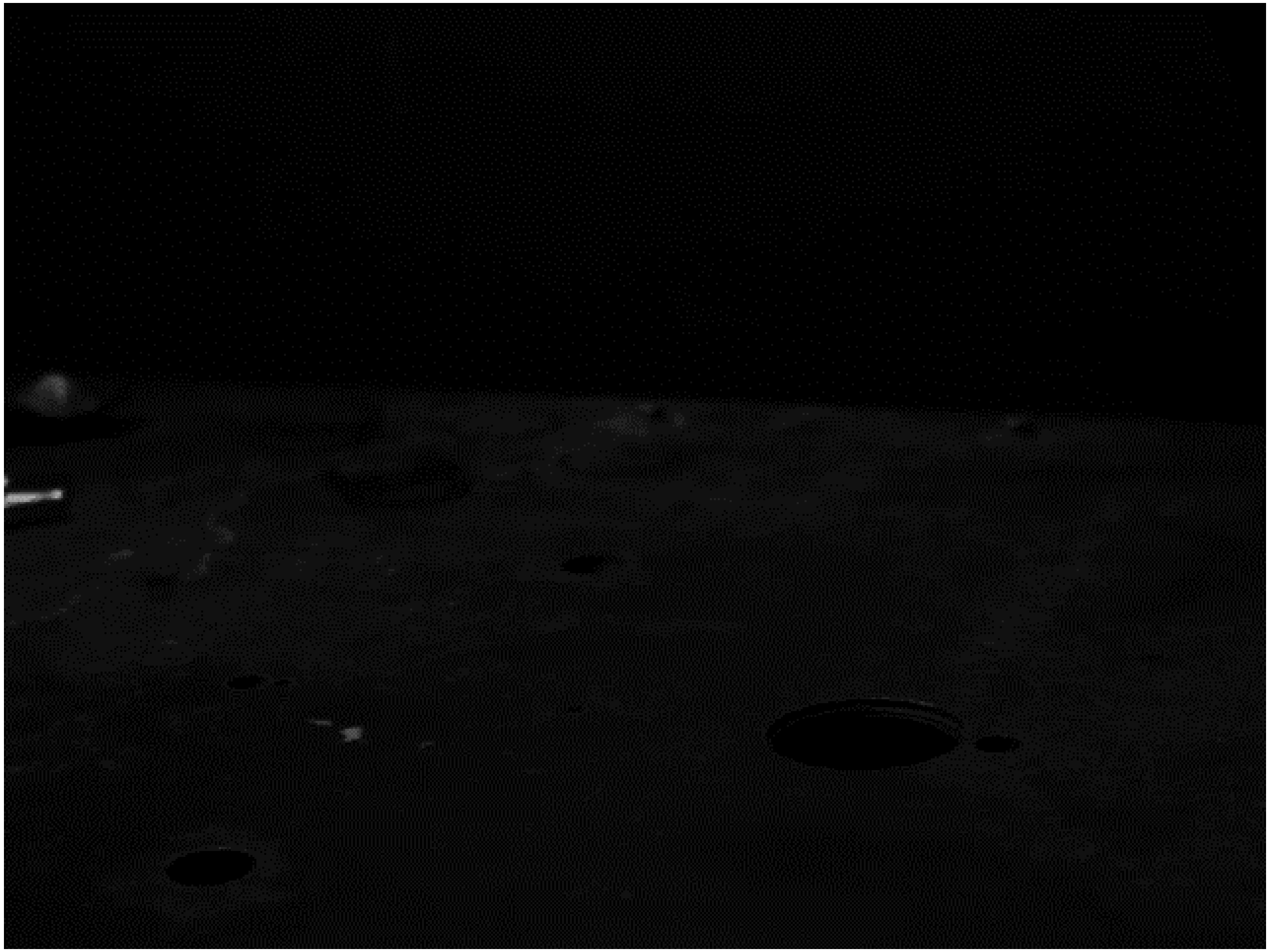
- The Coanda-effect UASs are not as vulnerable as conventional fixed-wings or helicopters to impacts against ceilings, walls, etc., so they may bump into obstacles without losing altitude or being damaged.

https://www.simscale.com/workbench/?pid=3588157303001314092&rru=ad4f6bf3-dcc0-433a-96b6-fbef5ca14e15&ci=0537fdbb-e050-46d0-9be0-0e40d2cdd6cd&ct=UNSTRUCTURED_LOG&mt=SIMULATION_RESULT

Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

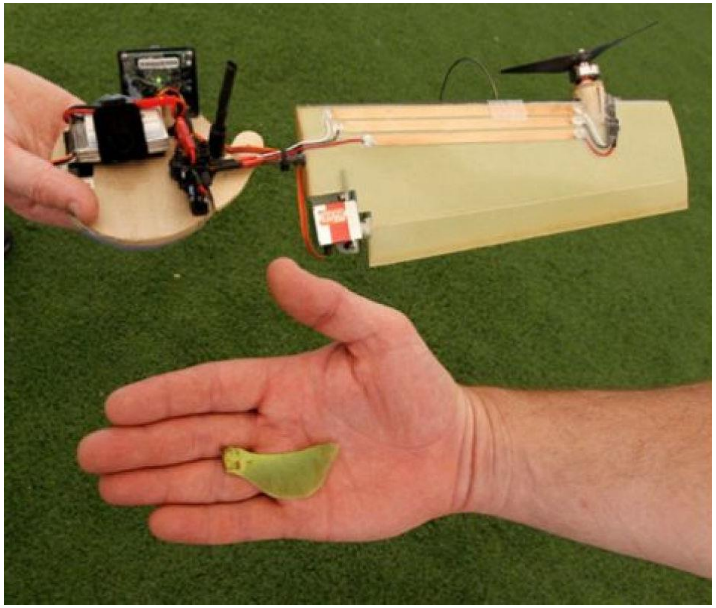
➢ **Single-wing rotor UASs**

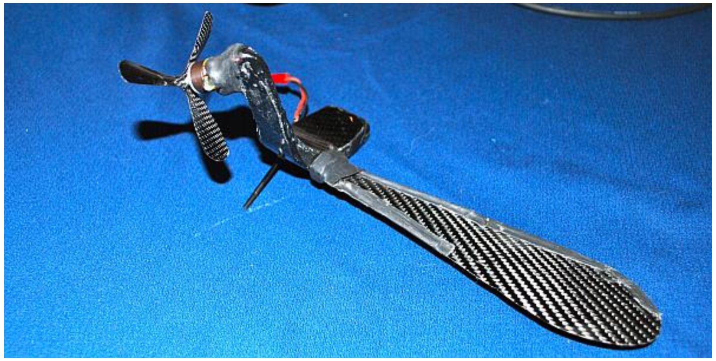


Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Single-wing rotor UASs**



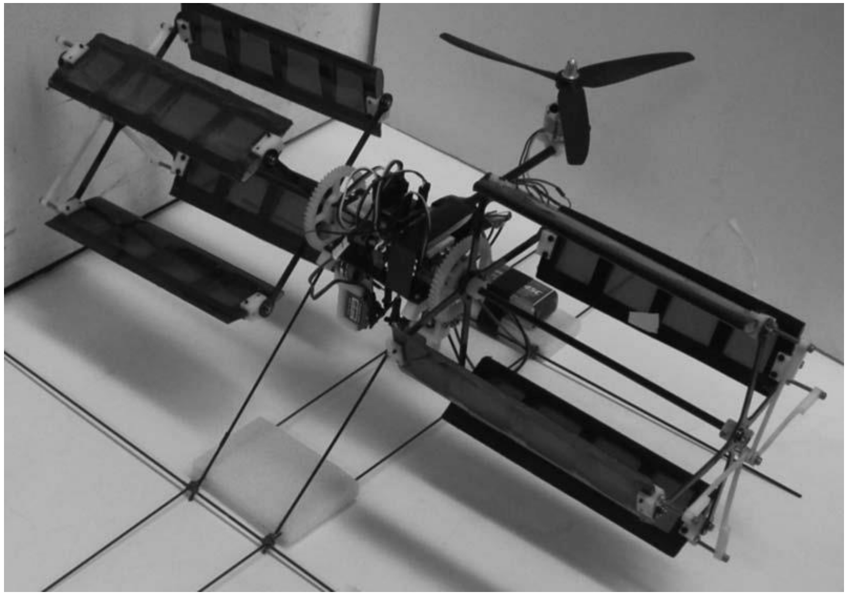


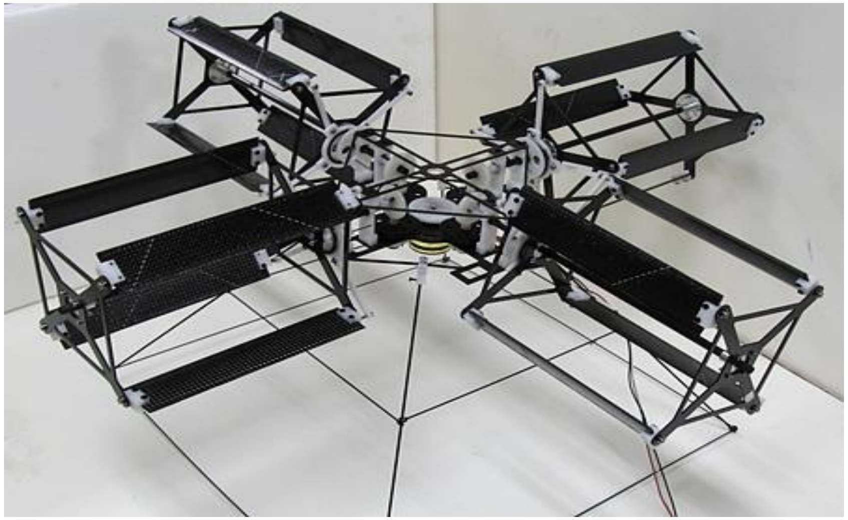
Drones Classification and Configurations

❖ Vertical Takeoff and Landing UASs

➢ **Cyclocopter UASs**

- This class of VTOL drones uses multiple wings or fins mounted on a rotating axis as a series of pedals to generate lift force.
- In cyclocopters, the rotors move like watermill or bicycle pedals.
- At first, these UASs required an initial speed and were hand-thrown; however, newer ones fly vertically.
- Generally, in some of the unmanned aerial vehicles, cyclic rotors can be used instead of propellers.





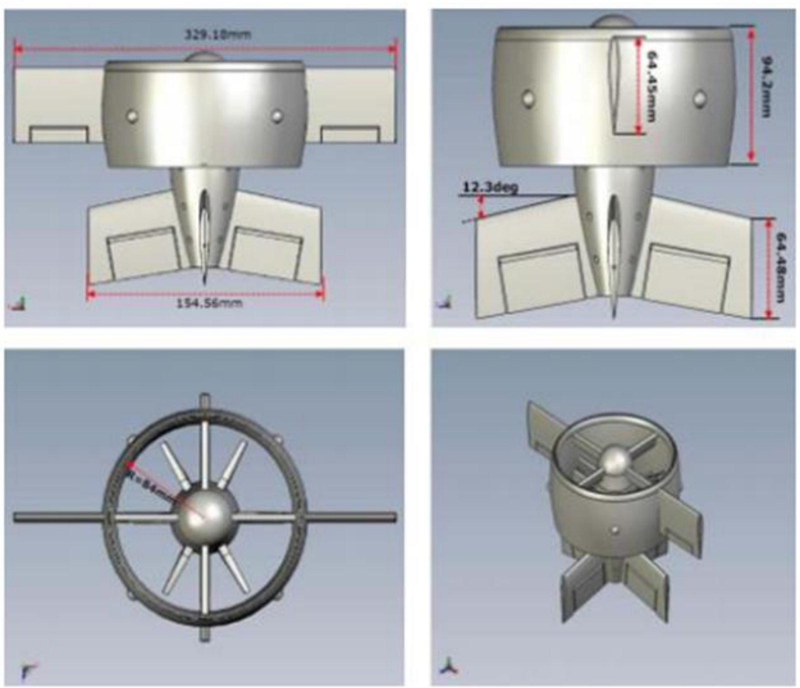
Drones Classification and Configurations

❖ Hybrid UASs

➢ **Tilt-body UASs**

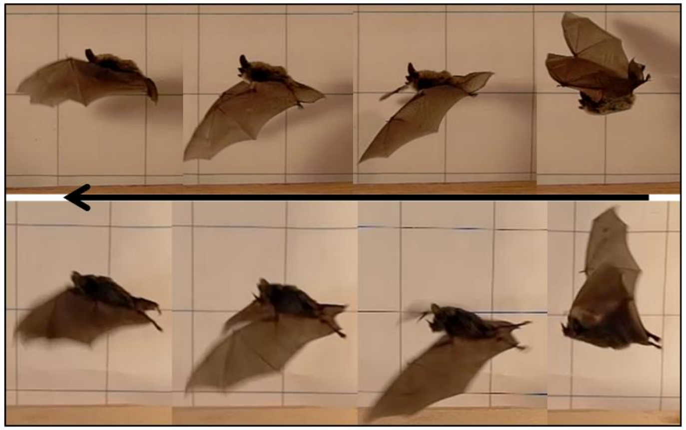
- Several attempts have been made to combine ducted fans with tail-sitters.

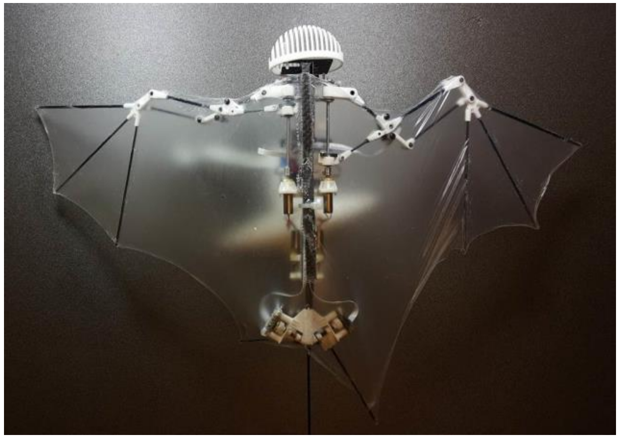
- Integrating a ducted fan into the tail-sitter UASs allows the use of individually controlled ducted-fan fins alongside with control surfaces to control the drone.



Flapping wing drones

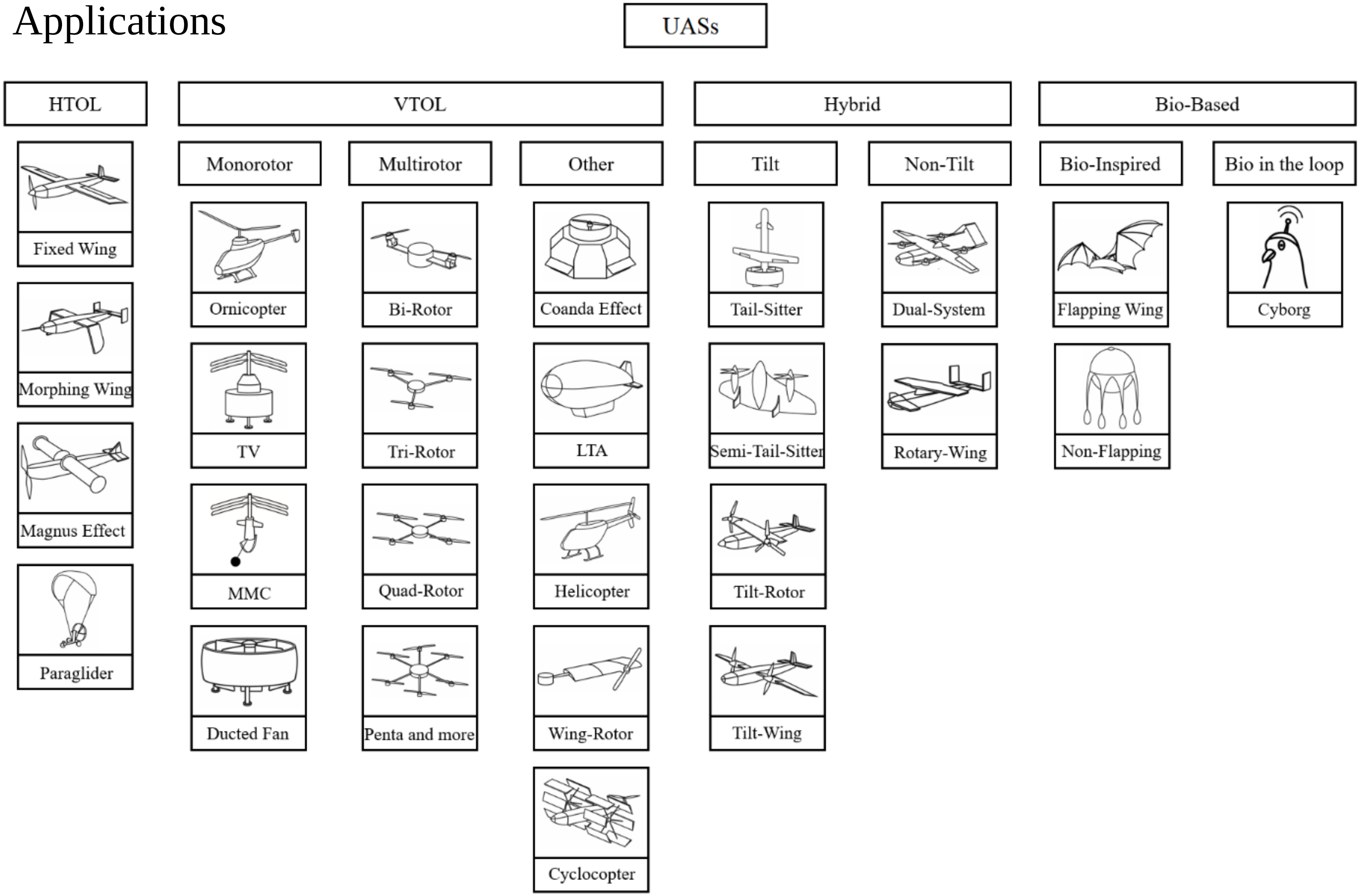
❖ Bat-inspired flapping wing





Drones Applications and Configurations

- Applications



Drones Applications and Configurations

- ❖ Applications

➢ **Applications and capabilities of different UAS configurations**

- ➢ UAS's specifications

- ❑ In order to demonstrate the applications of the UASs, it is necessary to examine their specifications. Each application requires its own specifications.

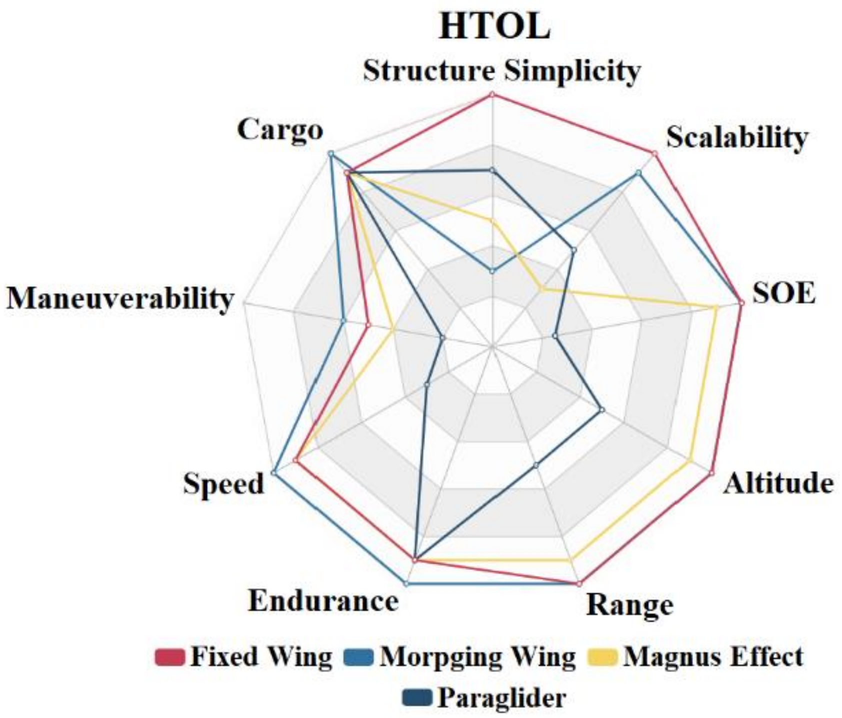
- ❑ Typical specifications which determine the fitness of a UAV for a specific application include;
  - Structural simplicity,
  - Scalability,
  - Utilize different sources of energy: solar, electrical, chemical, hybrid energies
  - Operational altitude and range,
  - Endurance,
  - Cruise speed,
  - Ability to hover,
  - Maneuverability,
  - Cargo-carrying capacity.

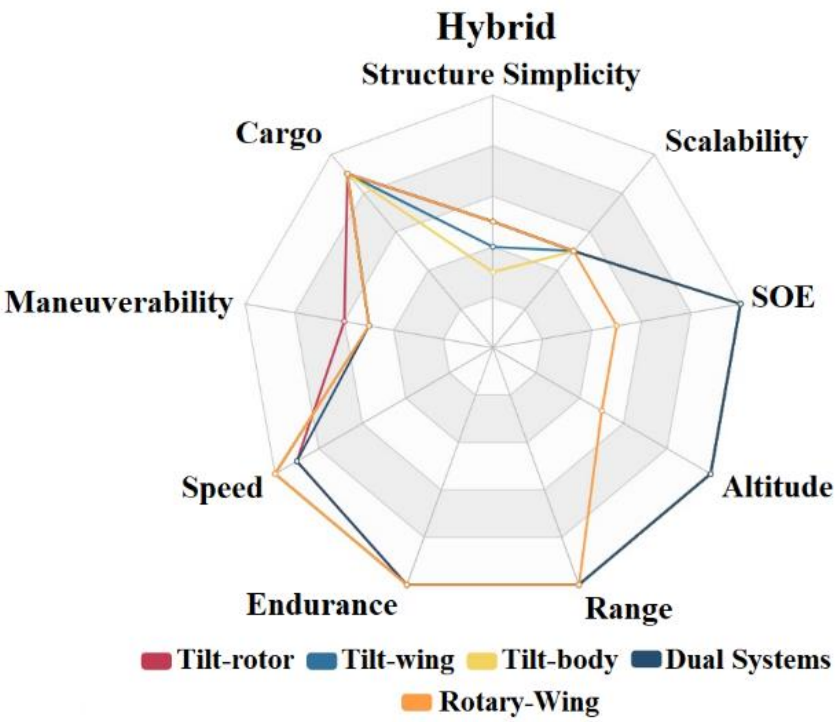
Drones Applications and Configurations

❖ Applications

➢ **Applications and capabilities of different UAS configurations**

- ➢ UAS's specifications

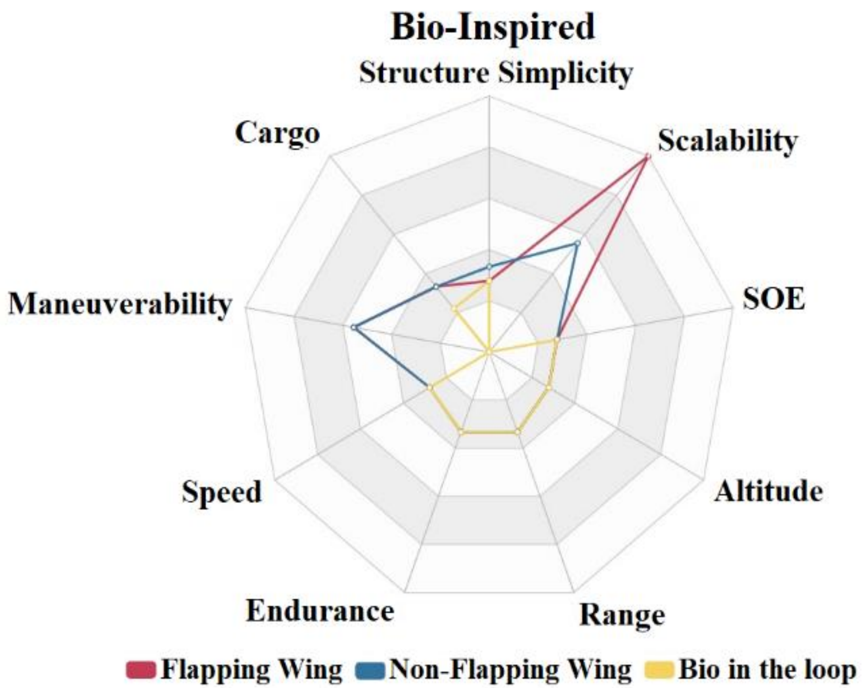


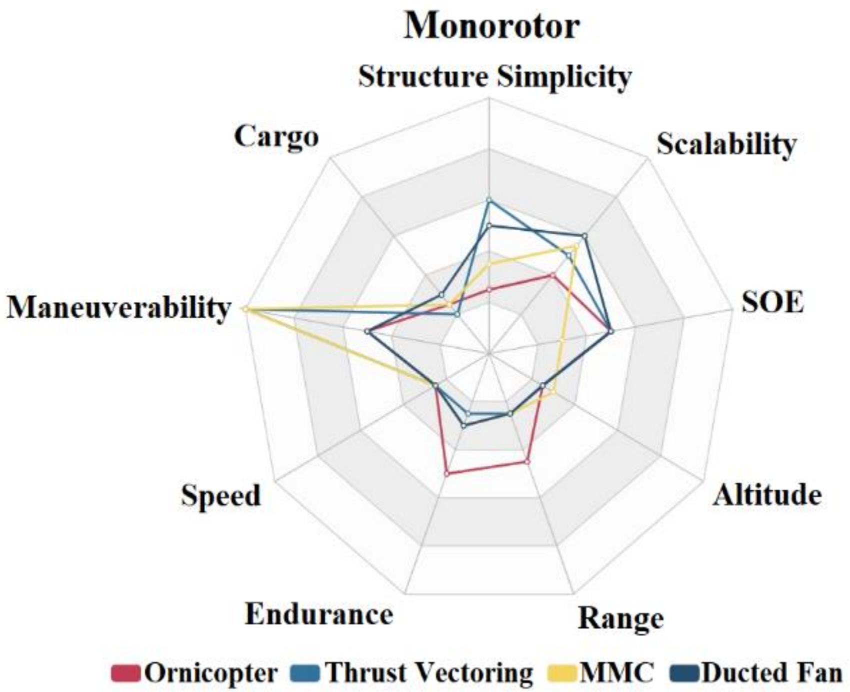


❖ Applications

➢ **Applications and capabilities of different UAS configurations**

  ➢ UAS's specifications



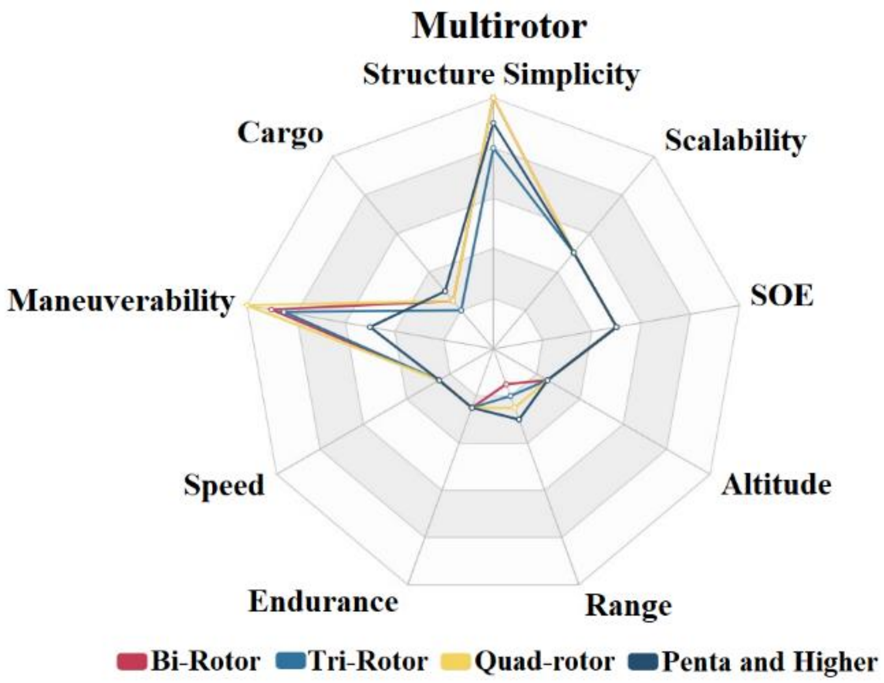


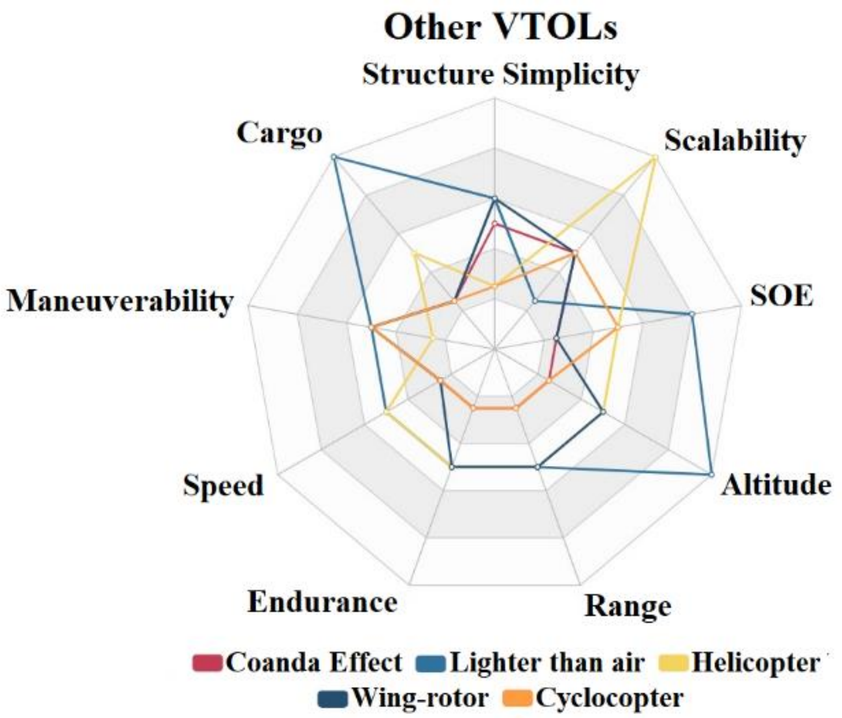
Drones Applications and Configurations

❖ Applications

➢ **Applications and capabilities of different UAS configurations**

➢ UAS's specifications



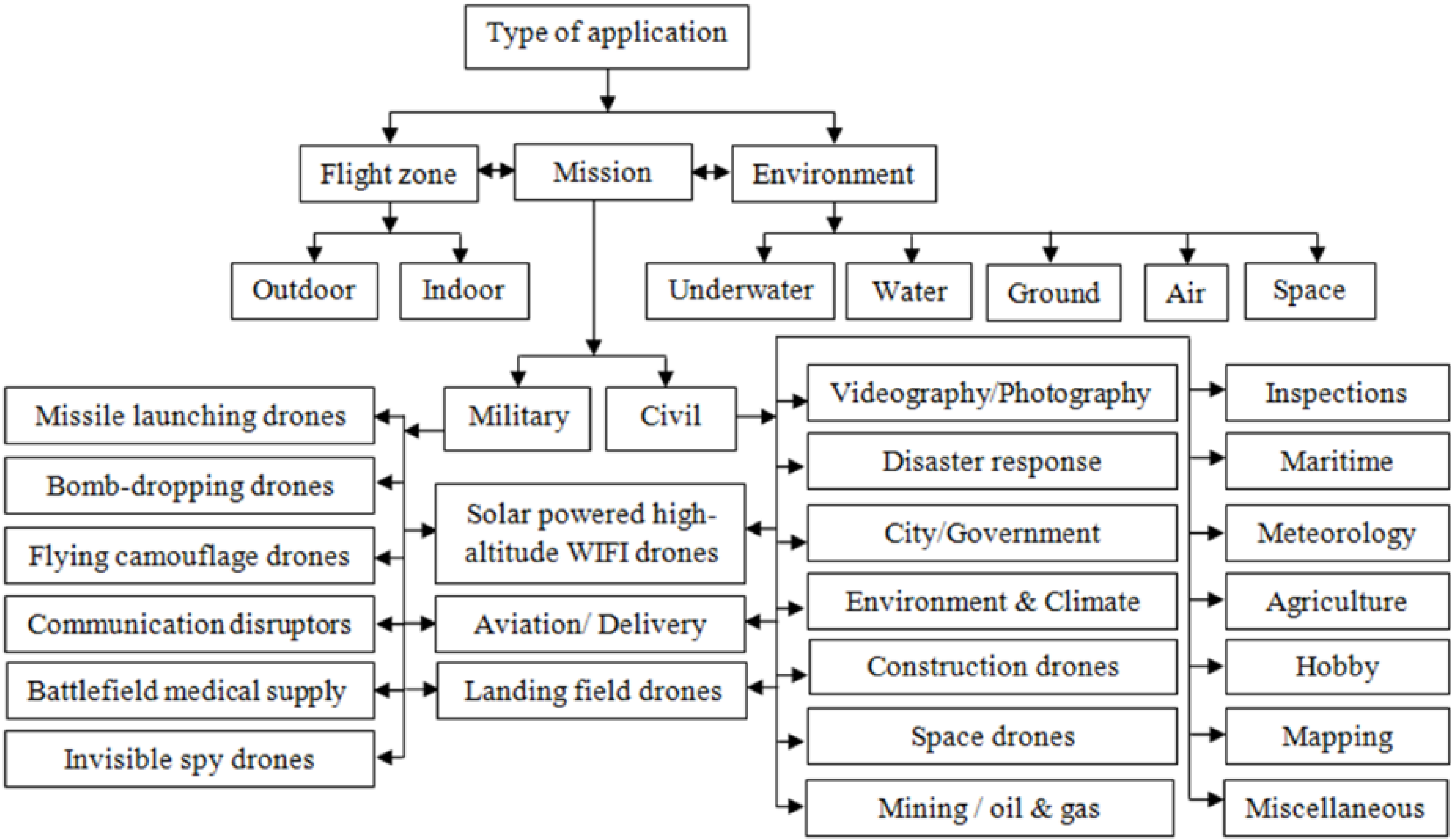


Drones Applications and Configurations

❖ Applications

➢ **Applications and capabilities of different UAS configurations**

➢ UAS's applications and required specifications



Drones Applications and Configurations

❖ Applications

- **Applications and capabilities of different UAS configurations**
  - UAS's applications and required specifications

    - UASs have applications in a wide range of civilian and military operations, where they perform both outdoor and indoor tasks in diverse environments extending from underwater (amphibious UASs) to space-related missions.

    - Due to the similarity in the requirements and the nature of missions, the applications of UASs are assessed in terms of the following categories;

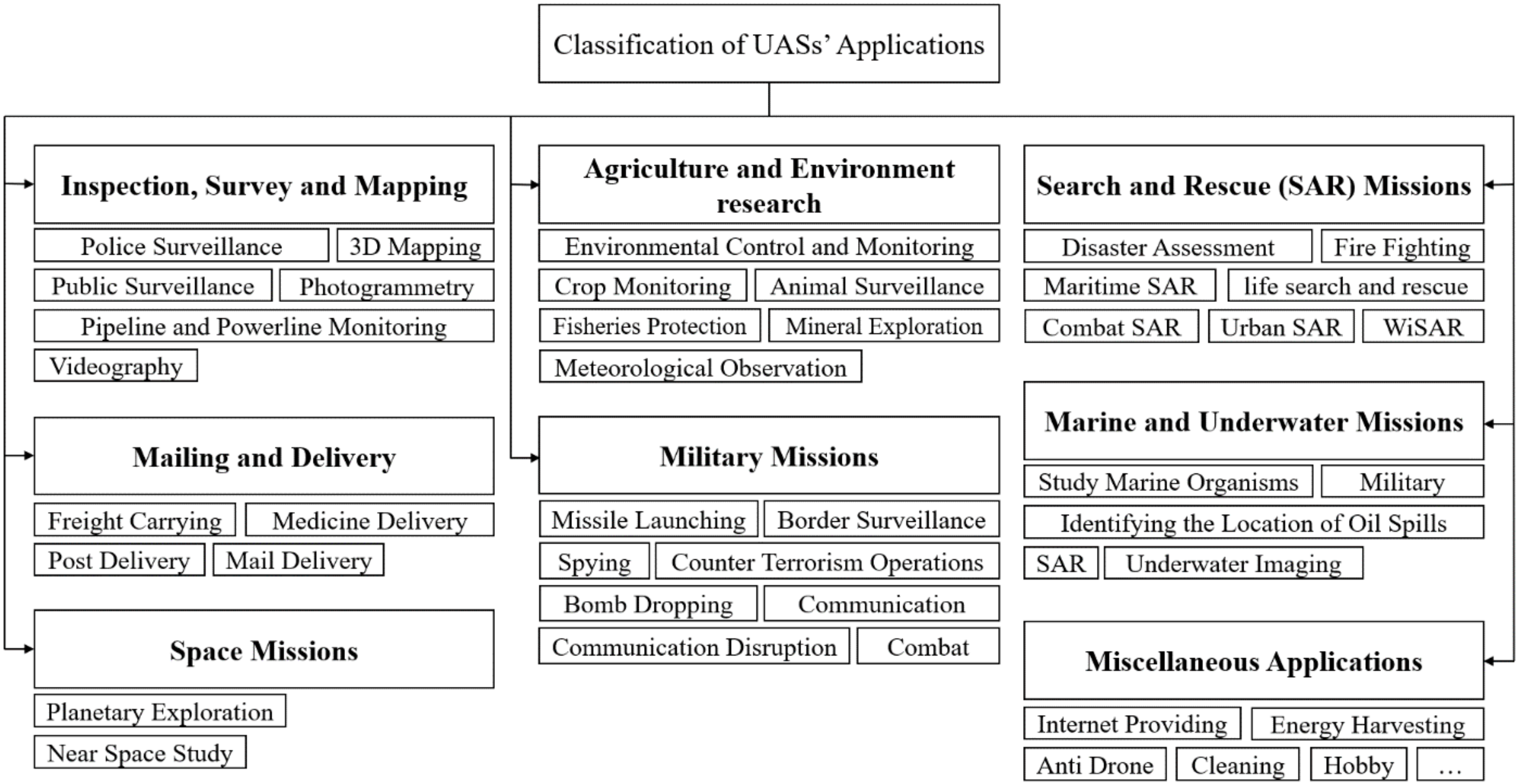
      - Inspection, Survey and Mapping,
      - Agriculture and Environment research,
      - Search and Rescue (SAR) Missions,
      - Mailing and Delivery,
      - Military Missions,
      - Marine and Underwater Missions,
      - Space Missions
      - Miscellaneous Applications

Drones Applications and Configurations

❖ Applications

➢ **Applications and capabilities of different UAS configurations**

  ➢ UAS's applications and required specifications



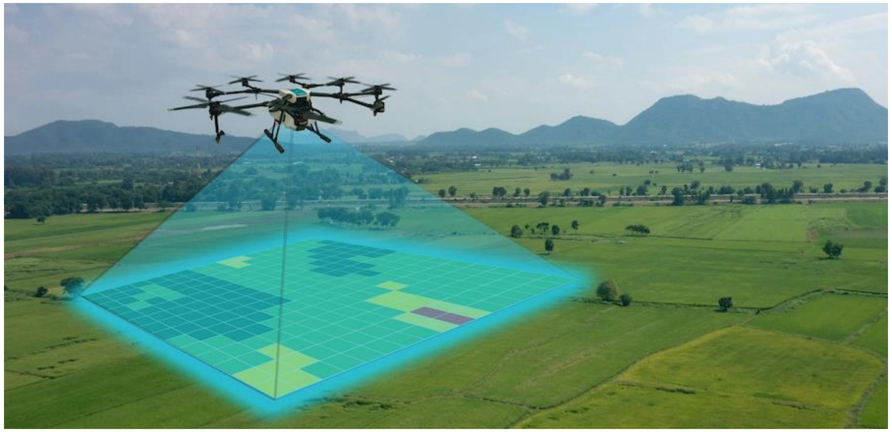
Drones Applications and Configurations

❖ Applications

➢ **Applications and capabilities of different UAS configurations**

➢ Inspection, survey and mapping

❑ The main required specifications of drones for mapping are:
- Payload capacity,
- Wind resistance,
- Autonomous flight,
- High endurance
- Portability



❑ Mapping is one of the popular applications in archeology, agriculture, forestry, and architectural and environmental areas.

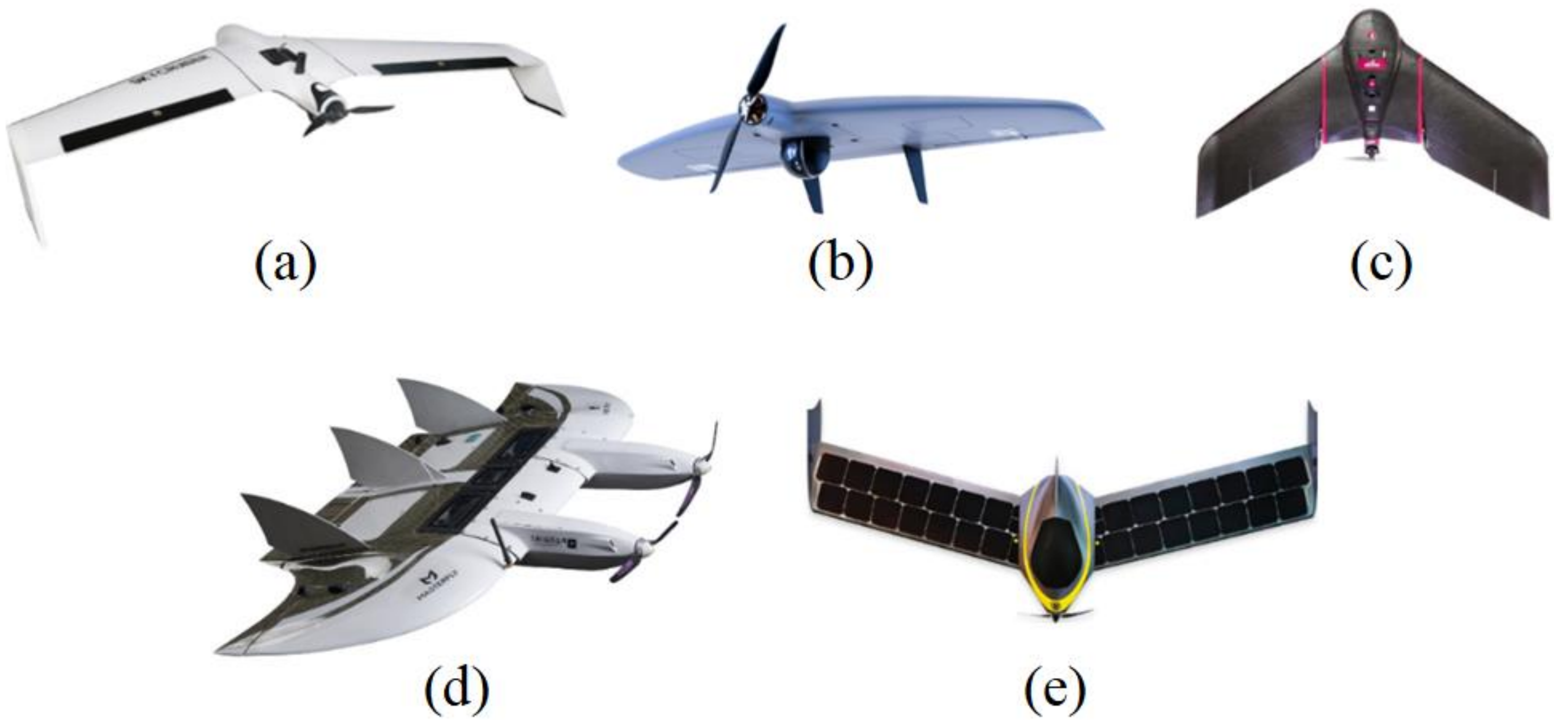
❑ drones designed for mapping missions are also usable for inspections and survey missions.

Drones Applications and Configurations

❖ Applications

- **Applications and capabilities of different UAS configurations**
  - Inspection, survey and mapping

- Fixed-wing configurations, mainly flying wing platform with manual launch capability have been used for inspection, survey and mapping.



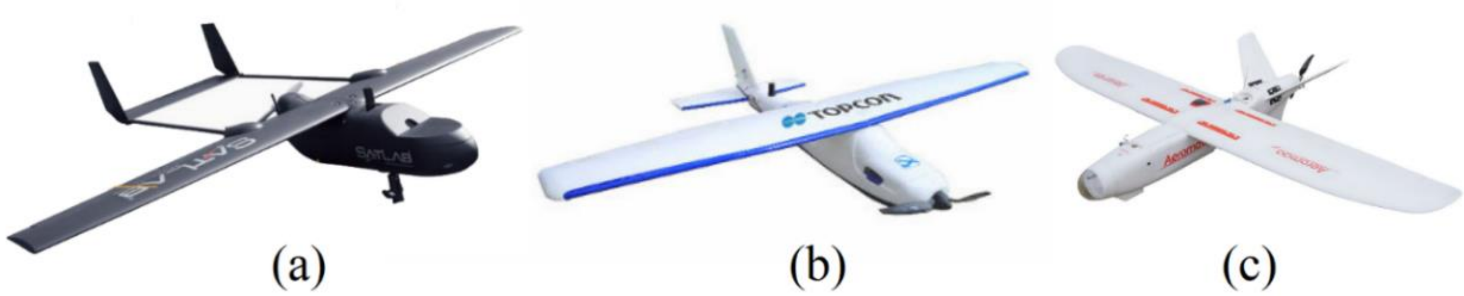
Drones Applications and Configurations

❖ Applications

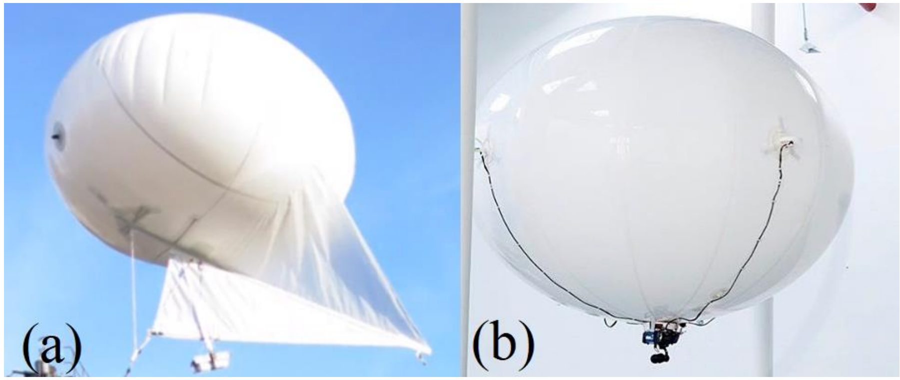
➢ **Applications and capabilities of different UAS configurations**

  ➢ Inspection, survey and mapping

  ❑ There are also some versions of classical fixed-wing UASs for these types of missions.



  ❑ Lighter than air UASs are also one of the configurations that are applicable to these types of missions.



Drones Applications and Configurations

❖ Applications

➢ **Applications and capabilities of different UAS configurations**

  ➢ Inspection, survey and mapping

  ❑ One of the popular configurations for mapping, inspection and surveying missions is multirotors.

Drones Applications and Configurations

❖ Applications

➤ **Applications and capabilities of different UAS configurations**

  ➤ Inspection, survey and mapping

❑ Helicopters have also been used as UASs to conduct survey and inspection missions.

❑ Another popular class of drones is the hybrid configuration (tilt-rotor, tilt-body and dual systems). The main reason for the popularity of hybrid drones is their high endurance, high payload capacity, as well as the ability to vertically take-off and land.

Drones Applications and Configurations

❖ Applications

➢ **Applications and capabilities of different UAS configurations**

  ➢ Inspection, survey and mapping

❑ Another popular class of drones is dual system hybrid UASs.

Drones Applications and Configurations

❖ Applications

➢ **Applications and capabilities of different UAS configurations**

  ➢ Agriculture and environment research

❑ Environmental missions are summed up in surveying and inspection.

❑ Most of the UASs developed for environmental protection are equipped with cameras and enable scientists to study, monitor and track wildlife and the effect of climate change in the national parks, forests, oceans and deserts.

Drones Applications and Configurations

❖ Applications

- **Applications and capabilities of different UAS configurations**
  - Agriculture and environment research

❑ The most popular configurations in environmental protection are fixed-wing and quadrotor drones.

Drones Applications and Configurations

- ❖ Applications

➢ **Applications and capabilities of different UAS configurations**

  ➢ Agriculture and environment research

- ❑ In some cases, the dead or taxidermied bodies of animals are used in the structure of the UAVs to track the animal's behavior.

- ❑ In some cases, this was to calm animals down and prevent them from being frightened. It also has some military applications such as espionage.

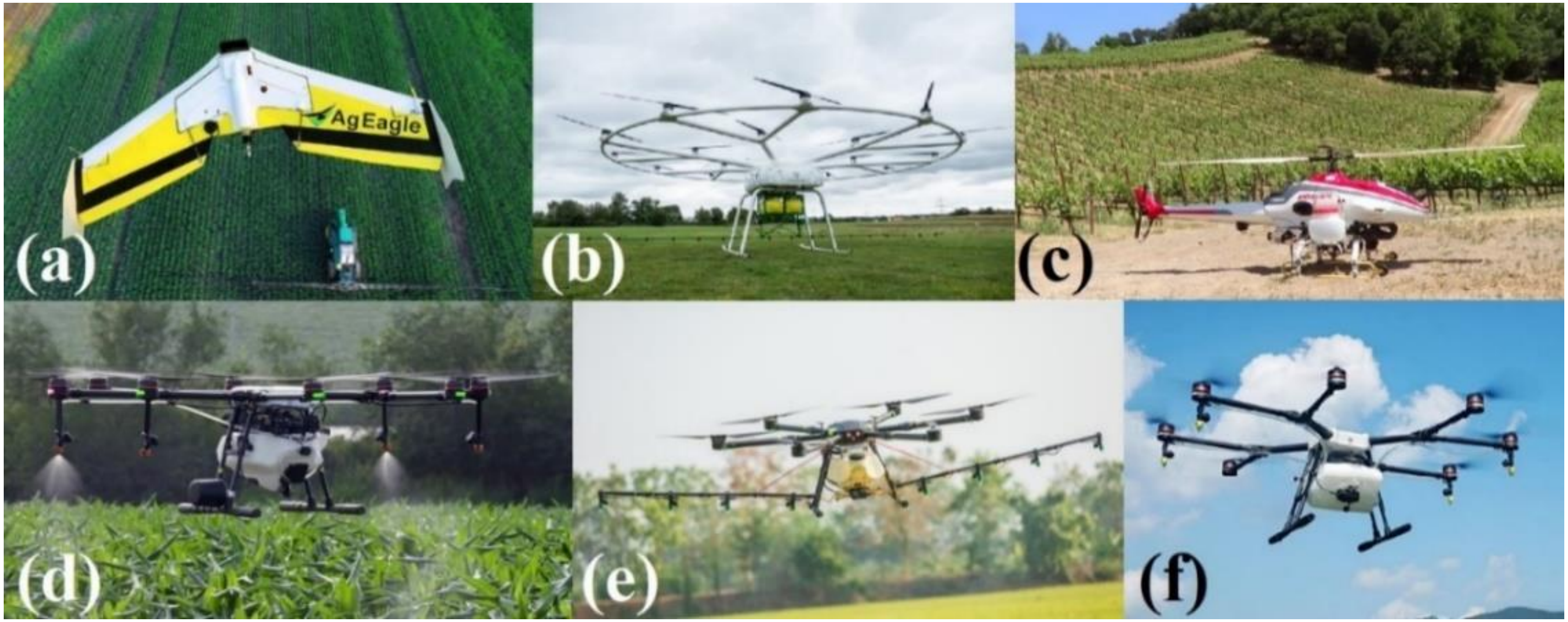
Drones Applications and Configurations

❖ Applications

➢ **Applications and capabilities of different UAS configurations**

➢ Agriculture and environment research

❑ UASs are also applicable in agriculture, specifically in irrigation and spraying, soil and field analysis, planting, crop monitoring and health assessment.



Drones Applications and Configurations

❖ Applications

➢ **Applications and capabilities of different UAS configurations**

➢ Search and Rescue (SAR) missions

❑ Drones are agile and fast and can be controlled autonomously to perform missions that are hard for human operators to execute.

❑ In search and rescue missions, there are sets of constraints, such as the limited time to perform the mission, potential loss of human lives, and unfriendly operational environments, e.g., disaster scenes, forests, etc.

❑ UAS potentially can be used in various natural and man-made disasters and emergencies like storms, floods, droughts, earthquakes, volcanic eruptions, fires and accidents.

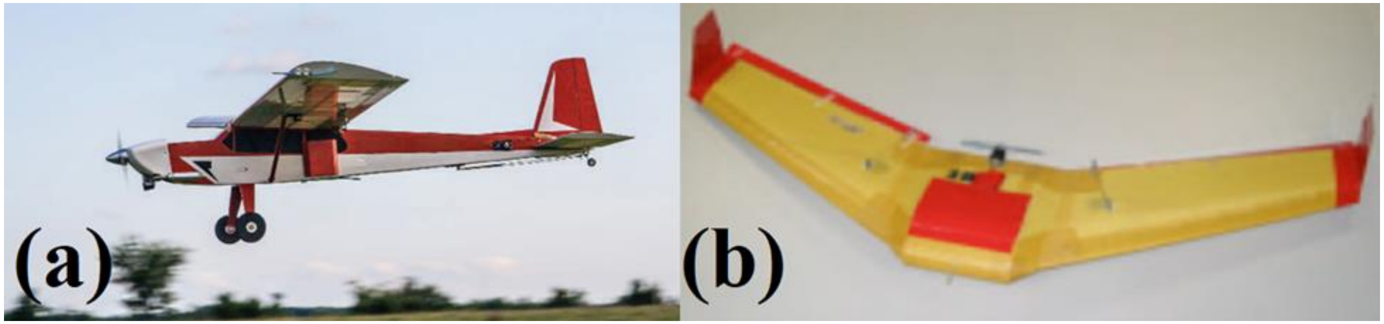
Drones Applications and Configurations

❖ Applications

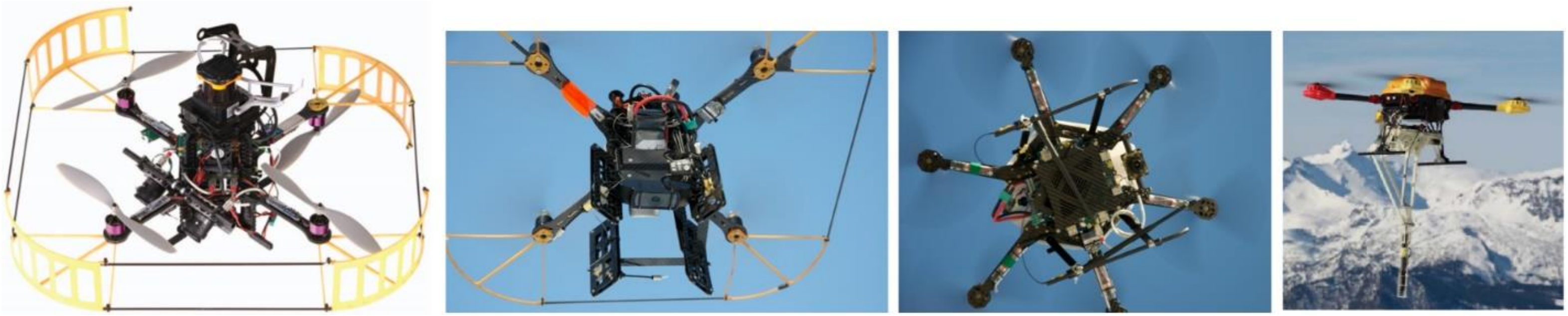
➢ **Applications and capabilities of different UAS configurations**

- ➢ Search and Rescue (SAR) missions

❑ Drones with vertical takeoff and landing capability can be appropriate for these missions.



❑ Another configuration that has been used widely in SAR missions is multirotor, specifically quadrotor configuration.

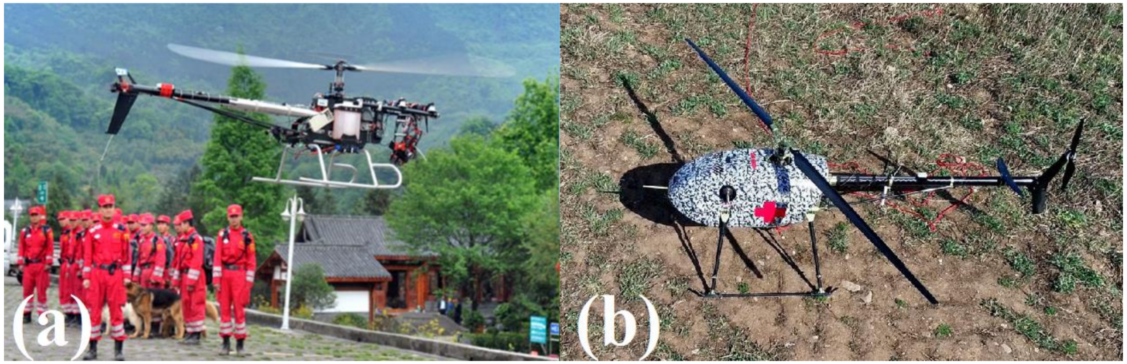


Drones Applications and Configurations

❖ Applications

➢ **Applications and capabilities of different UAS configurations**

- ➢ Search and Rescue (SAR) missions

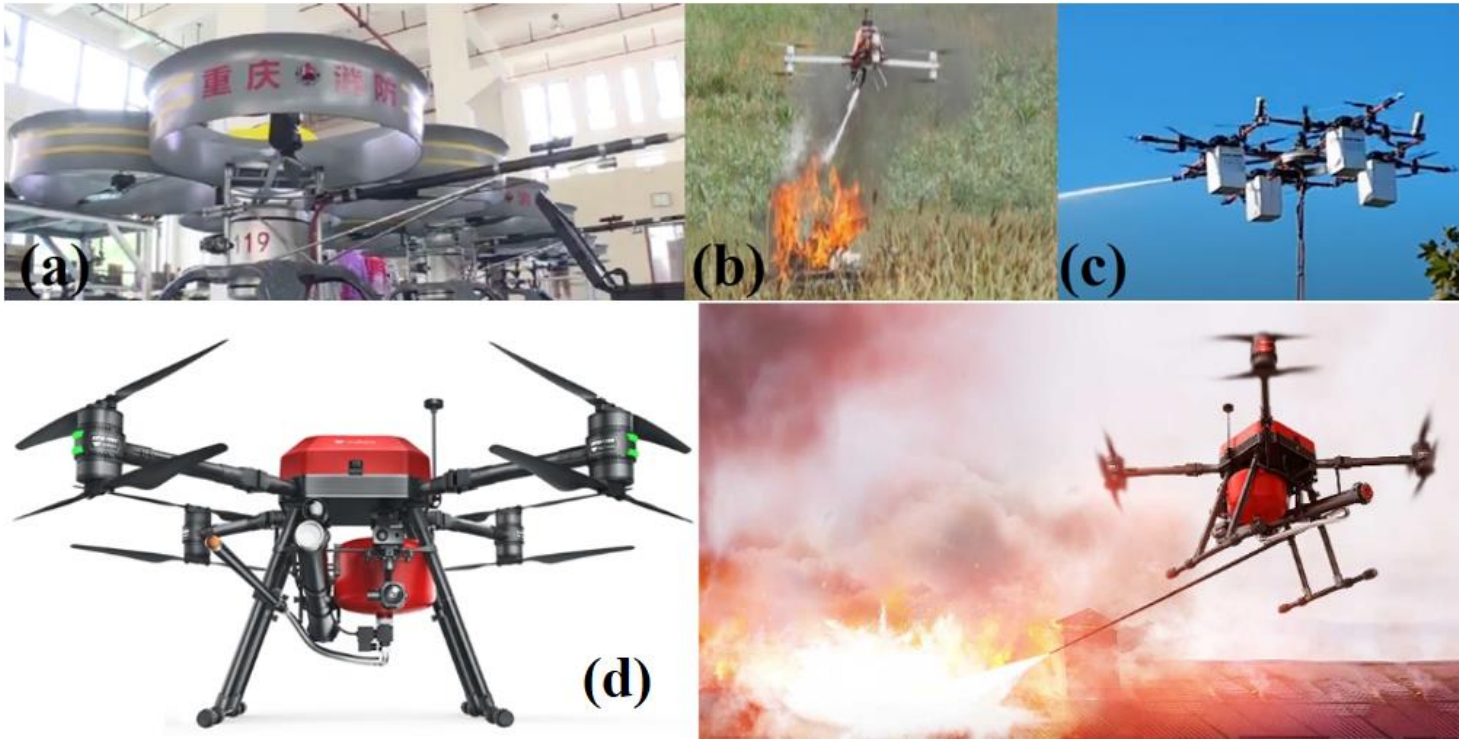


Drones Applications and Configurations

❖ Applications

➢ **Applications and capabilities of different UAS configurations**

- ➢ Search and Rescue (SAR) missions
  - ❑ Multi-rotors are also a popular group of UASs for firefighting missions.



Drones Applications and Configurations

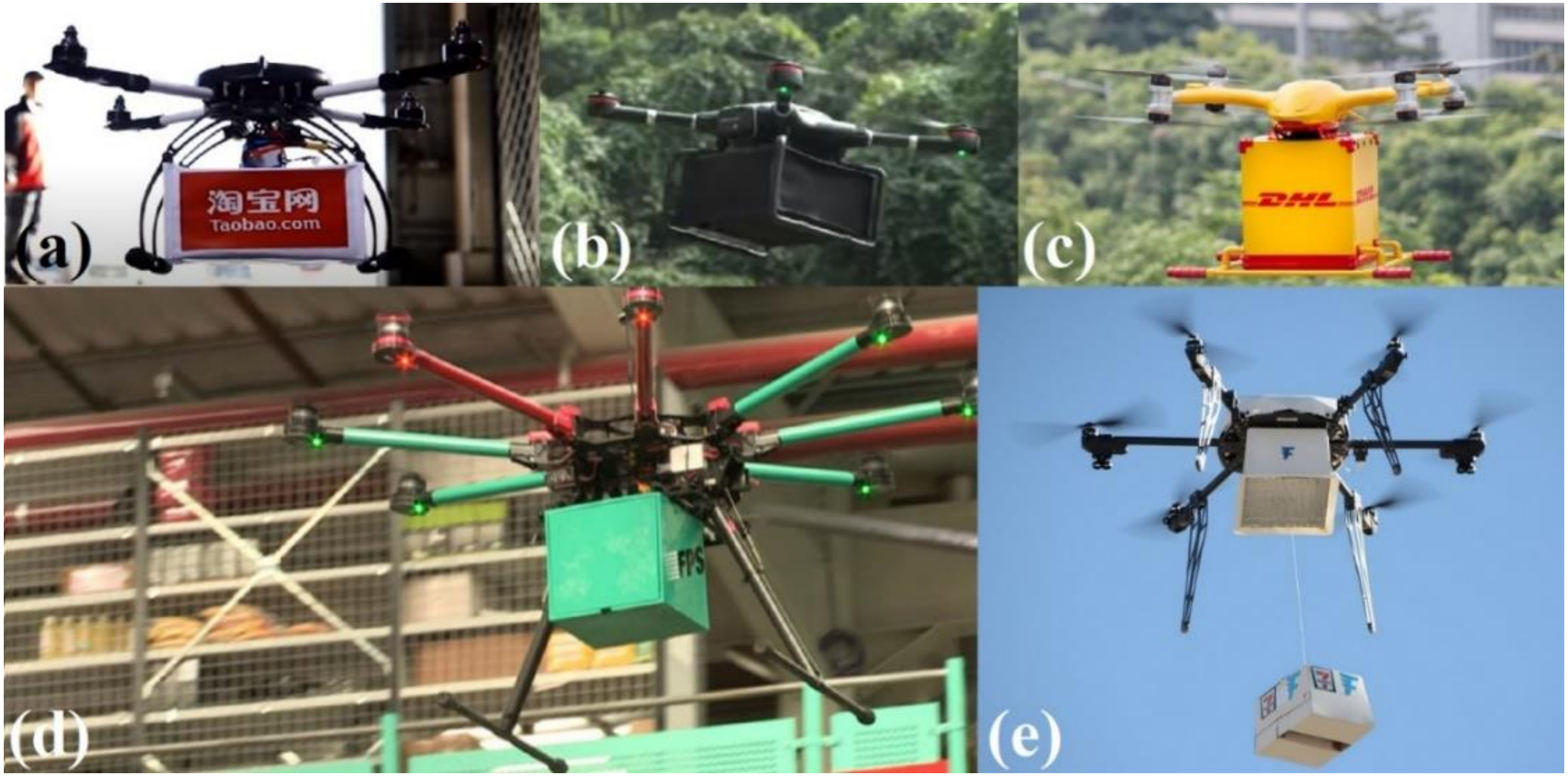
❖ Applications

- **Applications and capabilities of different UAS configurations**
  - Mailing and delivery
    - Drone delivery service is of interest to many companies all over the world, including Amazon, Google and DHL. Fixed-wing UASs are also a suitable configuration for mail and delivery service.


Drones Applications and Configurations

❖ Applications

- **Applications and capabilities of different UAS configurations**
  - Mailing and delivery



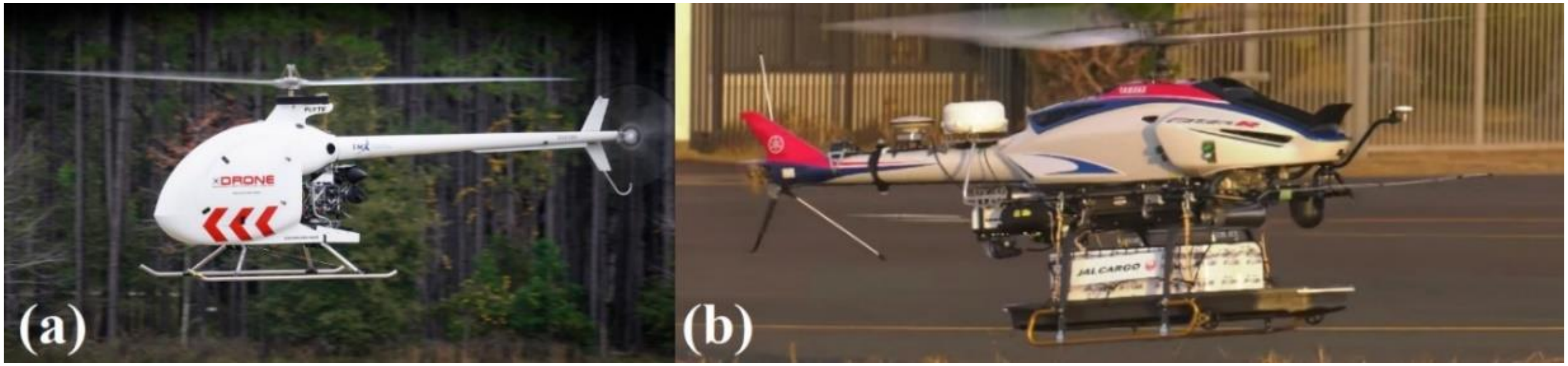
Drones Applications and Configurations

- ❖ Applications

➢ **Applications and capabilities of different UAS configurations**

- ➢ Mailing and delivery

  - ❑ Helicopters and dual systems are also popular configurations that have been employed for delivering goods.



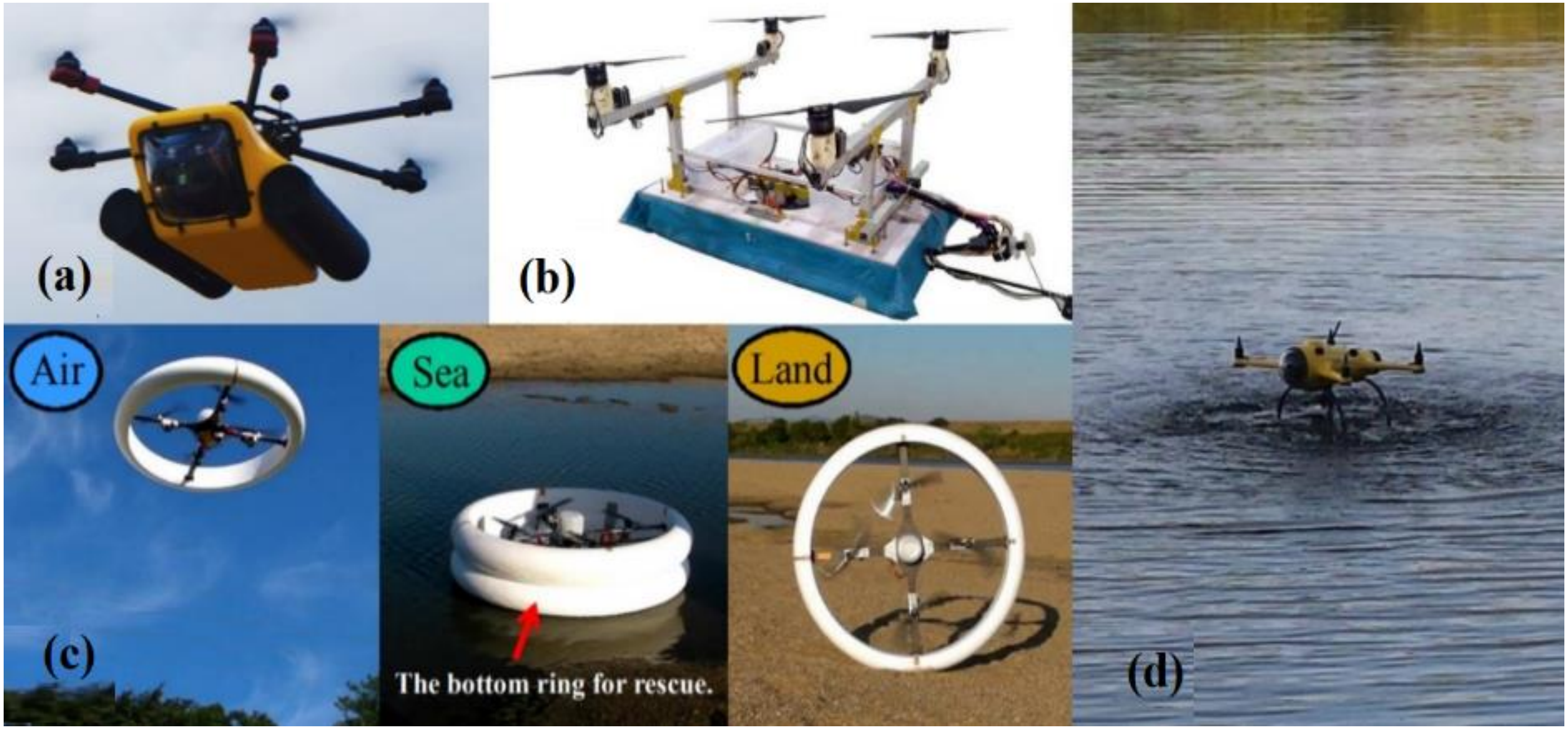
Drones Applications and Configurations

❖ Applications

➢ **Applications and capabilities of different UAS configurations**

- ➢ Marine and underwater missions

❑ Multi-rotors are also popular for underwater and on the water operations.



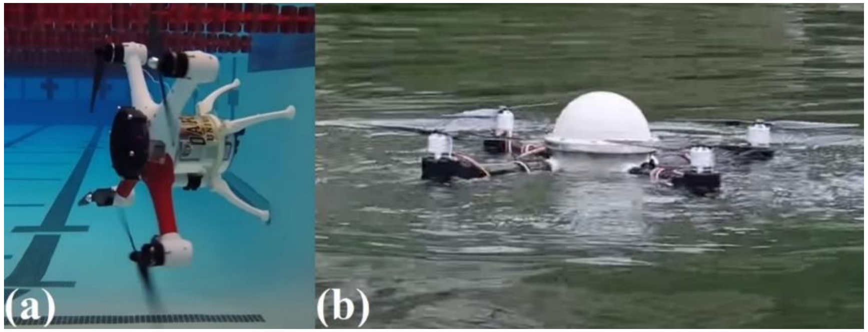
Drones Applications and Configurations

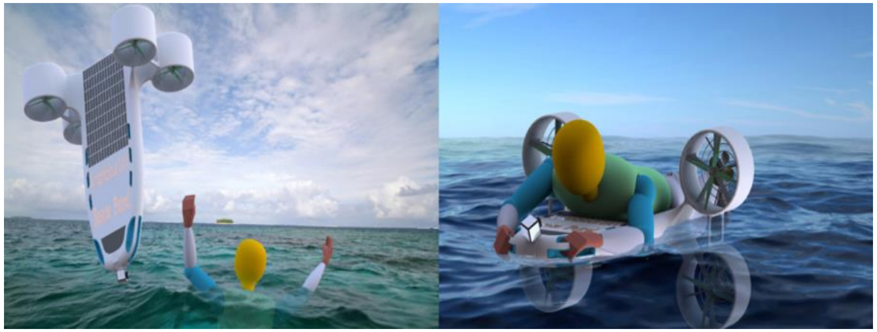
❖ Applications

➢ **Applications and capabilities of different UAS configurations**

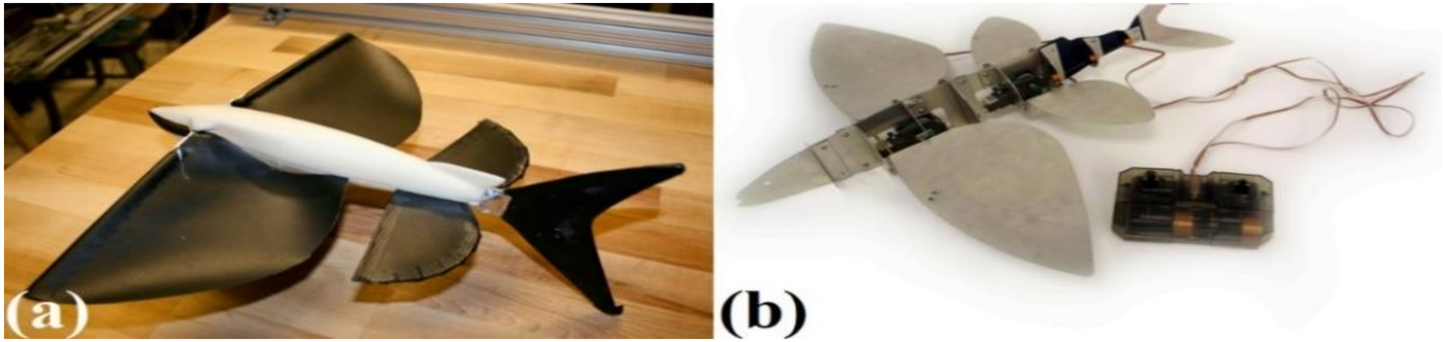
➢ Marine and underwater missions

❑ Multirotors also have been used as underwater drones.





❑ Bio-Inspired drones are one of the most useful configurations for underwater operations.



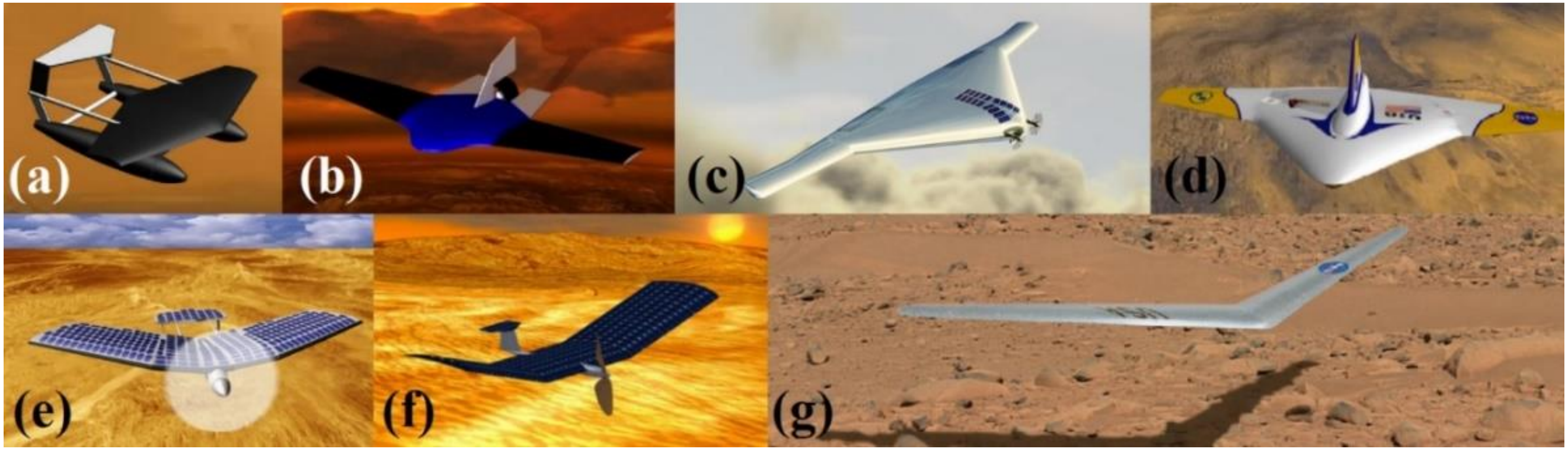
Drones Applications and Configurations

❖ Applications

➢ **Applications and capabilities of different UAS configurations**

- ➢ Space mission

❑ One of the newer applications of drones involves space missions. Several drone designs and concepts have been proposed by researchers for space explorations.



Drones Applications and Configurations

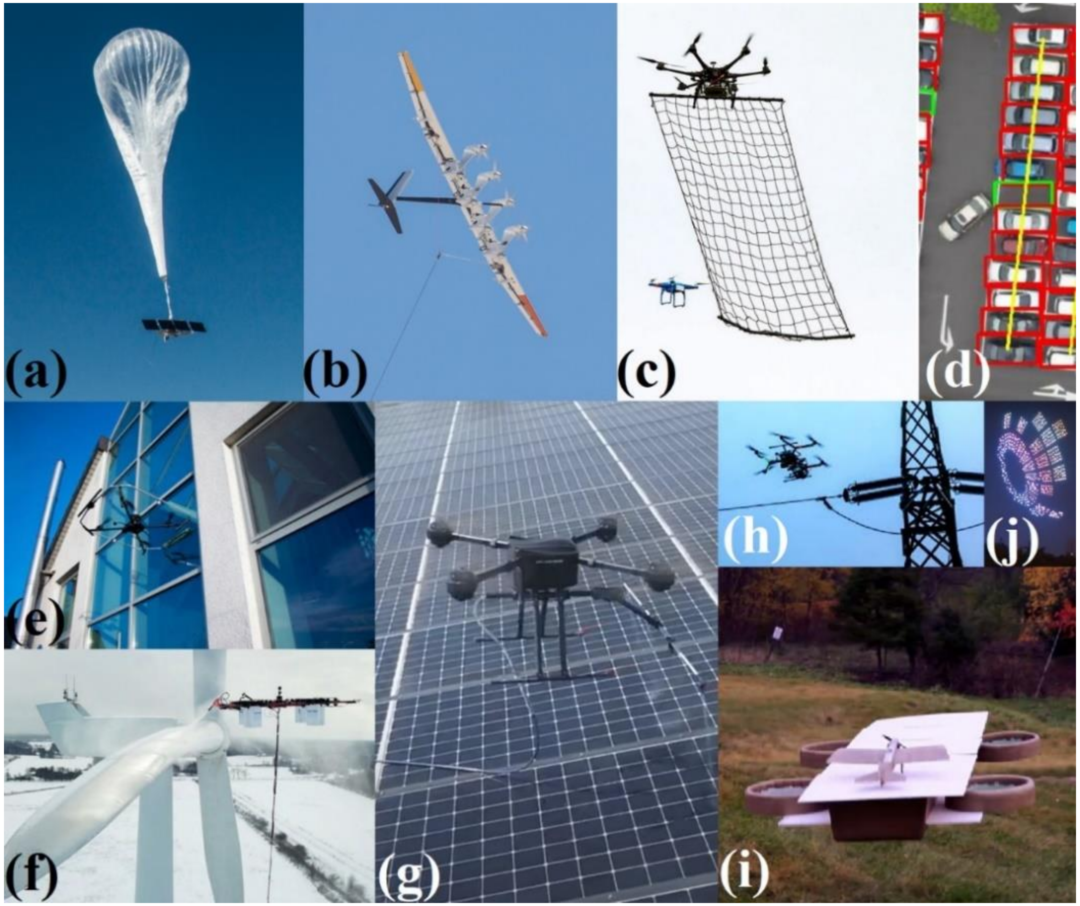
❖ Applications

➢ **Applications and capabilities of different UAS configurations**

  ➢ Space mission

Drones Applications and Configurations

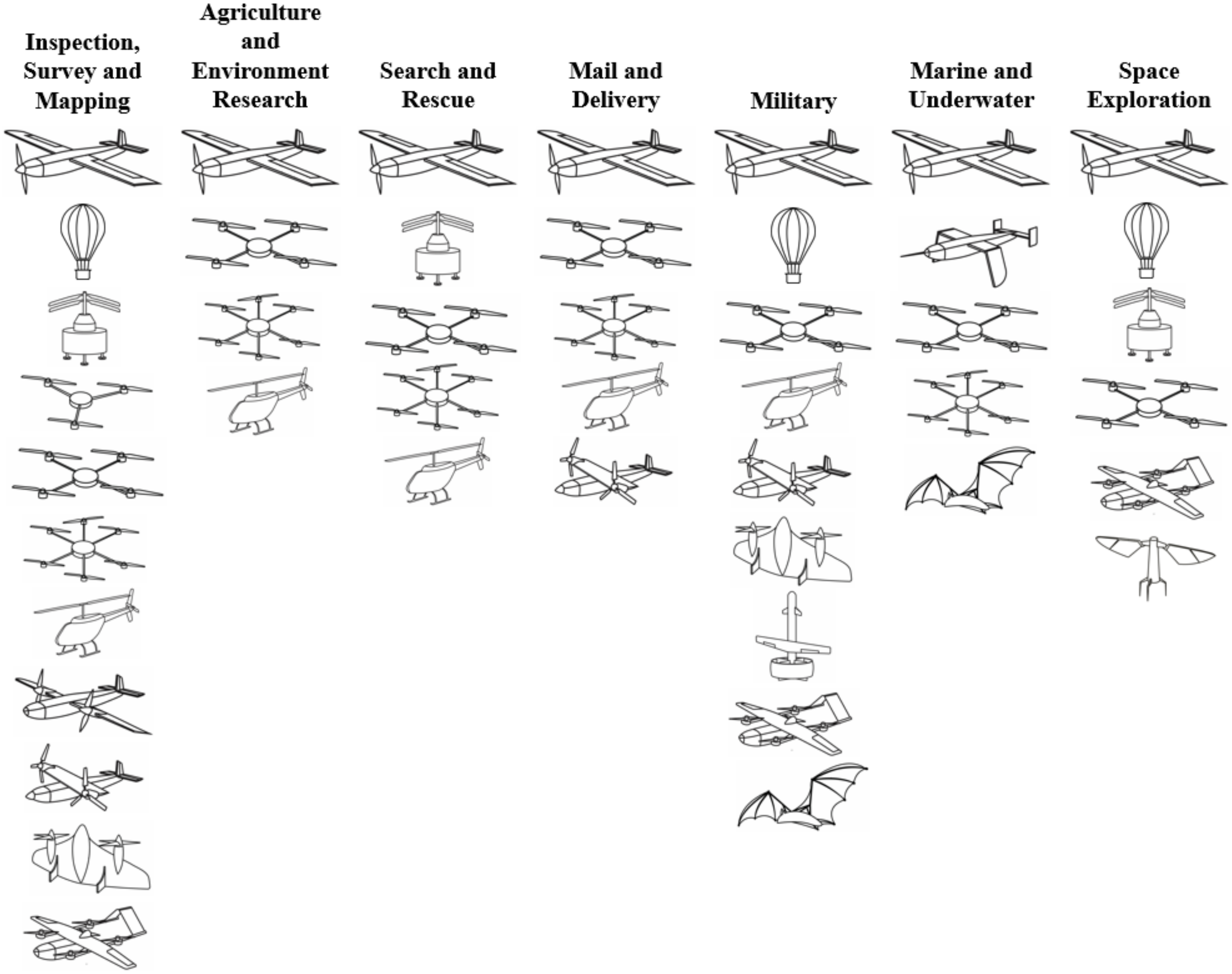
- ❖ Applications
- ➢ **Applications and capabilities of different UAS configurations**
  - ➢ Miscellaneous applications



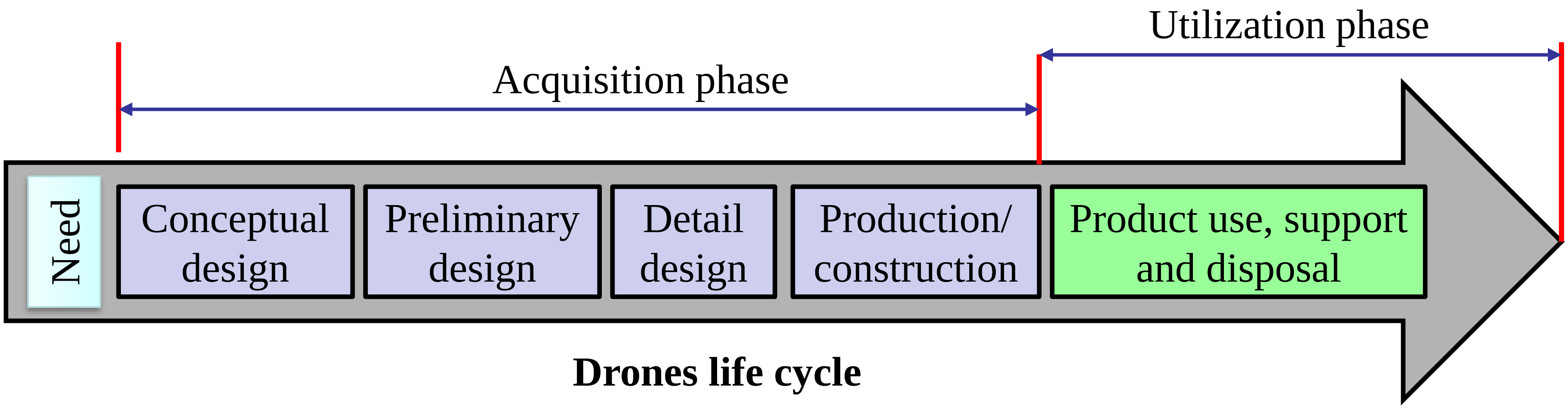
Drones Applications and Configurations

❖ Applications

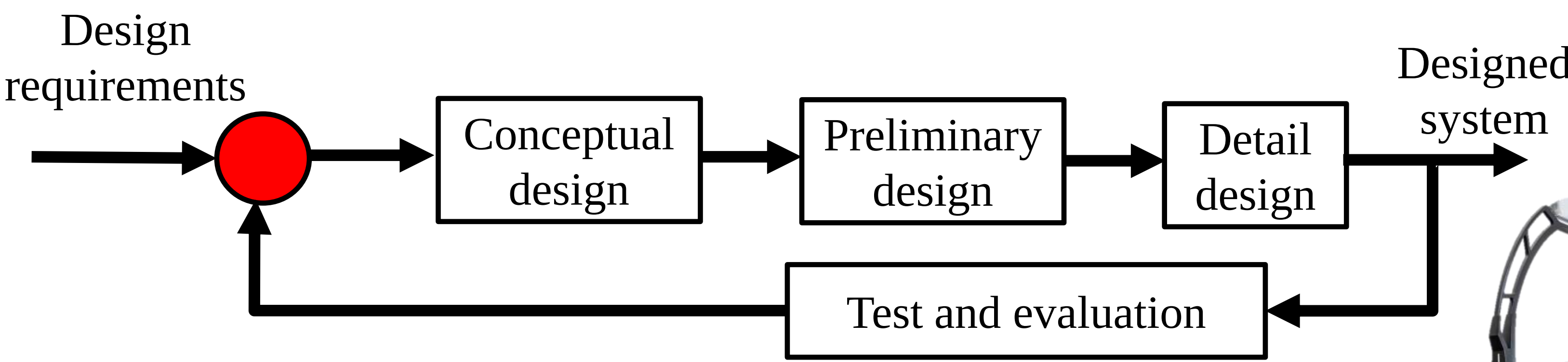
➢ **Applications and capabilities of different UAS configurations**



Design Process of Drones



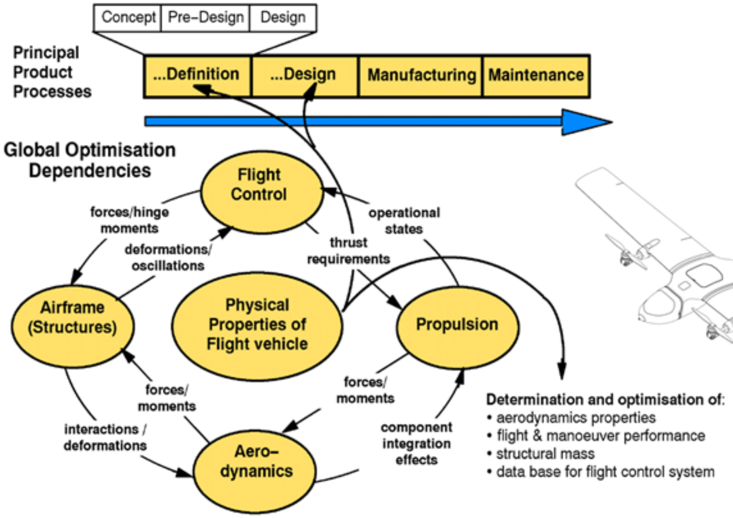
Drones life cycle

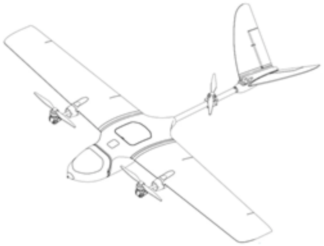


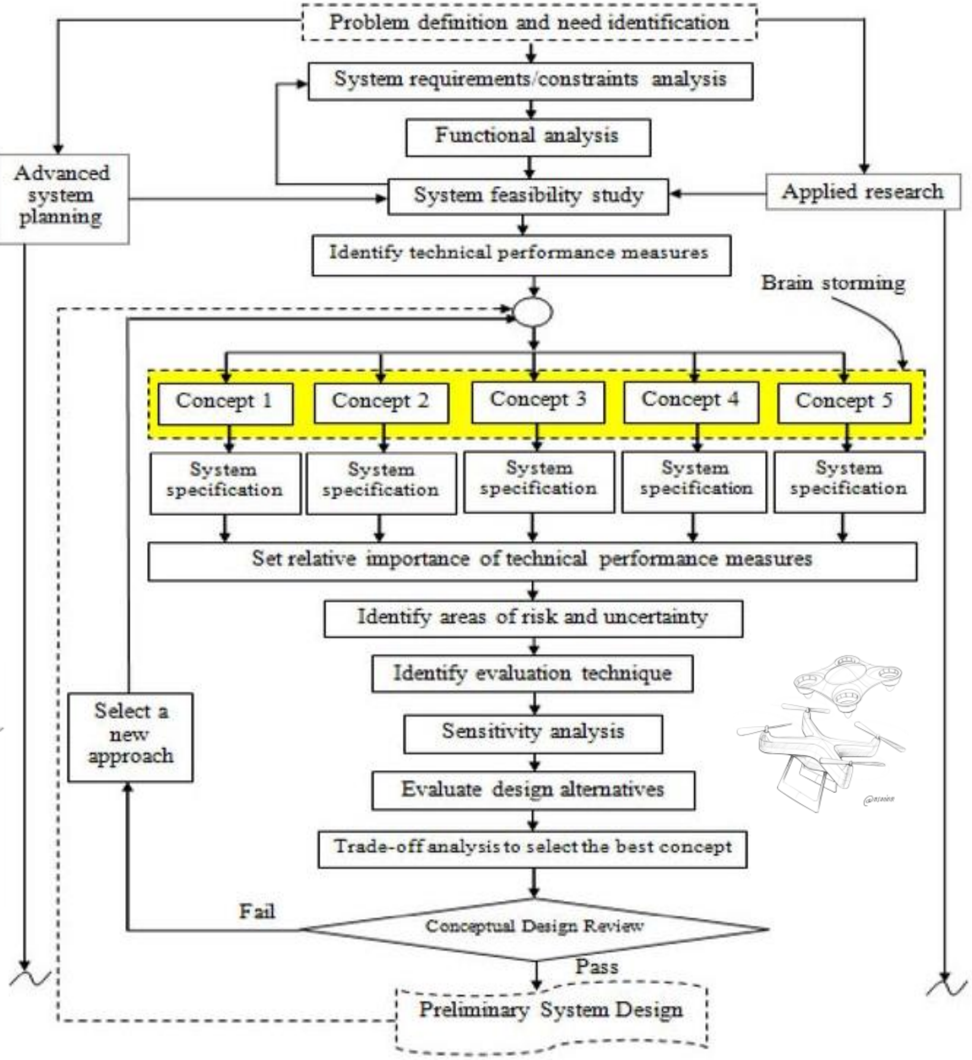
Relationship among four major design activities

Design Process of Drones

❖ **Conceptual system design**: Develop and define specific design to requirements for the system as entry



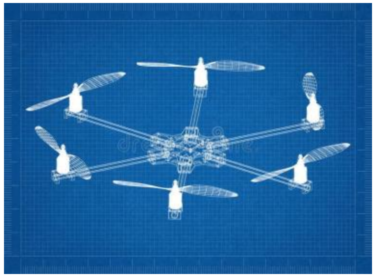




❖ **Preliminary system design**

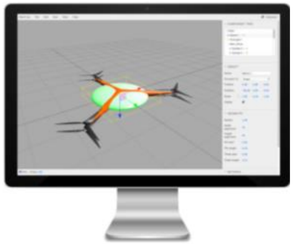
➢ By the end of the conceptual design phase, design evolution continues by addressing some of the most fundamental system characteristics.

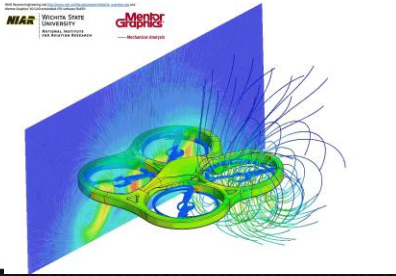
➢ The essential purpose of the preliminary design is to determine features of the basic components and subsystems.

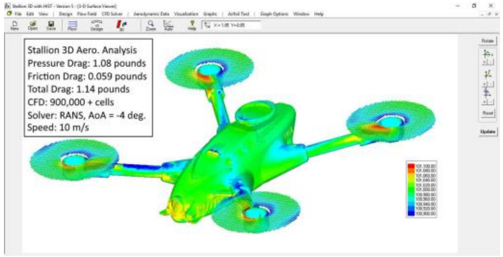


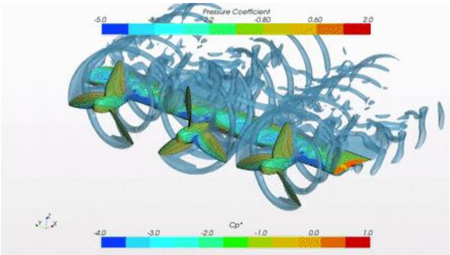
➢ The preliminary design phase includes the following steps:

- *Develop design requirements for subsystems*
- *Prepare development, process, and materials specification for subsystems*
- *Determine performance technical measure at the subsystem level*
- *Conduct functional analysis at the subsystem level*
- *Establish detailed design requirements*
- *Identify appropriate technical design tools, software, and technologies*



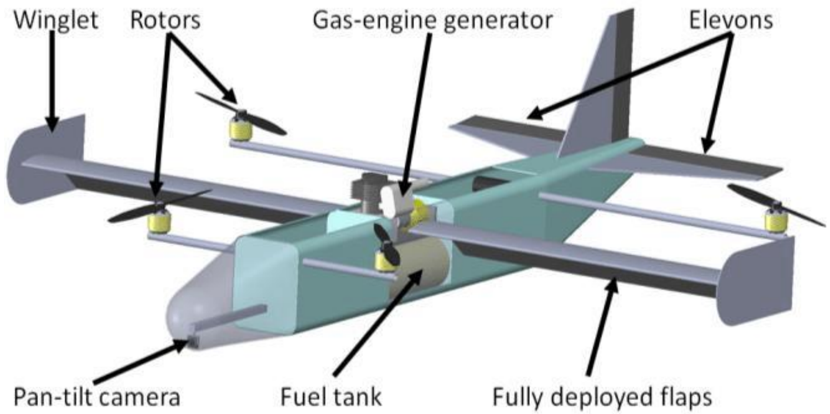


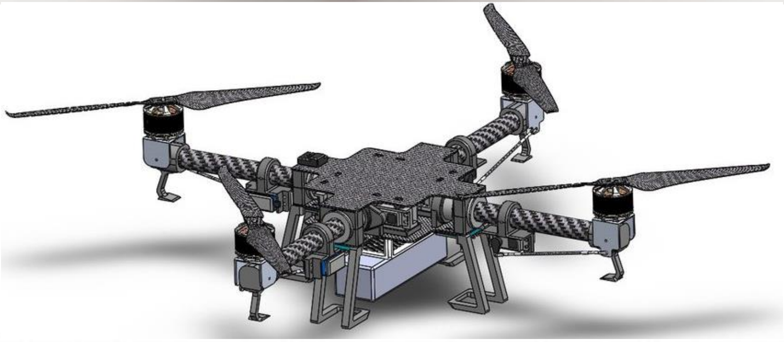


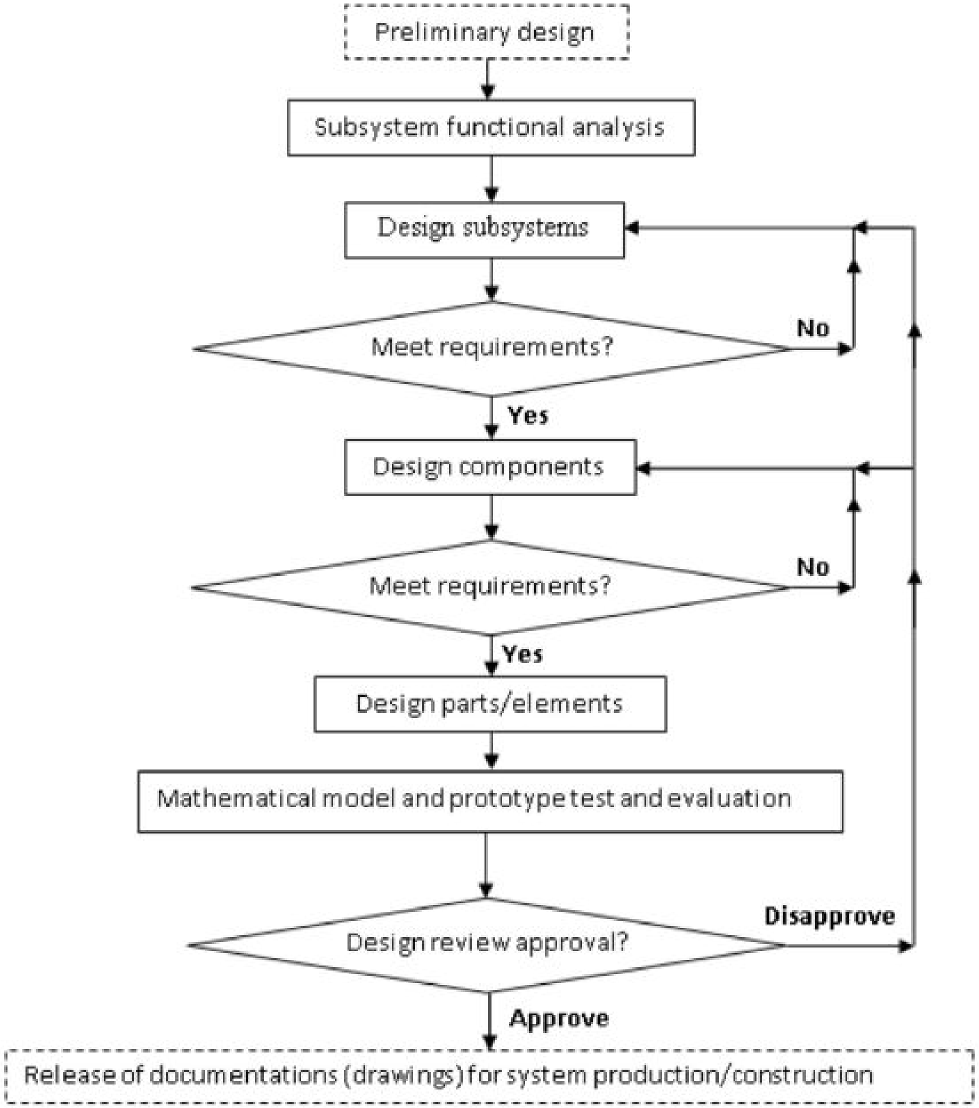


Design Process of Drones

❖ Detail system design



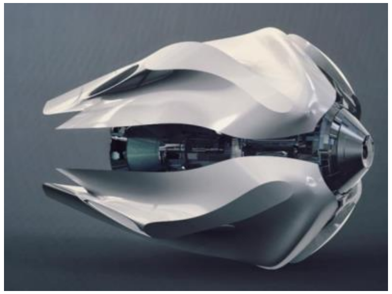


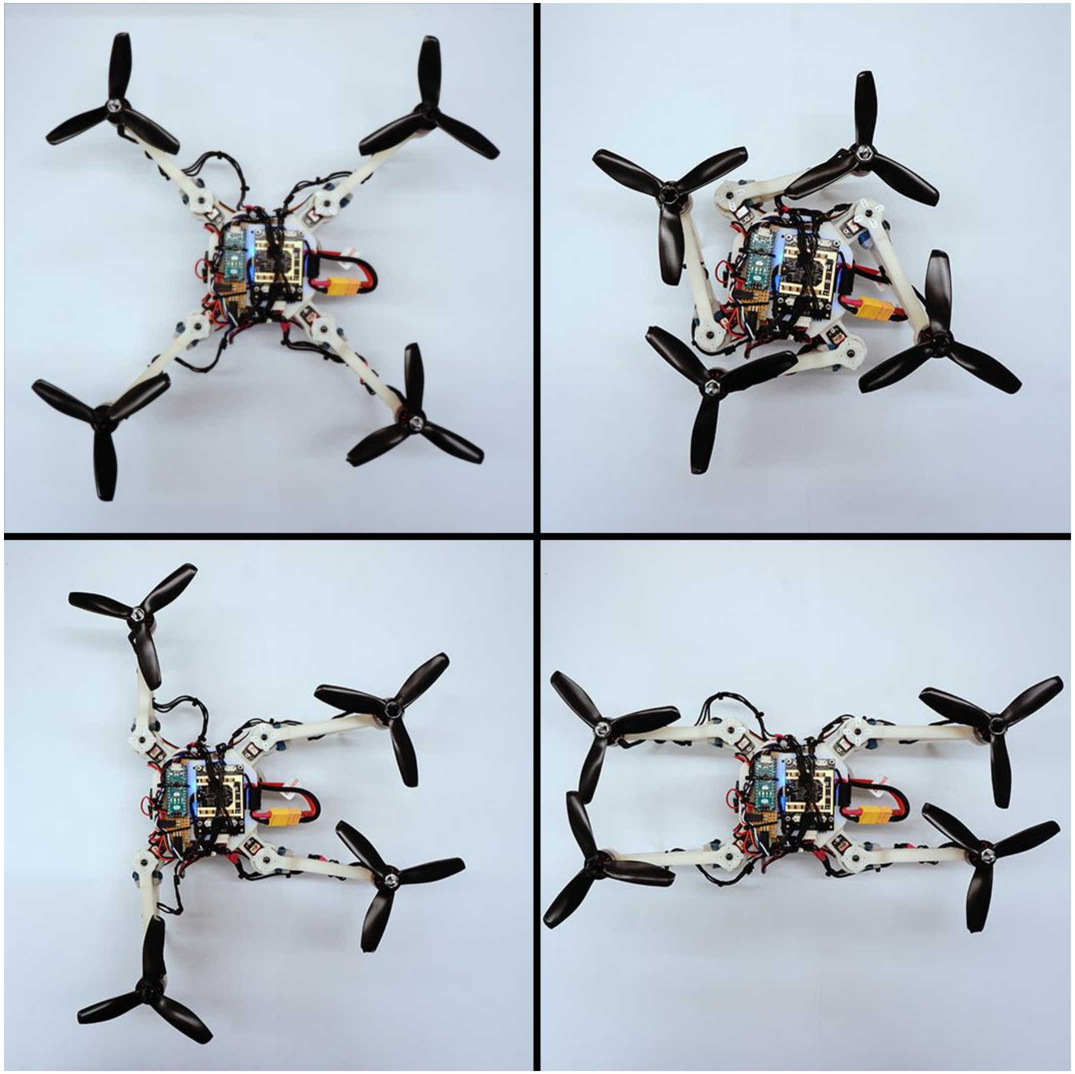


Design Process of Drones

❖ Design requirements

1. Performance requirements
2. Stability requirements
3. Handling requirements
4. Operational requirements
5. Affordability requirements
6. Reliability requirements
7. Maintainability requirements
8. Producibility requirements
9. Evaluability requirements
10. Usability requirements

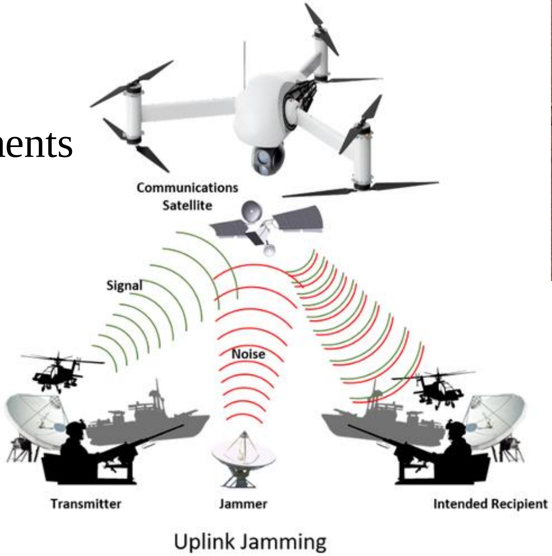




Design Process of Drones

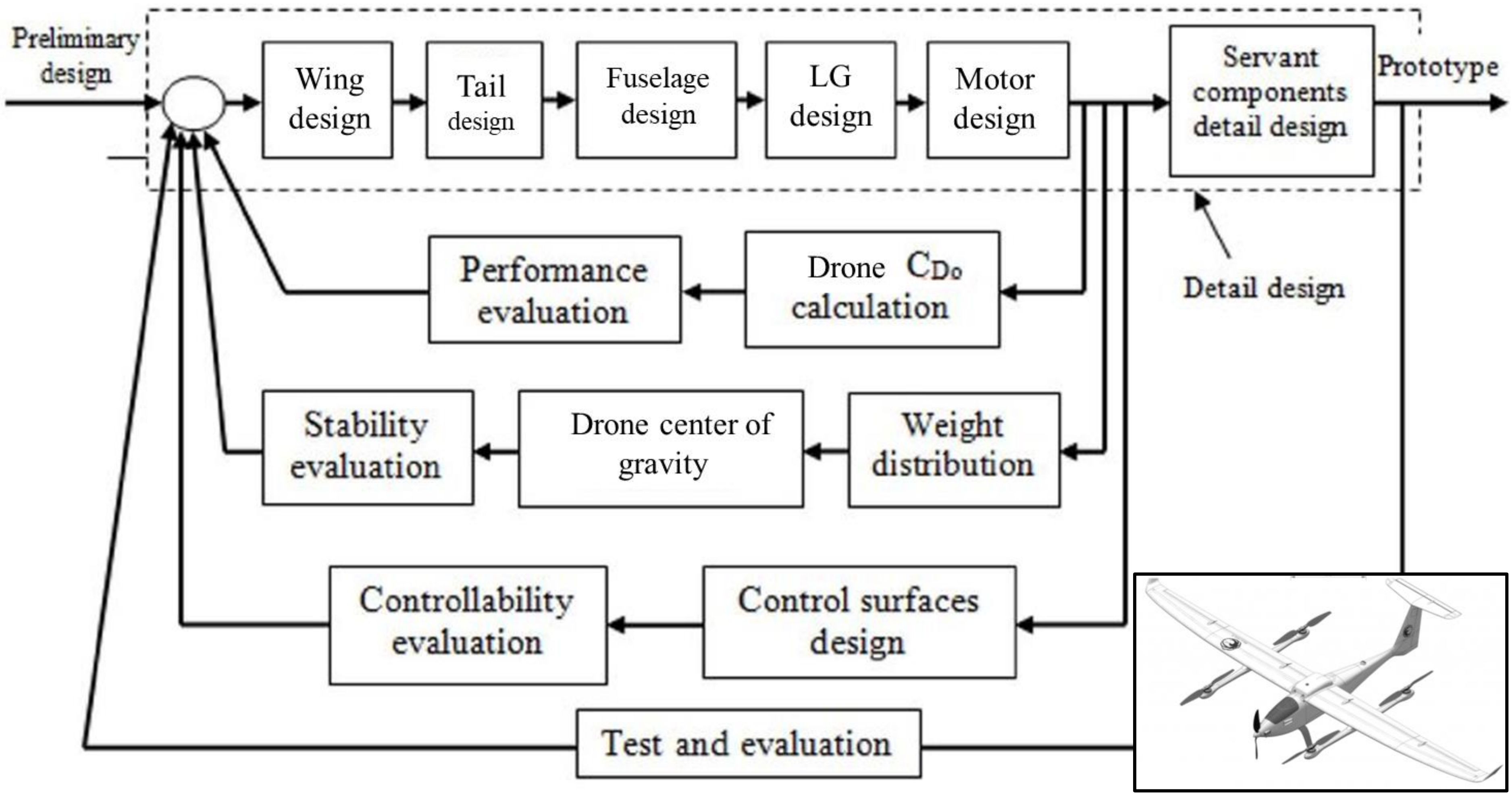
❖ Design requirements

11. Safety requirements
12. Crashworthiness requirements
13. Supportability and serviceability requirements
14. Sustainability requirements
15. Disposability requirements
16. Marketability requirements
17. Environmental requirements
18. Detectability requirements
19. Standards requirements
20. Legal requirements



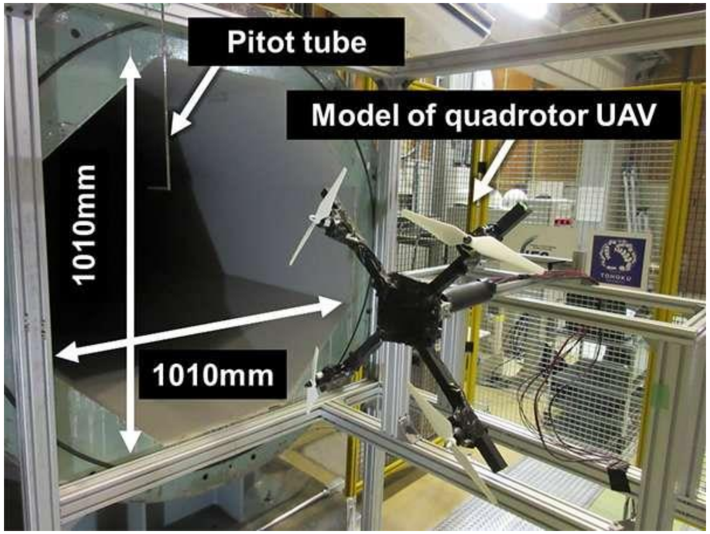
Design Process of Drones

❖ Detail design phase and design feedbacks



Design Process of Drones

❖ Design phase and test and evaluation



Design Requirements

Configuration design

Preliminary Design

Flight Tests

Detail design of dominant components

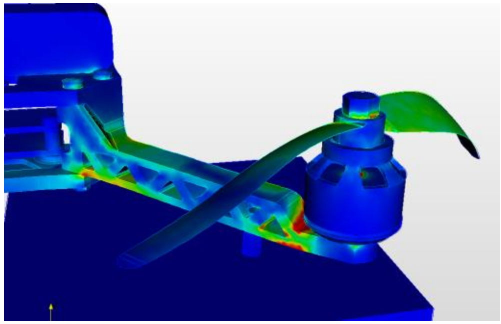
Wind Tunnel Tests

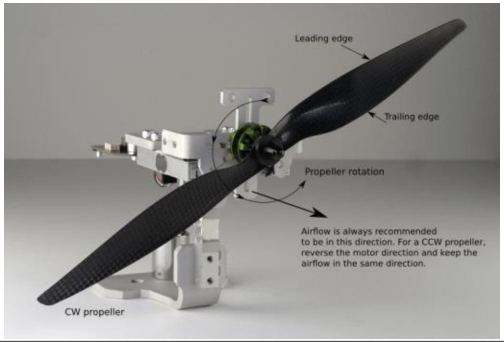
Structural Tests

Detail design of servant components

Engine Tests

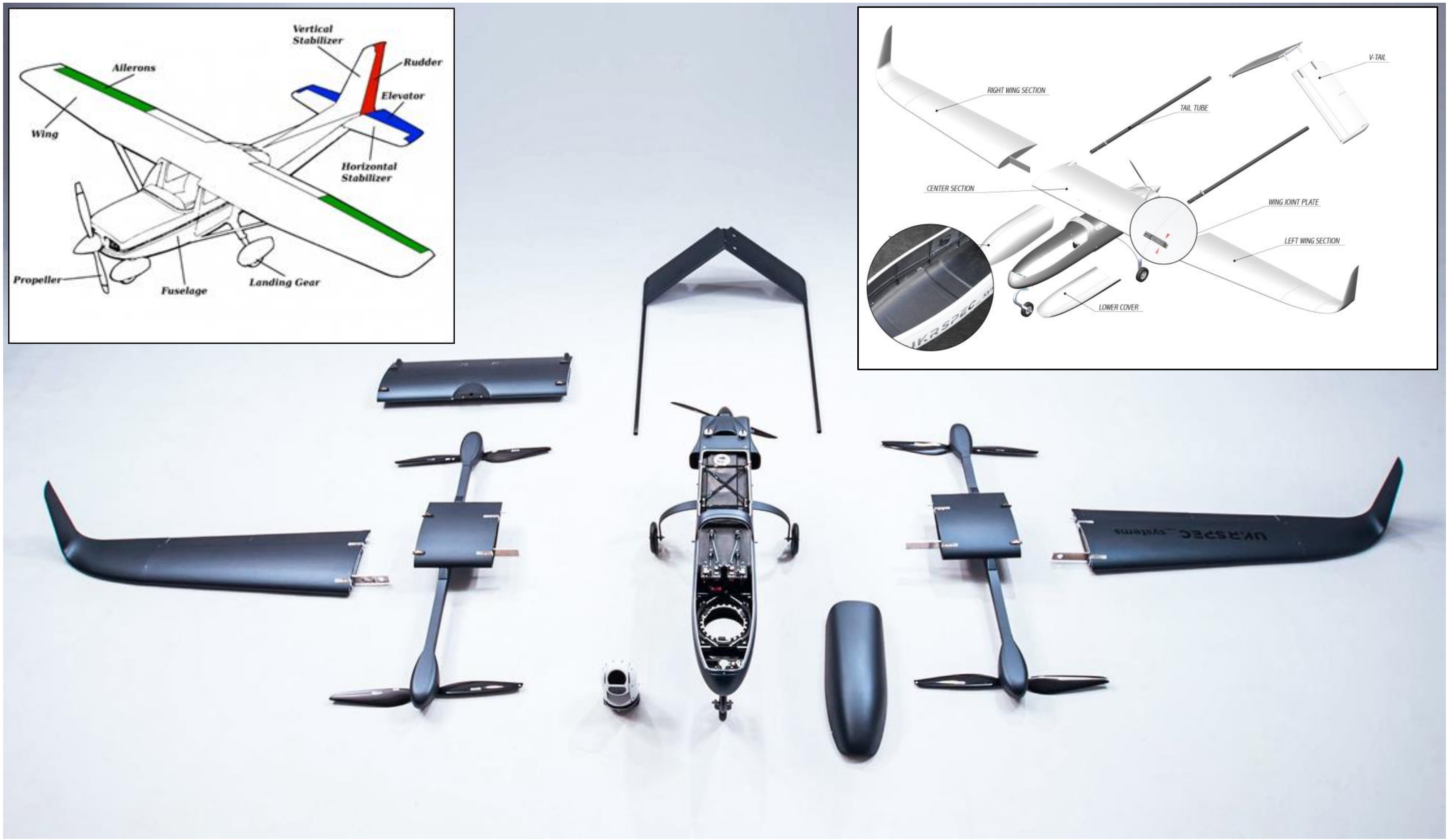
Certification





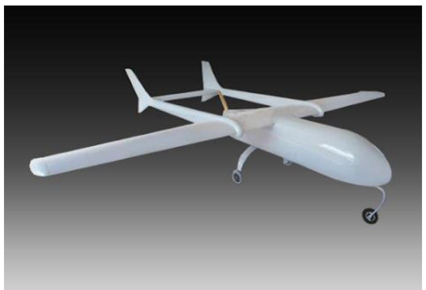
Design Process of Drones

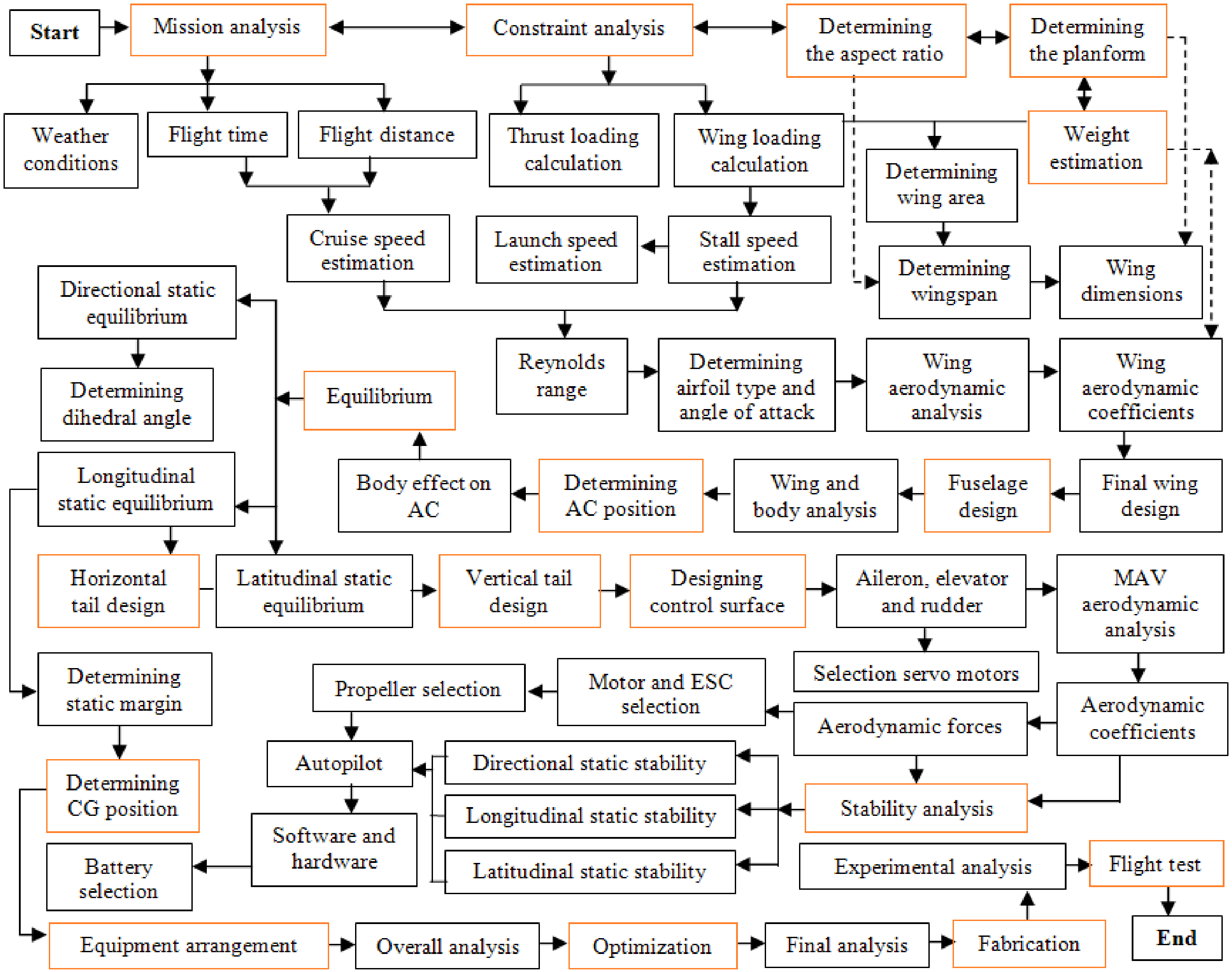
❖ **Design process of fixed-wing drones**



Design Process of Drones

❖ Design process of fixed-wing drones

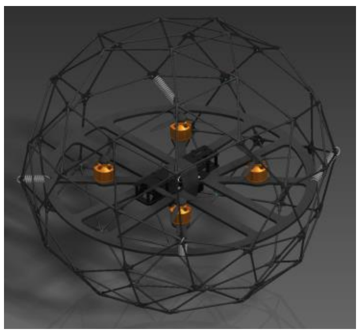


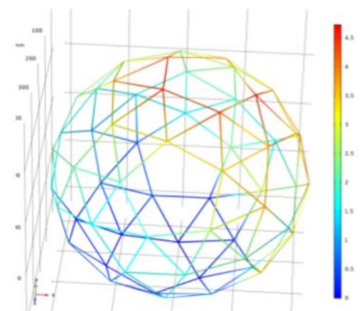


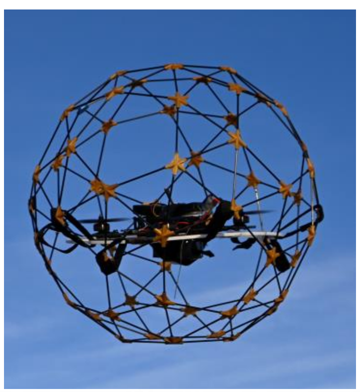
Drones and applications

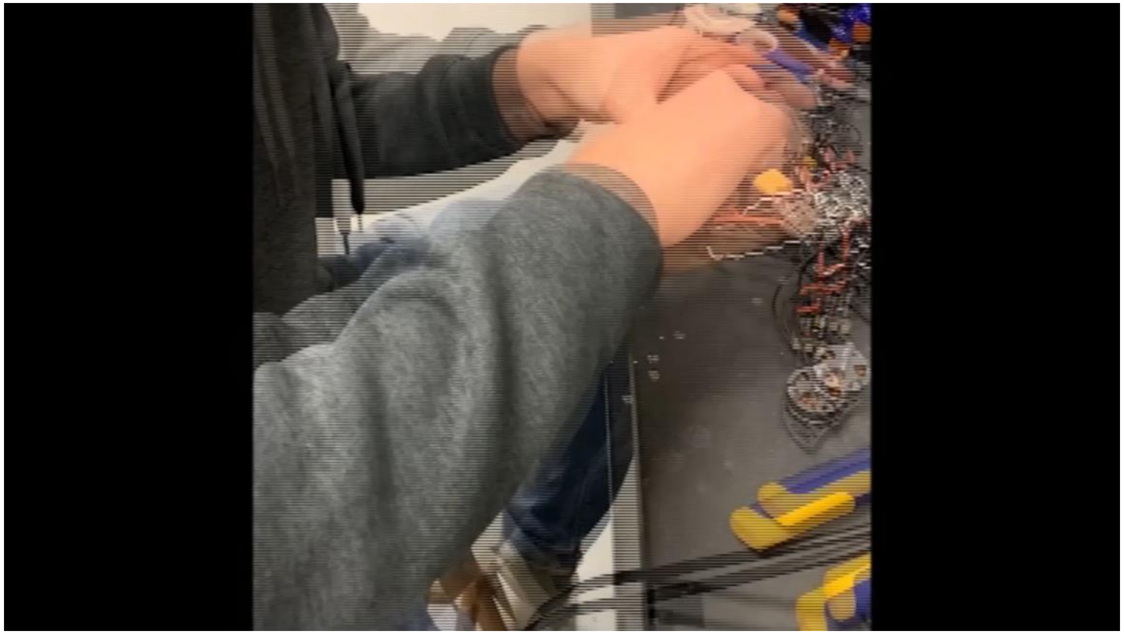
❑ Drones for mining and subways inspection

- ❖ Design of a fully autonomous encased micro drone for mining applications
- ❖ Autonomous routing of drones in an enclosed areas such as mines and subways









Shahmoradi, J., Talebi, E., Roghanchi, P. and Hassanalian, M., 2020. A Comprehensive Review of Applications of Drone Technology in the Mining Industry. Drones, 4(3), p.34.

❖ Design of multirotors drones

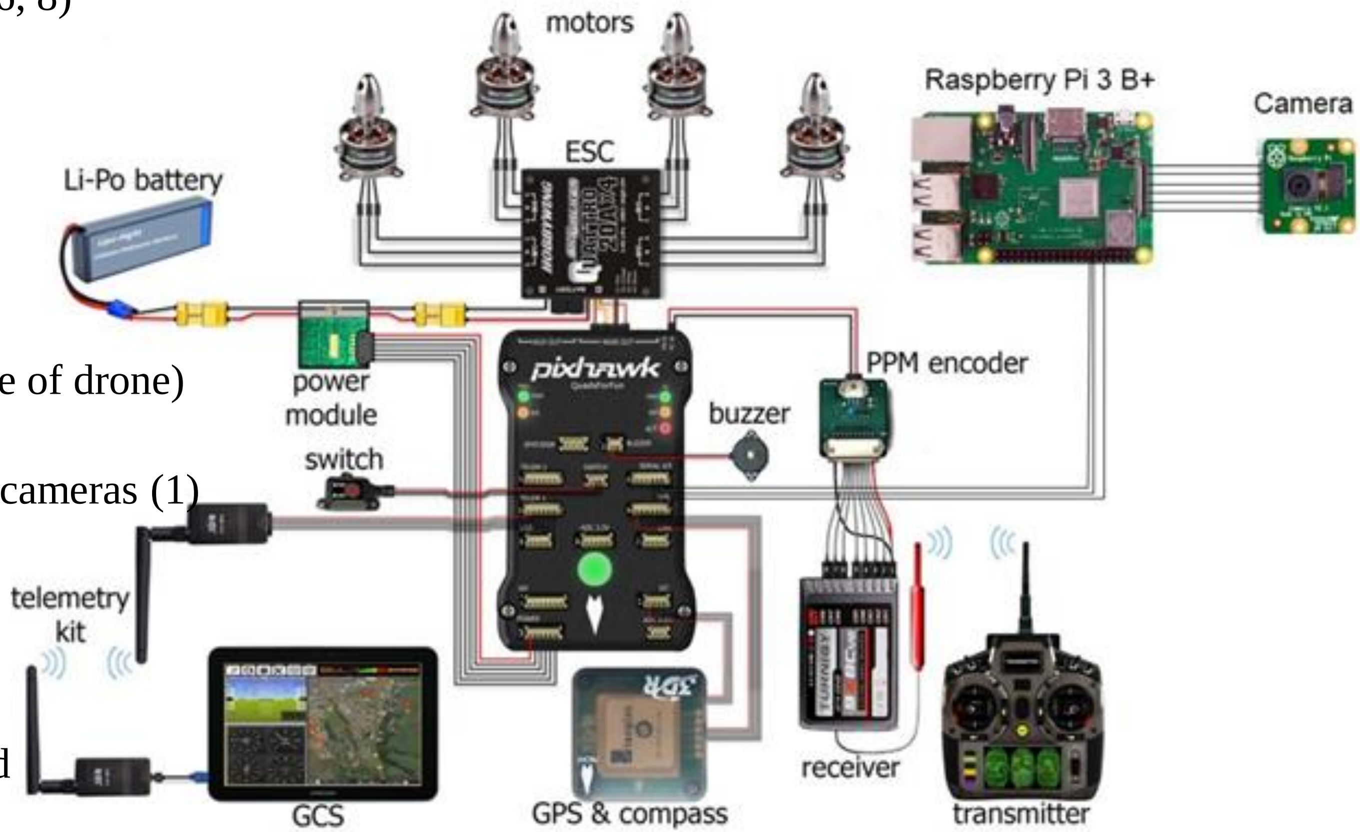
Structure parts:

- Carbon Fiber RC Drone-frames
- Motor Mount
- Polymers:
- Carbon sheet
- Carbon rods
- 3D printing materials: Polycarbonate, Polypropylene (PP)
- Ceramic coating
- Nuts and bolts
- Bearings
- Cable
- Soldering lead

❖ Design of multirotors drones

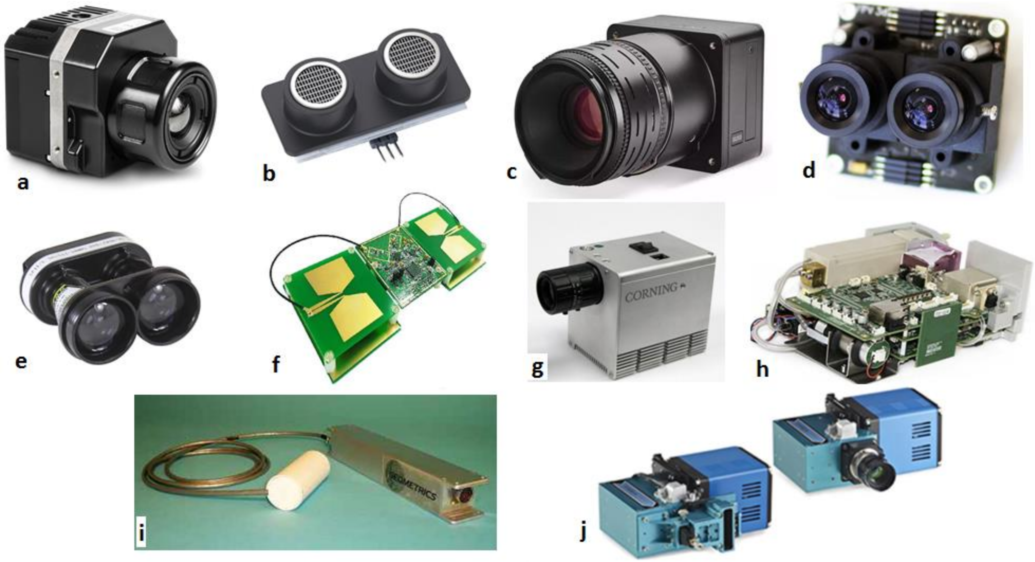
Electronics equipment:

- Motors (4, 5, 6, 8)
- Servo motors (In case of adding some capabilities to drone)
- Speed controllers (4, 5, 6, 8)
- Propellers (4, 5, 6, 8)
- Receiver
- Transmitter
- Antennas
- Modem
- GPS
- Battery (Depends on size of drone)
- Battery Monitor
- Camera Thermal vision cameras (1)
- Gimbal
- Gimbal Motor
- Gimbal Controller Unit
- Flight controller
- Power distribution board
- LEDs



Design Process of Drones

❖ Design of multirotors drones

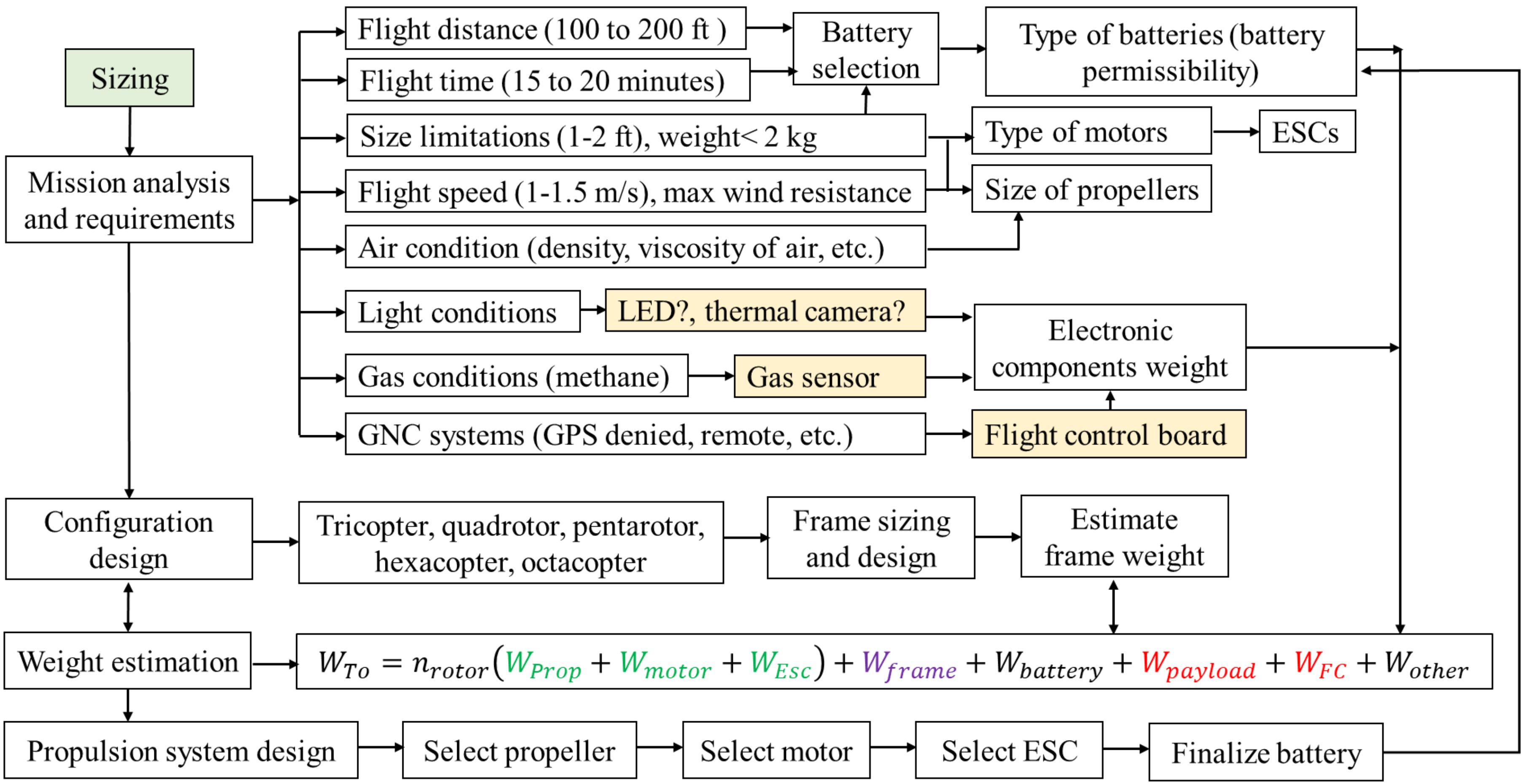


(a) infrared sensor, (b) ultrasonic sensor, (c) RGB camera, (d) stereo cameras, (e) laser range finders, (f) ultra-wideband radar (UWB), (g) hyperspectral sensors, (h) magnetic sensors, (i) gas detector, (j) visible and near-infrared spectral range (VNIR)

Sensors:

- Lidar
- LiDAR USA Snoopy
- LiDAR USA GNSS Ground Station
- LiDAR Laser Scanner
- LiDAR USA data processing packag
- Marco Polo System
- RealSense Module
- Gas detector sensor (coal mines)
- IMU sensors (Accelerator sensors, angular velocity sensors, Gyro)
- Collision Avoidance Sensors
- Monocular Vision sensor
- Ultrasonic (Sonar) sensor
- Infrared sensor
- Time-of-Flight (ToF) sensor
- Vision sensor

❖ Design of multirotors drones



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