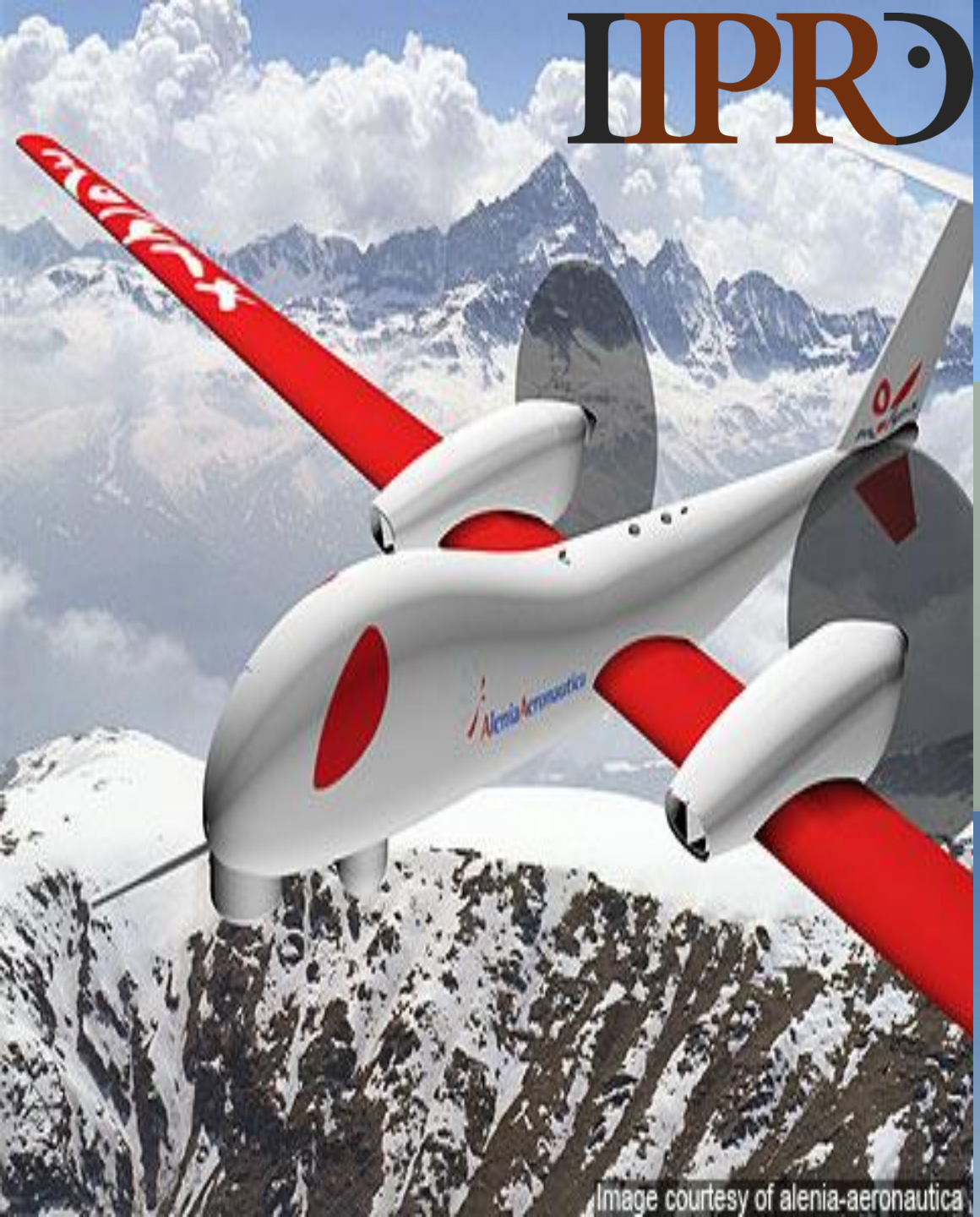
IIPRD



Exemplary Technology and Patent Landscape Report On Unmanned Aerial Vehicle (UAV)

Content

1) Introduction to UAV
2) Applications of UAV
3) Growth Prospects of UAV
4) Assumptions for the Instant Landscape Analysis
5) Study Methodology and Modus-Operandi
6) Graphical and Analytical Representation

Introduction-Drone

- **Definition- Drone**
  Unmanned Aerial Vehicle;
  An aircraft with no pilot on board;
  Can be a remotely operated aircraft (ROA).

- **Control Functionality**
  On-board self control of computers; or
  Remotely controlled by a pilot from the ground.

- **Communication Means**
  Equipped with different means of short range and long range communications;
  Terrestrial, Radar, Satellite, IR etc.

- **Application**
  Entertaining/Recording
  Protecting/Inspecting
  Evaluating/Managing
  Delivering/Transporting

- **Dimension and Payload**
  Varied dimensions according to targeted application.

- **Intelligence**
  Artificial intelligence;
  capable of self taking off;
  automatic landing, and flying.

Evolution of Drones

Image Courtesy:- Fairfaxnews.com

Evolution

- 1990-2015: Fully Automated Drones
- 1970-1990: Human Guided Drones
- 1951-1970: Fully Piloted Drones

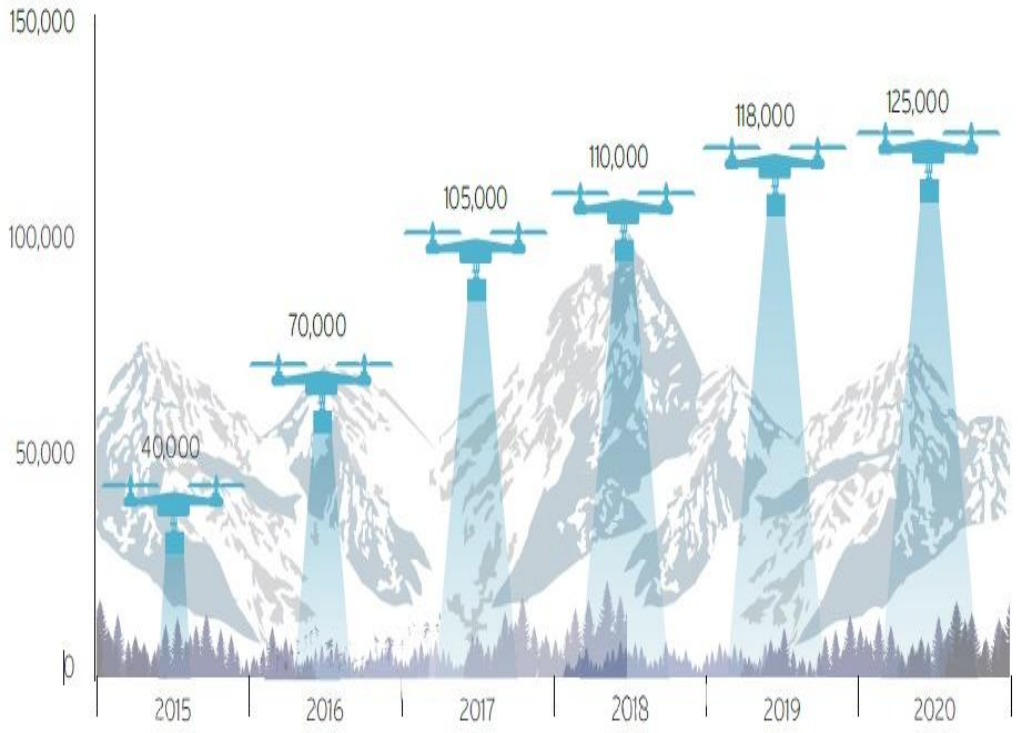
Applications of UAV

- With the announcement and successful trials of pizza delivery, drone technology got a boost. Now technology optimization oriented companies dealing in delivery of consumer products or FMCG, generally in E-commerce are taking keen interest.

- In coming future, drones could be used in day-to-day applications, even for applications in reporting, shooting, agriculture, defense etc.

Capability Timeline

Growth Prospects for UAVs



Source: Association of Unmanned Vehicle System International.

- According to projections and forecasts, market size of unmanned aerial vehicle was $6,762 million in 2014 and is expected to register a CAGR of 7.73%, to reach $10,573 million, by 2020.
- North American, APAC and Middle Eastern markets are expected to contribute largely in terms of procurement and manufacturing.

Objectives of the Landscape/Study

- To Understand Technology and Patent Landscape.
- To Understand major patent holders, geographical distribution of patents, top sub-technologies based on classification codes.
- To Analyze patent filing trends over the years, top assignees, top Patent Classifications, among others.
- To Conduct problem-solution approach based study of patents relating to constructional aspects of drones/UAVs.
- To Understand manufacturing problems, design issues, communication standards used, applications such as defense, agriculture, product delivery, wireless beaming etc., sensors incorporated, self drive/fly features, and other features and technology being incorporated.

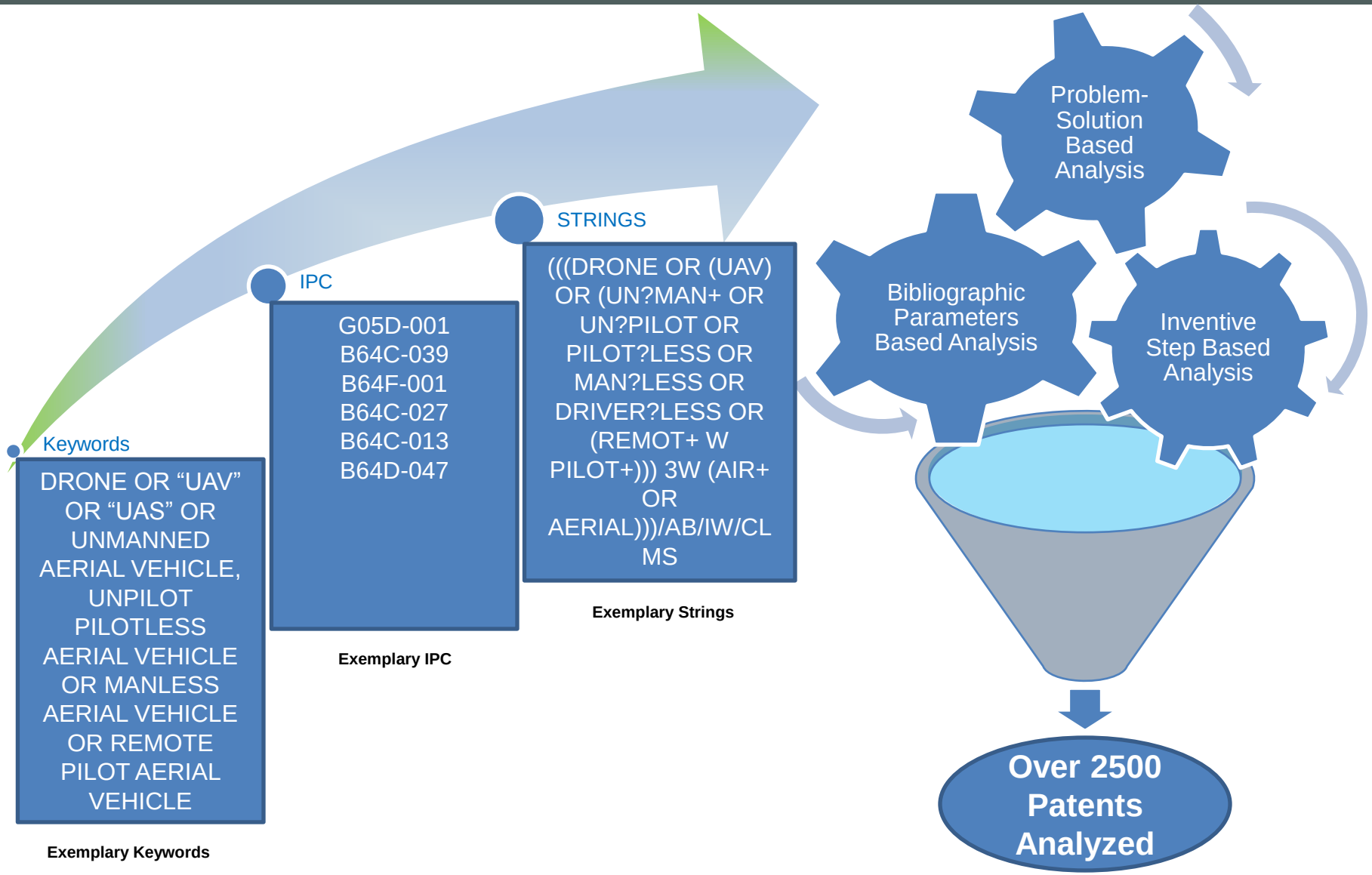
Assumptions

- The Report provides patent analysis for unmanned aerial vehicles (UAV) market, which includes study of manufacturing of drones, various components, and advance technology based patents.

- The study was focused to find out patents solving construction/structure level prior art problems related to drones in various areas e.g. navigation, control, power etc.

- The study does not focus on patents pertaining to drone applications in various fields, e.g. use of drones for delivery, agriculture, inspection and surveillance etc. Application-oriented patents disclosing use of drones in one or more industrial applications have therefore not been analyzed part of the study.

Snapshot of Working Methodology



Patent Filing Trend

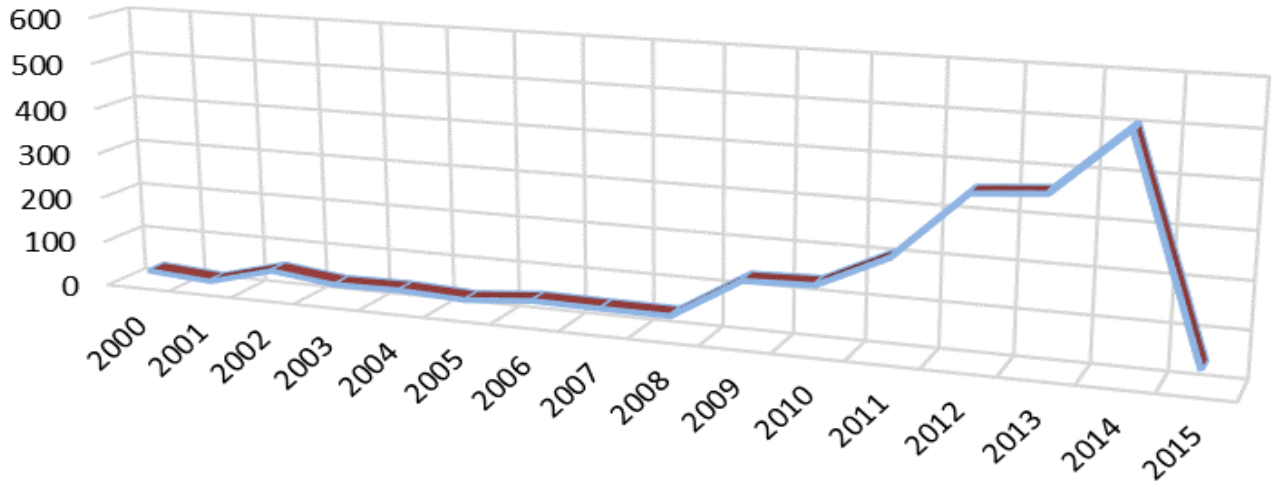


Exhibit 1. Patent Application Filing Trend For Last Fifteen Years.

As evident from Exhibit 1, global patent filing trend presents a significant increase in filing during the last decade. However, filing has grown tremendously during last five years specially in years 2012, 2013, and 2014. Numbers for 2015 are low as a number of patents are yet to be published. The number is based on Priority Date Based Analysis

Geographical Filing Trend

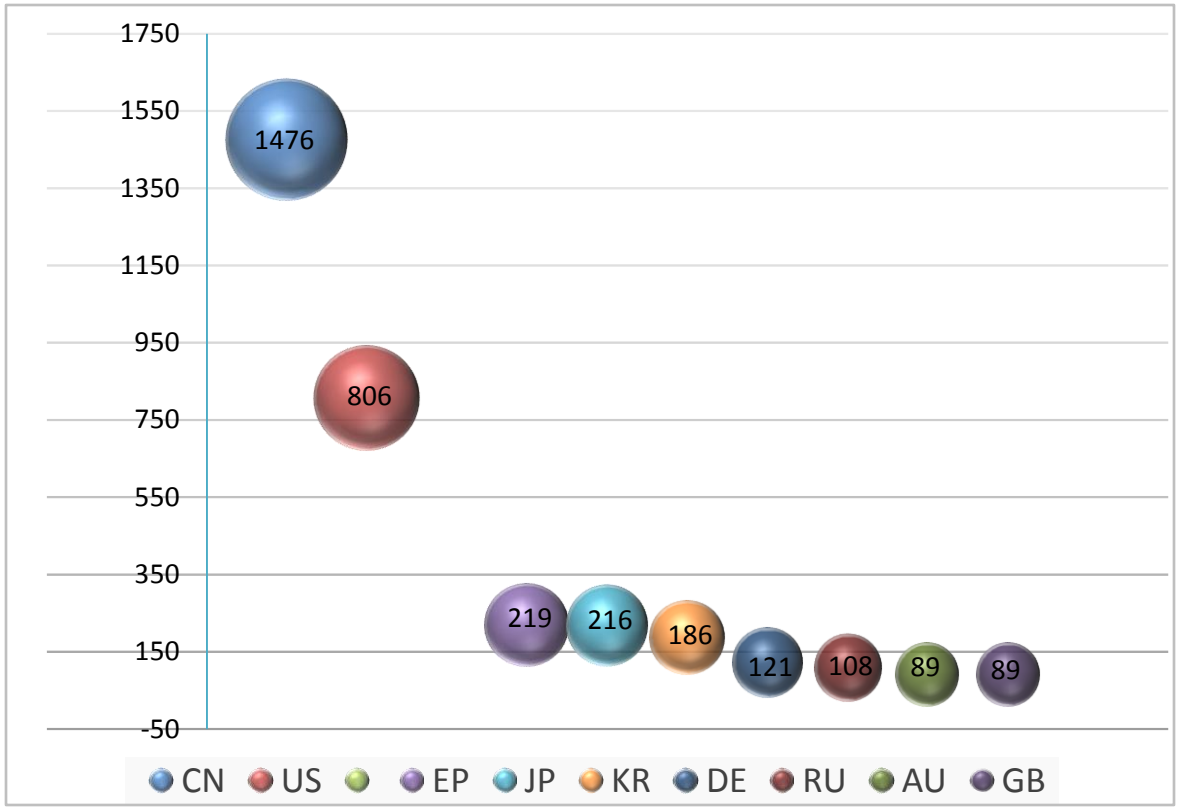


Exhibit 2. Geographical Filing Trend.

Exhibit 2 shows global patent distribution, which demonstrates that geographical patent distribution is led by China. China is a world leader in patent filing in UAV technology, followed by the US. Others geographies too have significant patent portfolio in this domain.

Overall Top Assignees

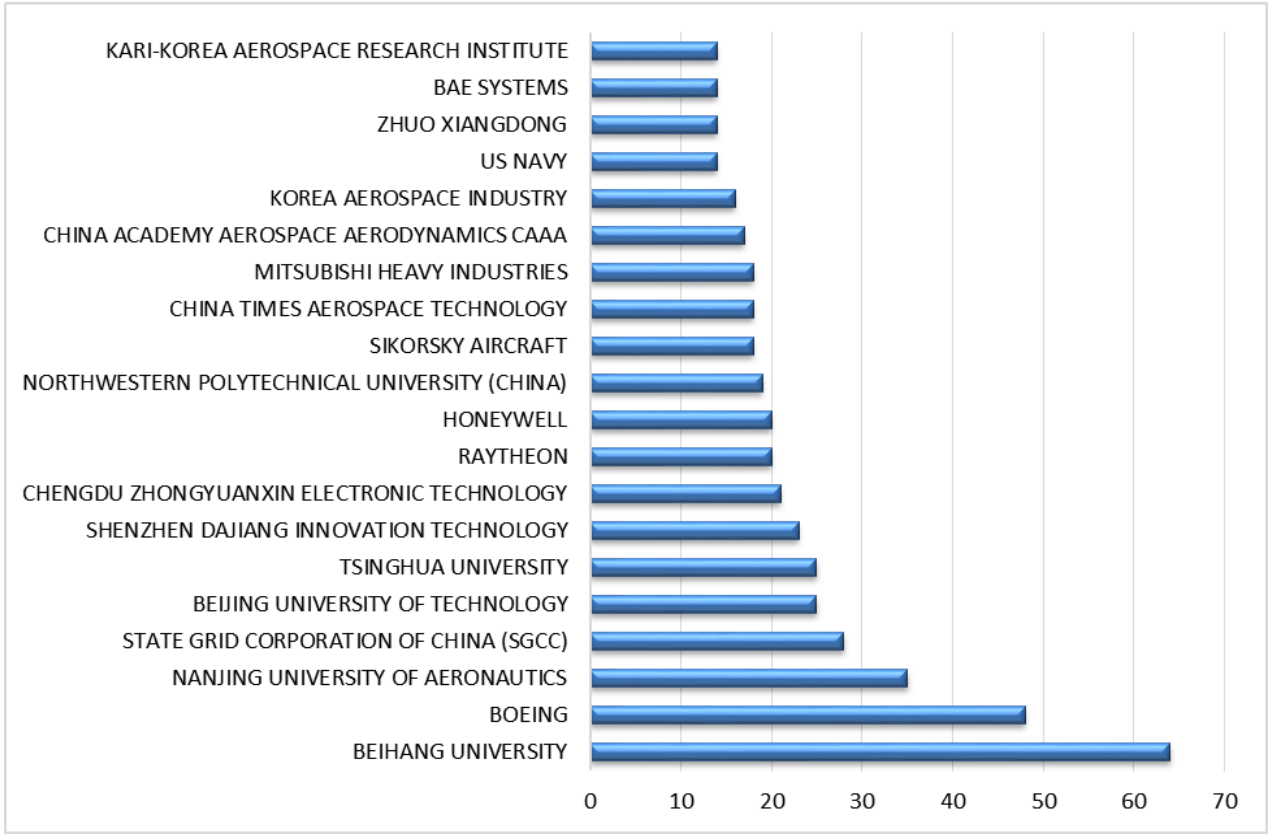


Exhibit 3. Top Patent Asset Holders

As is evident from Exhibit 3, Beihang University is among the leading patent filers in UAV Technology, followed by Boeing.

Corporate Top Assignees

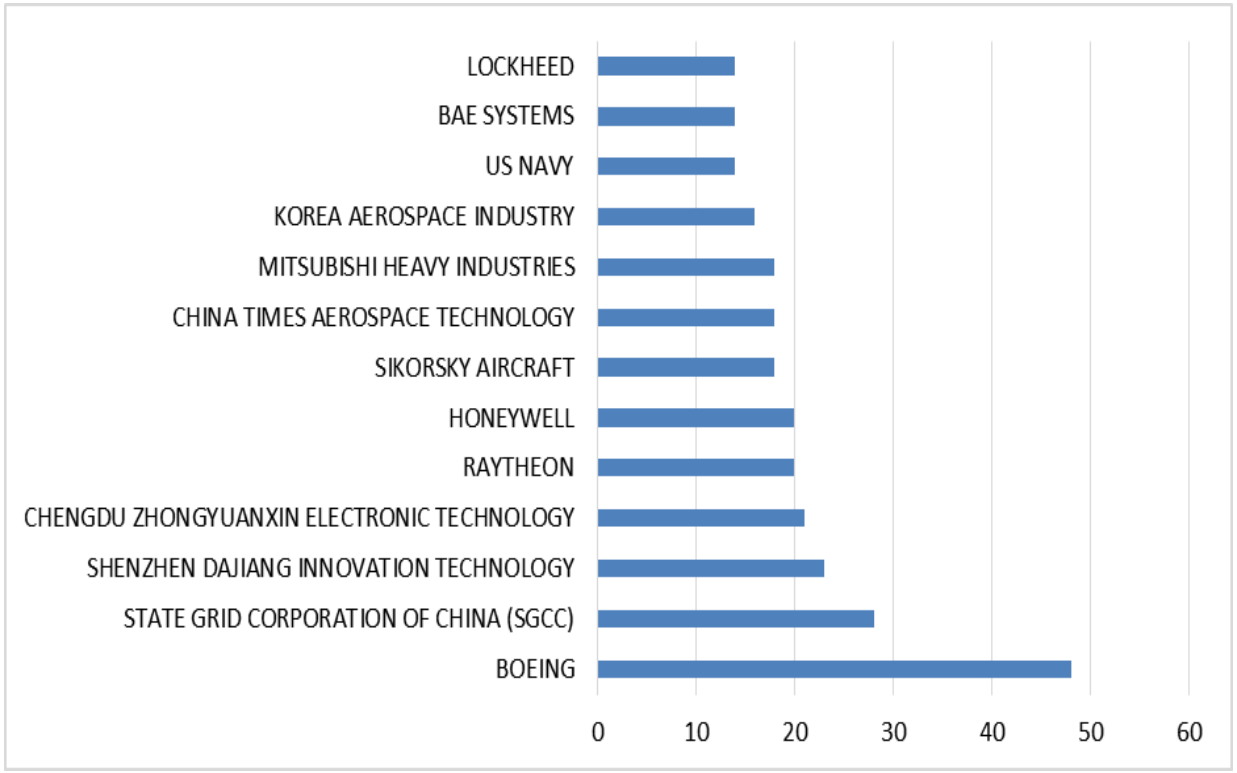


Exhibit 4. Top Corporate Patent Asset Holder

As is evident from Exhibit 3, Boeing is among the leading corporates filing Patents for Drones, followed by State Grid Corporation of China.

Top Assignees v/s Last Ten Year Filing Trend

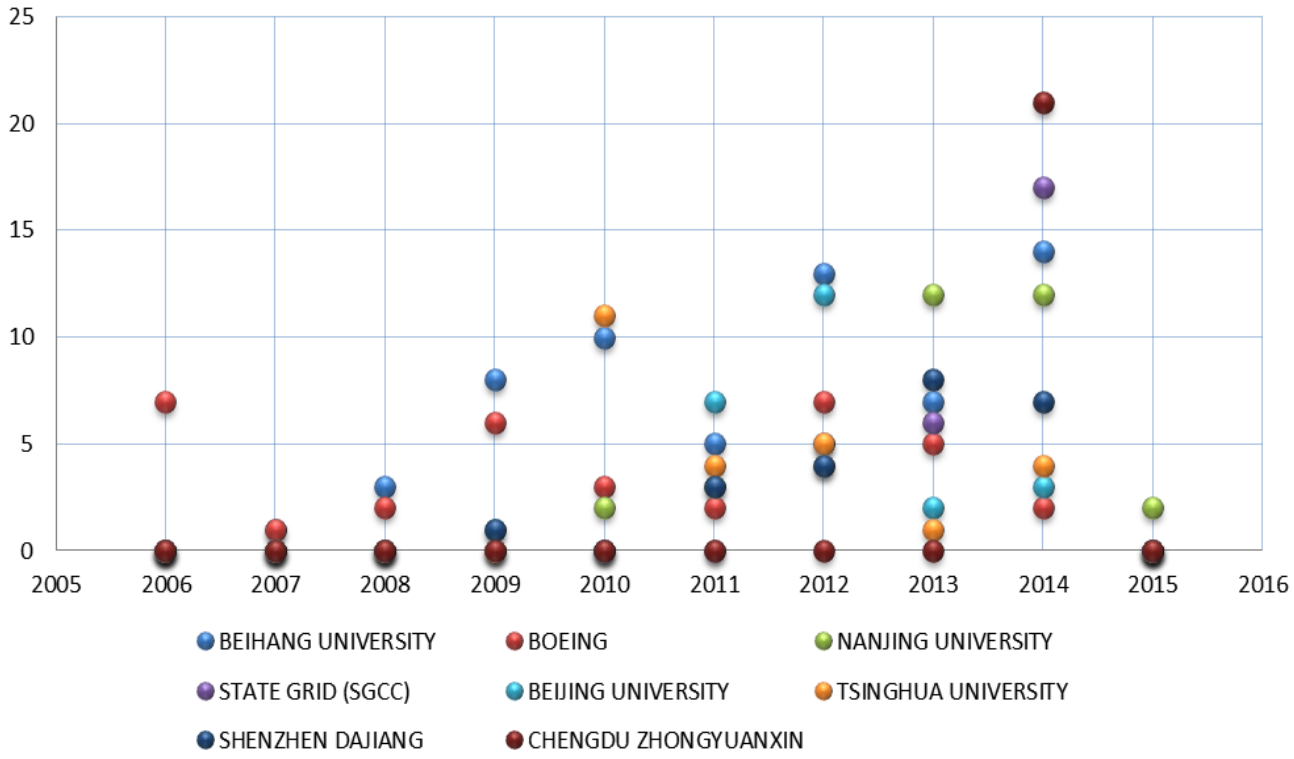


Exhibit 5. Top Assignee & Last Ten Years Filing Trend

Exhibit 5 shows last ten years filing trend for top Assignees. It is evident from the exhibit that each assignee has filed heavily in years 2012-2014.

Top Assignee vs. Category Distribution

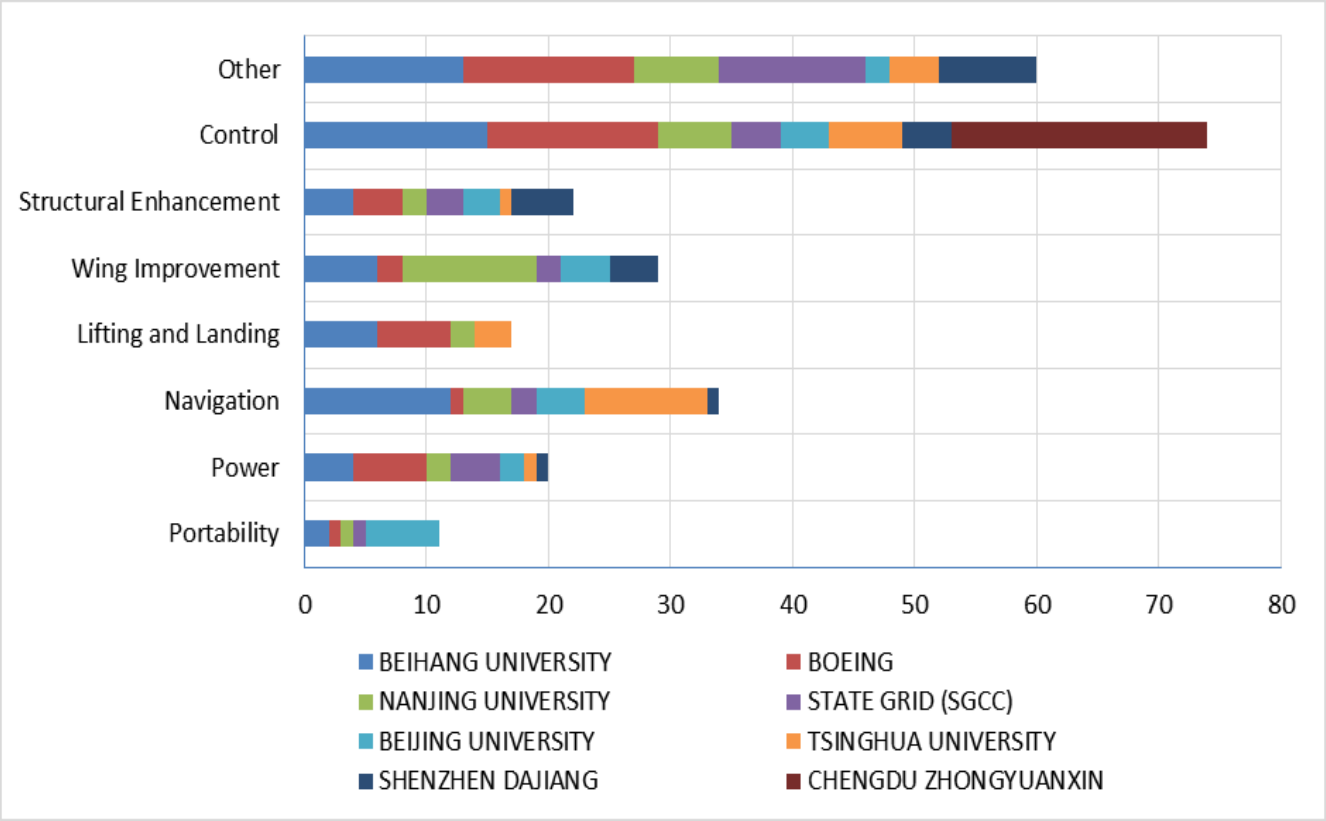
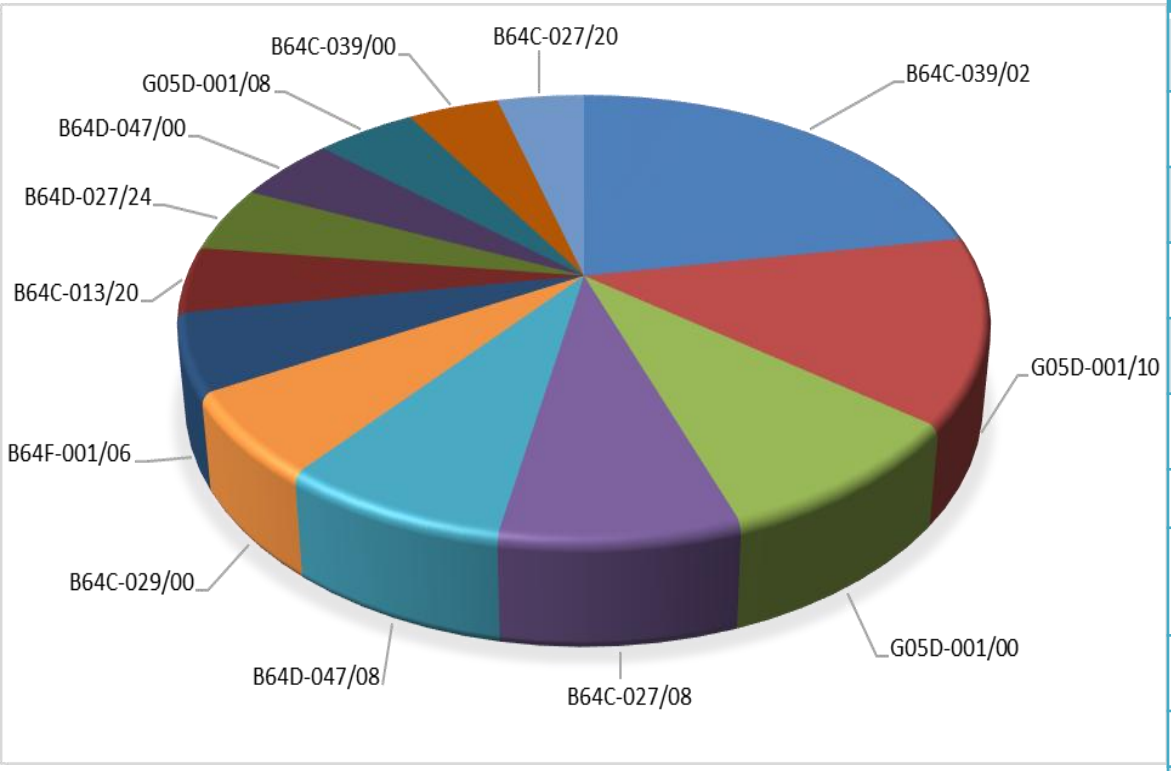


Exhibit 6. Top Assignee V/s Categorized Patent Filing

Exhibit 6 presents top assignees and their respective patent filing focus areas in various categories.

Top International Patent Classifications (IPCs)



IPC	Definition
B64C	Aeroplanes; helicopters
B64C-013/20	Using radiated signals.
B64C-027/20	Rotorcraft characterised by having shrouded rotors, e.g. flying platforms
B64C-027/08	With two or more rotors.
B64C-027/24	with rotor blades fixed in flight to act as lifting surfaces.
B64C-039/02	Characterised by special use.
B64D-047/08	Arrangements of cameras
B64D-027/00	Arrangement or mounting of power plant in aircraft; Aircraft characterised thereby
B64F-001/00	Ground or aircraft-carrier-deck installations.
B64F-001/06	using catapults
G05D	Systems for controlling or regulating non-electric variables.
G05D-001/00	Control of position, course, altitude, or attitude of land, water, air, or space vehicles, e.g. automatic pilot.
G05D-001/10	Simultaneous control of position or course in three dimensions.
G05D-001/08	Control of attitude, i.e. control of roll, pitch, or yaw.

Exhibit 7. Top International Patent Classification

Exhibit 7 presents top international patent classifications. It is evident from the Exhibit that classes B64C-039/02 and G05D-001/10 dominate.

Top Inventors

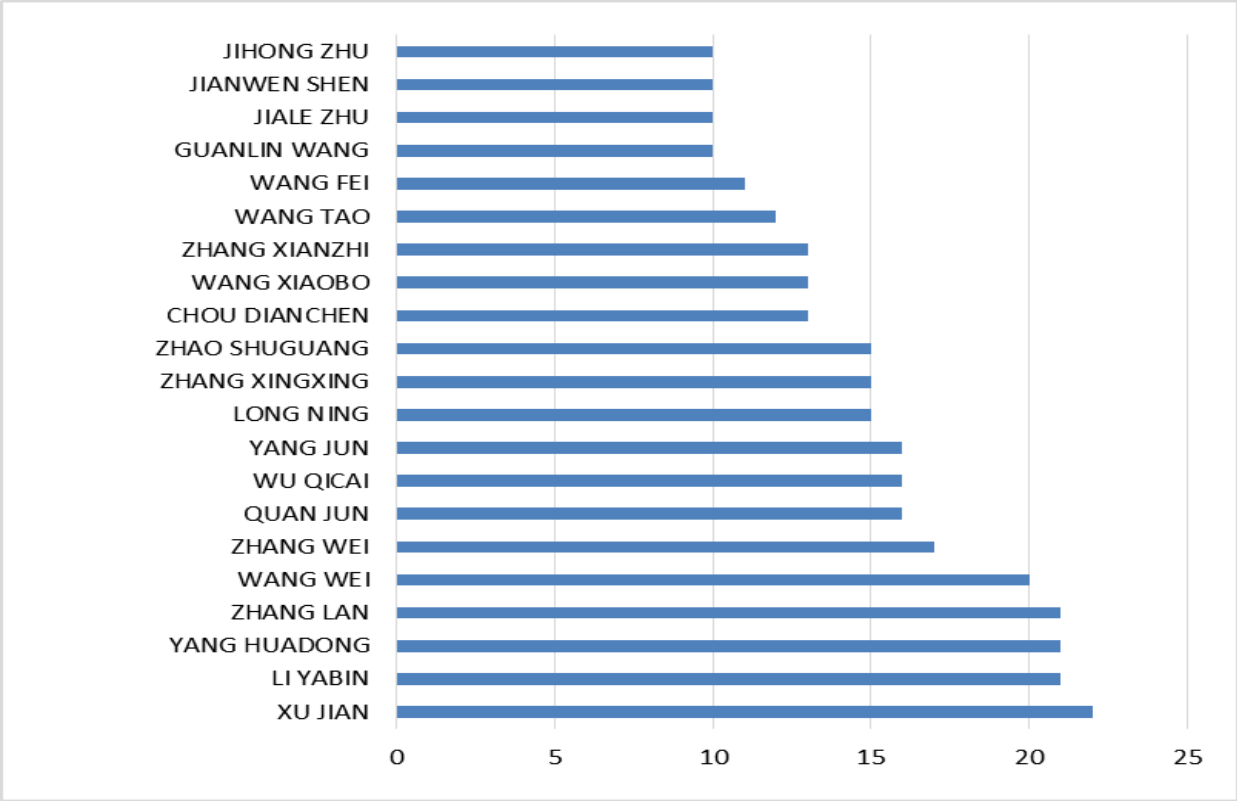


Exhibit 8. Top Inventors

As evident from the Exhibit 8, Xu Jian is among leading inventors in UAV Technology. Li Yabin, Yang Huadong and Zhang Lan follow thereafter.

Top Cited Patents

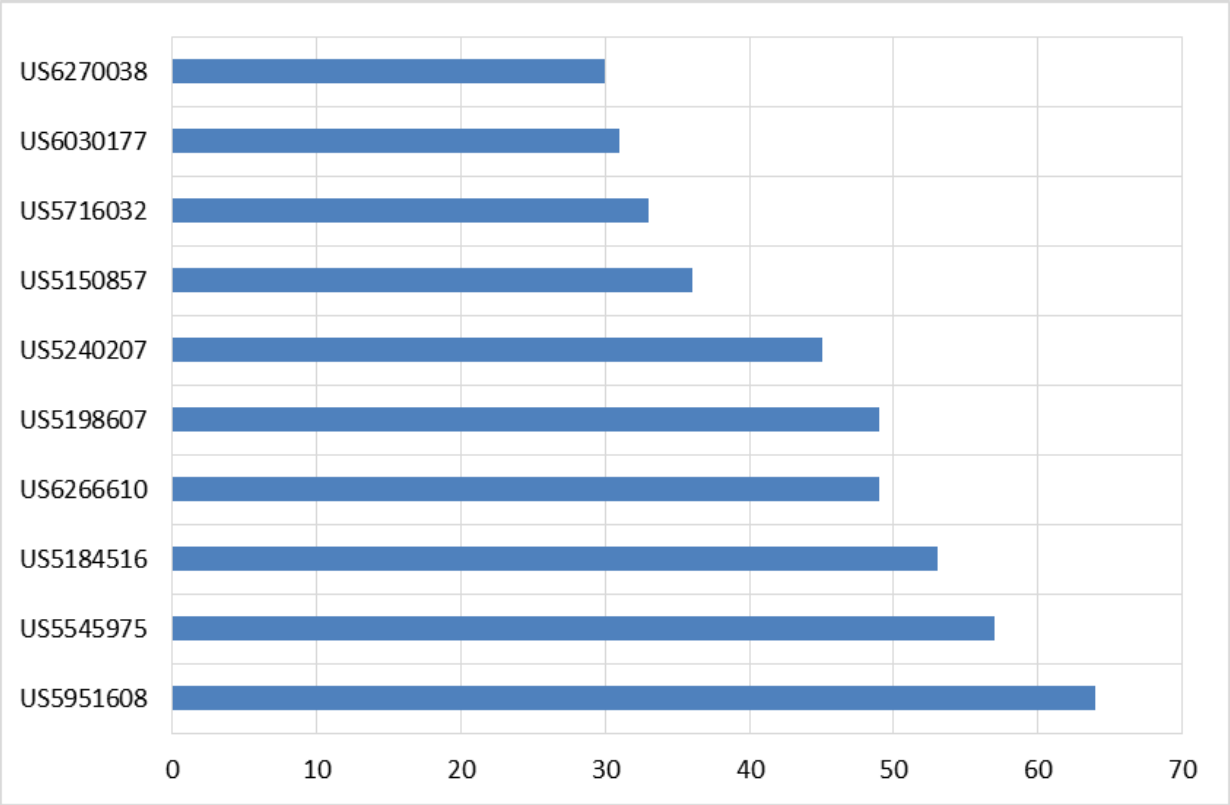


Exhibit 9. Top Cited Patents

As evident from Exhibit 9, from amongst the relatively new set of patents, US5951608, US5545975 and US5184516 are among the most cited patents in UAV Technology. US5951608 is cited more than 60 times.

Technology Classification

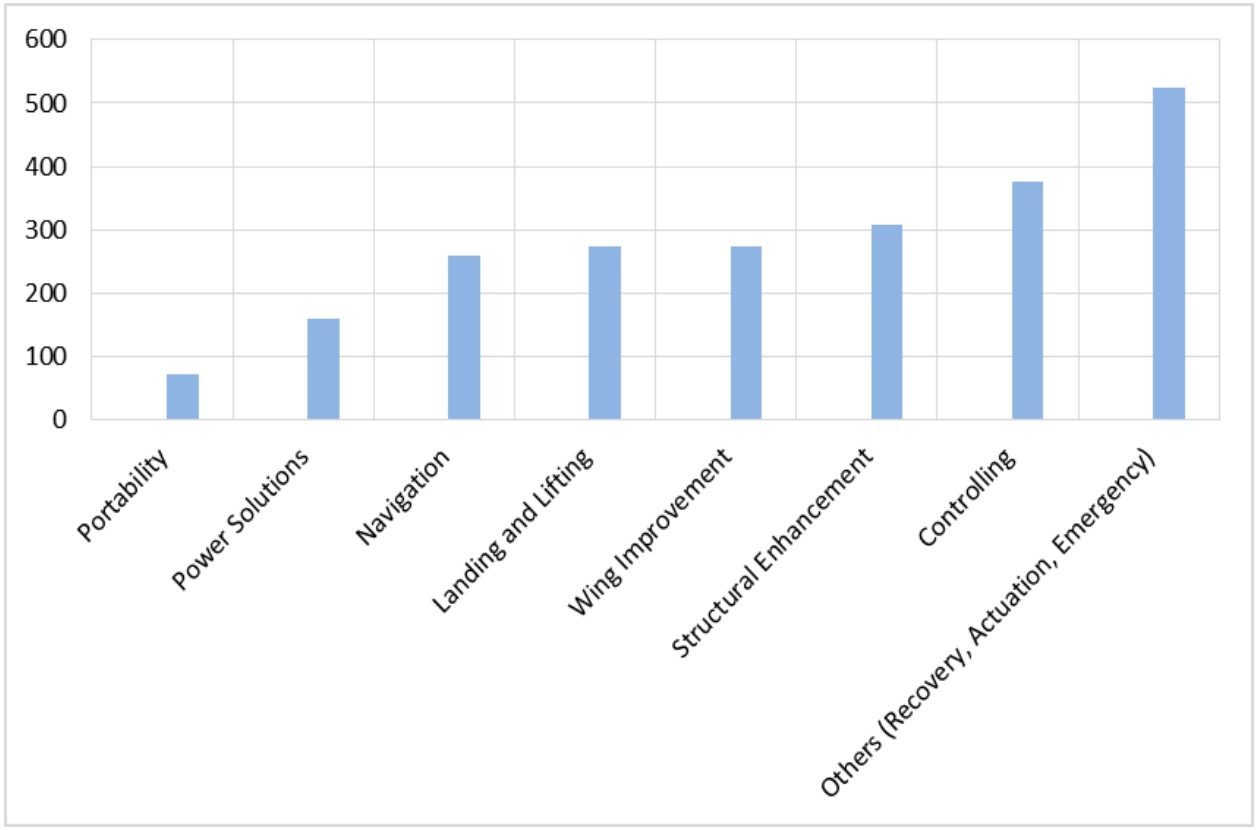


Exhibit 10. Categorized Distribution of Patents

Exhibit 10 presents patent distribution based on various categories pertaining to UAV technology.

Technology Classification

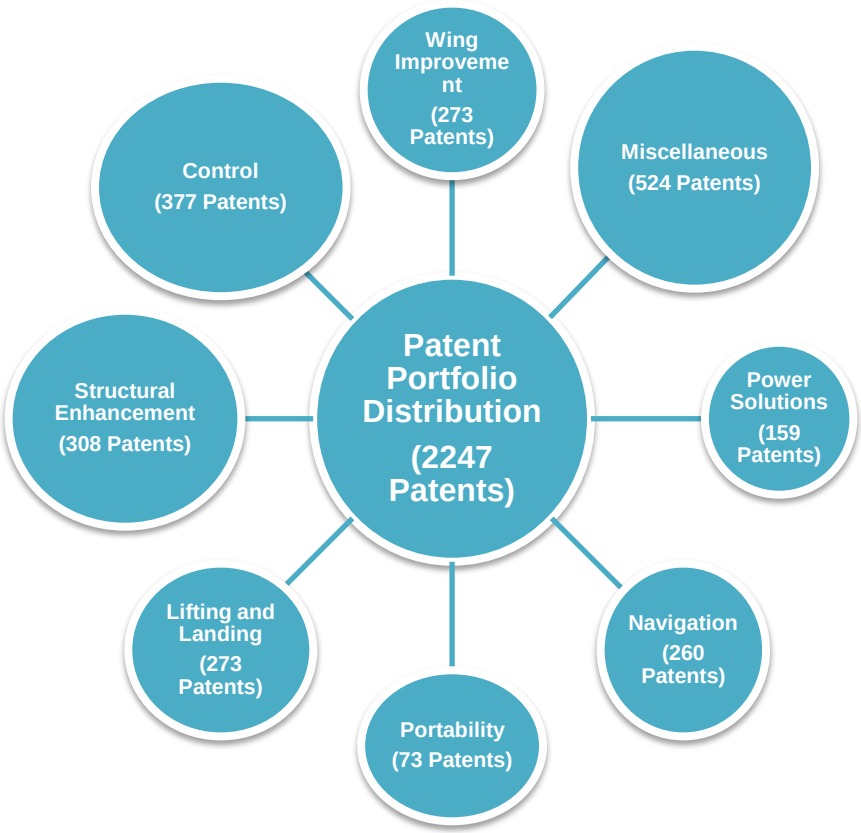
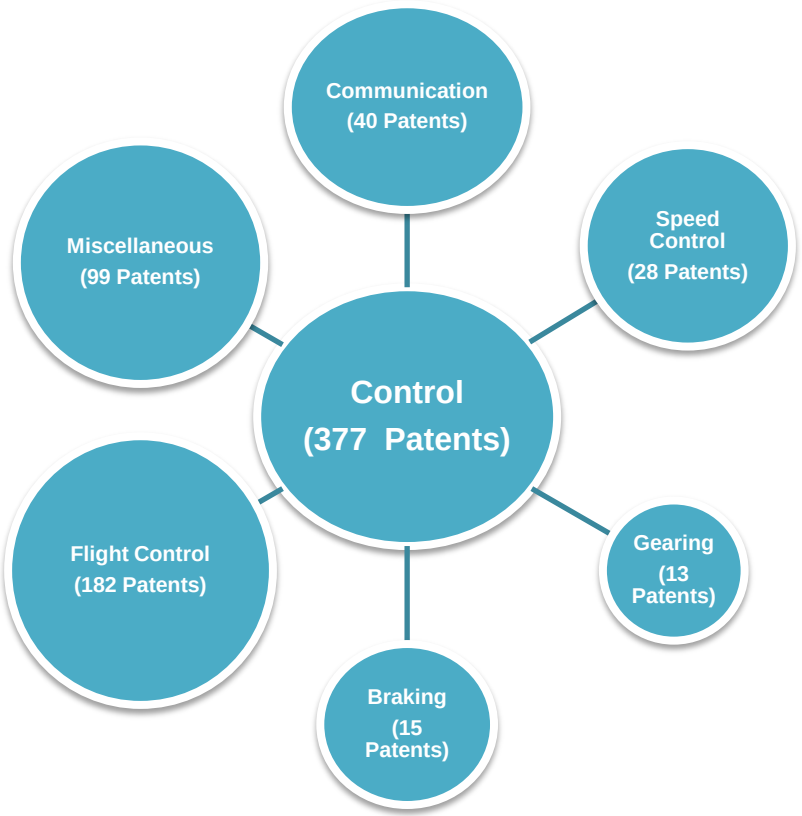


Exhibit 11. Categorized Distribution of Patents

Exhibit 11 displays patent distribution based on various problem solutions pertaining to UAV technology.

Technology Classification
Control

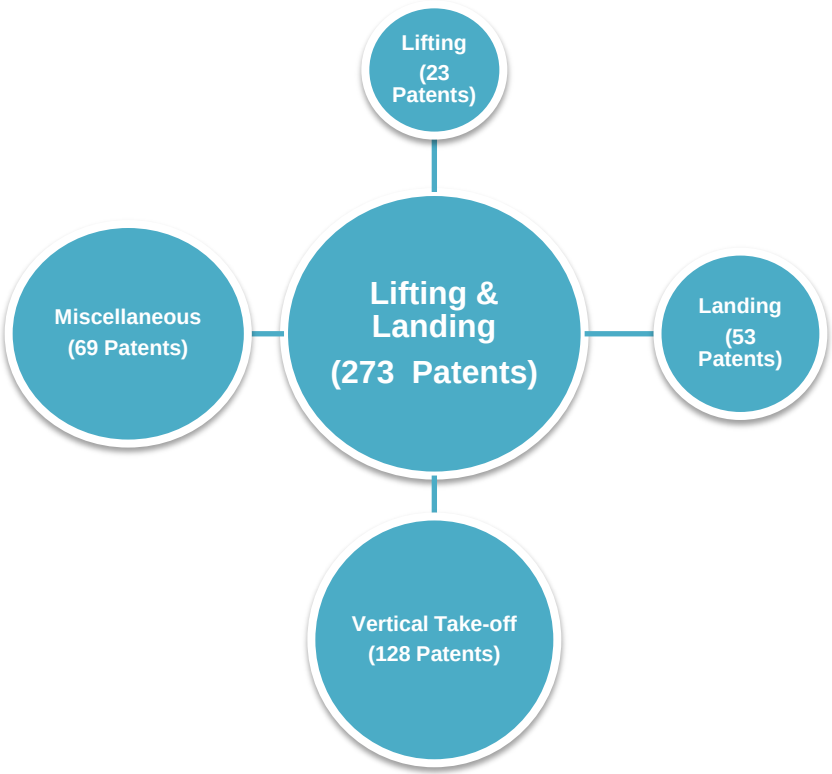


Patent No.	Analyzed Solution Offered by Patents
CN203894636U	Navigation through differential global positioning system.
US8594932	Flight control during plurality of targets on a single route.
US 8423204	Collision avoidance device by using movement data of foreign object.
CN101881971	Flight control by comparing ideal flight data and current flight data.
CN202642096U	UAV control and arresting device.
CN202541833U	Use of rotors to control speed of UAV.
CN202295289U	Power control using turbojet engines.
CN202166892U	Flight and steering control through CAN bus network.
US8886368	Steering Control using shape modification of UAV as designed to indicate longitudinal axis of aircraft.
US8577535	Flight control from commands from multiple axis.

Exhibit 12. Categorized Distribution of Controlling Based Patents

Exhibit 12 displays patent distribution based on Controlling. Table pertains to exemplary granted patents in controlling category and shows various solutions for controlling.

Technology Classification
Lifting and Landing

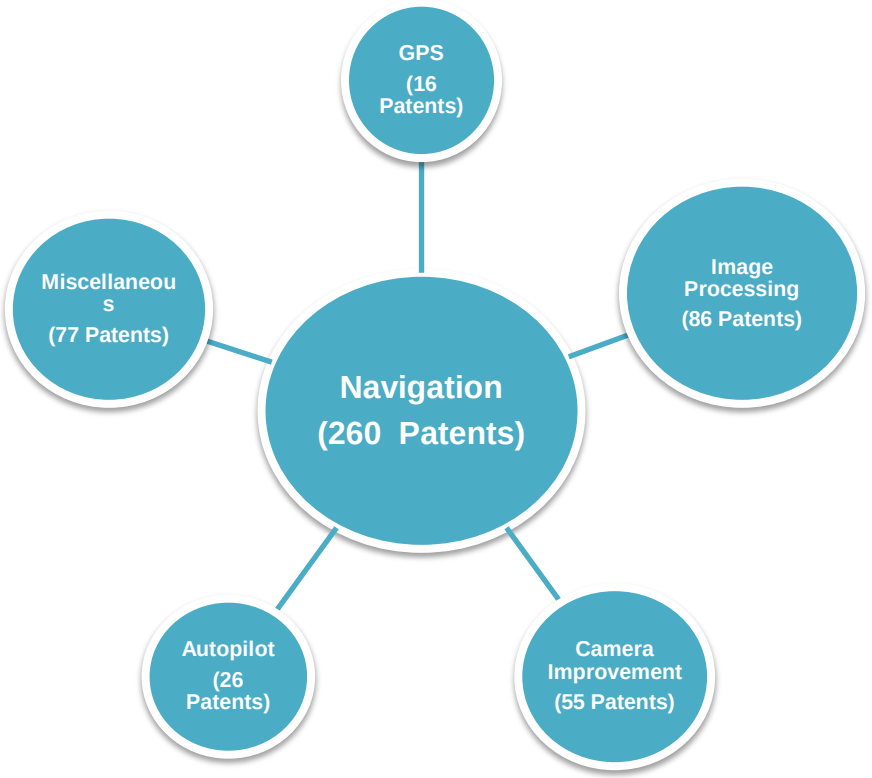


Patent No.	Analyzed Solution Offered by Patents
US8662441	Launch control assembly with discharge of gases in different thrust stages.
US8857754	Use of cable and flared gas basket for launching and recovering of UAV.
CN204038895U	Power steering axle connection seat for vertical takeoff and landing.
US8800936	Use of constant pitch angle blade and propeller motor.
US7780409	Hub assembly for vertical Lift with blade coupling.
CN203819492U	UAV with double lift equipment Mount.
CN203698662U	Rotary wing for vertical take off and landing.
CN204037895U	Landing gear with mounting bracket.
CN203996878U	UAV tail drop promoter structure with fin used for lifting.
CN203889080U	UAV vertical lifting with damping means and synchronous transmission.

Exhibit 13. Categorized Distribution of Lifting and Landing Based Patents

Exhibit 13 displays patent distribution based on lifting and landing. Table pertains to granted patents in lifting and landing category and shows various solutions for lifting and landing.

Technology Classification
Navigation

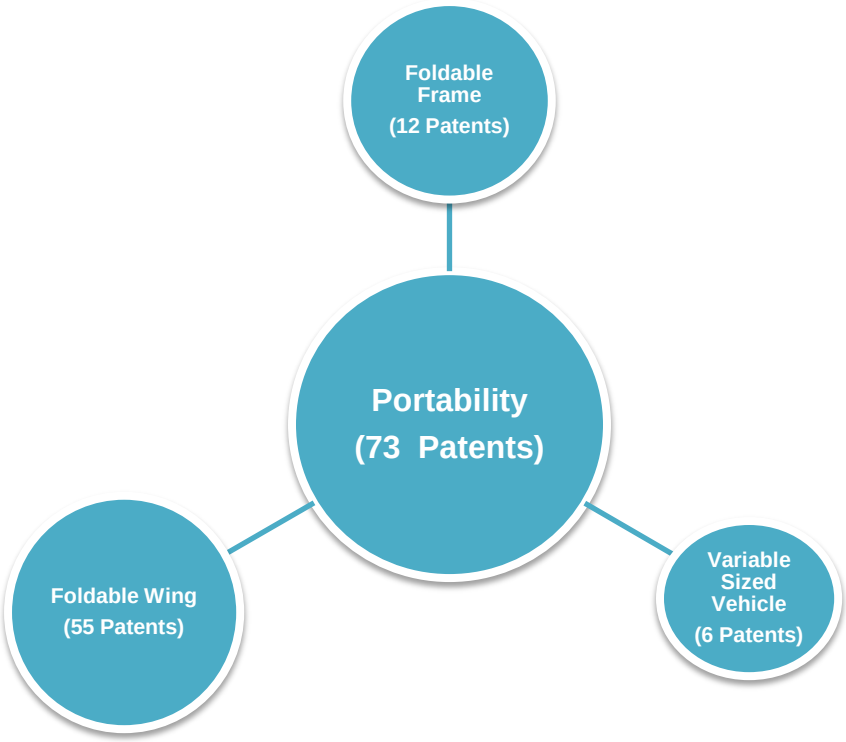


Patent No.	Analyzed Solution Offered by Patents
US8930044	Differential navigation process and flight control based on real time localization process.
CN203845017U	Night Navigational Lights.
CN202758241U	Use of inertial navigation and positional system.
CN202600150U	Low altitude remote sensing and mapping system.
CN204096095U	Imaging device with panoramic image collection for navigation.
CN203241540U	Navigation system with point to point positioning of GPS.
CN202582543U	Advance GPS antenna for navigation.
CN202579804U	Camera damping device for vibration reduction.
CN202383293U	Anti collision warning system.
CN202395853U	Image processing and image conditioning system.

Exhibit 14. Categorized Distribution of Navigation Based Patents

Exhibit 14 displays patent distribution based on navigation. Table pertains to granted patents in navigation category and shows various solutions for navigation.

Technology Classification
Portability

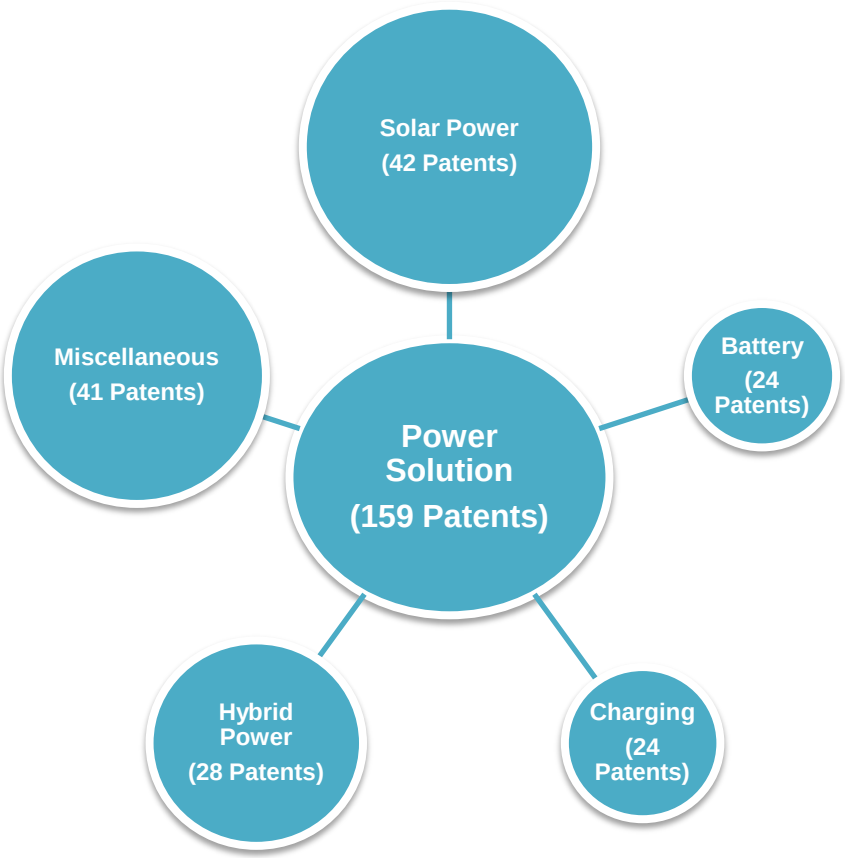


Patent No.	Analyzed Solution Offered by Patents
US9010693	An unmanned aircraft system that includes the collapsible wing.
CN204223178U	Foldable UAV.
CN204173158U	A folding triangle unmanned rotorcraft with foldable bracket.
CN204078065U	UAV with tail folding structure and foldable Wing.
CN203946278U	Umbrella compartment for parachute.
CN203767064U	Fuselage for foldable wing UAV.
CN203020540U	Symmetrically mounted fuselage for folding wing.
CN202609086U	Foldable UAV with fuselage on both side of the wings.
US8946607	Deployment mechanism supported by fuselage for folding wing.
CN202414170U	Parachute for UAV.

Exhibit 15. Categorized Distribution of Portability Based Patents

Exhibit 15 displays patent distribution based on portability. Table pertains to granted patents in portability category and shows various solutions for portability.

Technology Classification
Power Solution

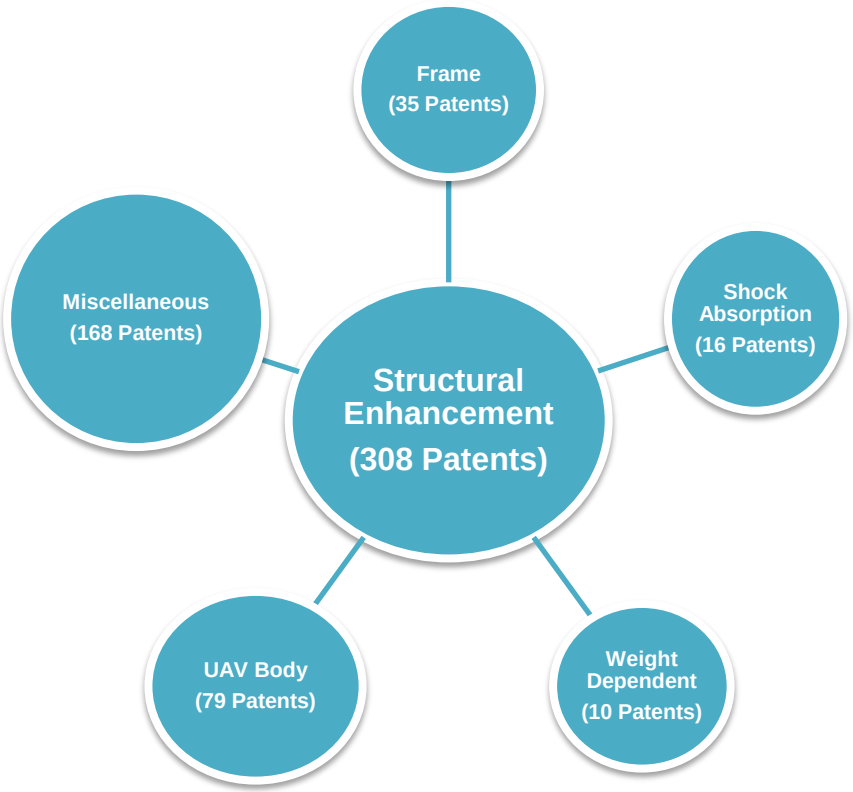


Patent No.	Analyzed Solution Offered by Patents
CN204216106U	Battery Holding device.
CN204179174U	Battery thermal management with conductive housing.
CN204056307U	Hybrid power utilization by thrust from various parts of UAV.
CN203996885U	Multi rotor internal combustion engine.
CN203871930U	Wireless Charging system.
CN203707822U	Multipath output power supply.
CN204021254U	Solar power for UAV by solar cells on wings of aircraft.
CN203669995U	Supercharging device for UAV battery.
CN203512040U	Power generation using wind energy.
CN203593165U	Solar cells for UAV.

Exhibit 16. Categorized Distribution of Power Solution Based Patents

Exhibit displays patent distribution based on power solution. Table pertains to granted patents in power solution category and shows various solutions for power solution.

Technology Classification
Structural Enhancement

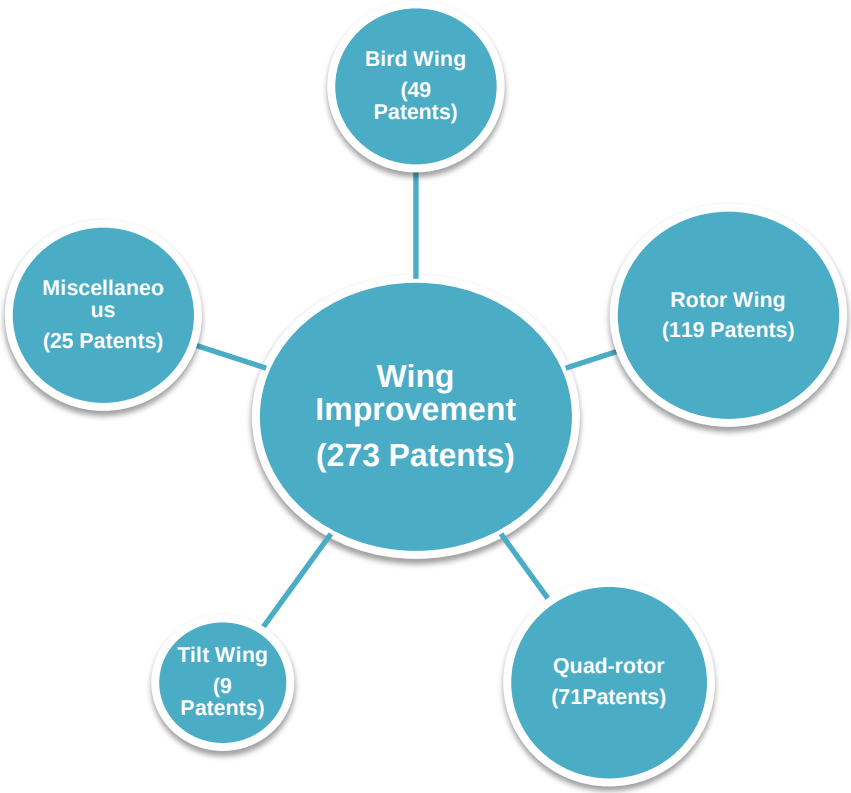


Patent No.	Solution Offered by Patents
CN204197277U	Landing gear shock arches with both sides of the fixed-wing fuselage in the unmanned card slot.
CN204078075U	Anti-explosion unmanned aircraft with fuselage, wings and empennage.
CN203975220U	Landing gear shock absorber, the lower beam cross the main landing gear set mounted.
CN203793652U	Frame structure with elliptical circular sheet body made of board.
CN203698670U	Quick mounting and dismounting the housing.
US9061558	UAV with rolling cage for both aerial and terrestrial locomotion.
CN203098771U	Rotating shaft with both ends are hinged to the mounting seat in a UAV.
CN203064199U	Wing and the fuselage are merged into one in UAV.
CN203143011U	Handheld type small fixed-wing unmanned aerial vehicle.
CN202765289U	Multi-rotor UAV with multiple propeller units.

Exhibit 17. Categorized Distribution of Structural Enhancement Based Patents

Exhibit displays patent distribution based on structural enhancement. Table pertains to granted patents in structural enhancement category and shows various solutions for structural enhancement.

Technology Classification
Wing Improvement



Patent No.	Analyzed Solution Offered by Patents
CN204197282U	Connection mechanism for rotor.
CN203996890U	Fuselage provided with numerous plane of symmetry relative to the fuselage .
CN203921195U	UAV rotor with leading edge and trailing edge convex arc concave arc.
CN203889054U	Unmanned aerial vehicle with diamond-shaped wing, thruster and a rotation mechanism.
CN203806134U	Back pushing fixed wings for UAV.
CN203698668U	Double-parachute wing symmetrically installed on the two sides of the vehicle body.
CN203698649U	Collecting disc for multiple rotor wings and uniformly distributed round grooves, formed in the outer edge surface.
CN203727641U	Fuselage, wing and the fuselage plug connected to the gondola body.
CN103482054	Low-Reynolds-number wing section matched with a full-wing .
CN203078755U	Rotor with independent tail rotor power system.

Exhibit 18. Categorized Distribution of Wing Improvement Based Patents

Exhibit 18 displays patent distribution based on wing improvement. Table pertains to granted patents in wing improvement category and shows various solutions for wing improvement.

Disclaimer

IIPRD has prepared this sample report as an exemplary report, wherein the content of the report is based on internal evaluation of Patents and Non-Patent Literature that is conducted based on Databases and Information sources that are believed to be reliable by IIPRD. A complete list of patent documents retrieved is not disclosed herein as the report is exemplary but can be shared if desired based on terms and conditions of IIPRD. IIPRD disclaims all warranties as to the accuracy, completeness or adequacy of such information. The above sample report is prepared based on the search conducted on the keywords and other information extracted from the understanding of the Patent Analysts of IIPRD, and subjectivity of the researcher and analyst. Neither IIPRD nor its affiliates nor any of its proprietors, employees (together, "personnel") are intending to provide legal advice in this matter.

About IIPRD

IIPRD is an established and leading Intellectual Property (IP) Consulting and Commercialization/Licensing Firm with over 65 Professionals spread across 5 offices (4 in India and 1 in California) with a diversified business practice providing services in the domain of Commercialization, Valuation, Licensing, Transfer of Technology and Due-Diligence of Intellectual Property Assets along with providing complete IP and Patent Analytics and Litigation Support Services to International Corporate and Global IP Law Firms. Complete Details about IIPRD and other sample reports/presentations can be viewed at www.iiprd.com

Contact Details

CALIFORNIA . DELHI . MUMBAI . BANGALORE . PUNE

Contact Details

Noida (NCR) Office – Head Office
E-13, UPSIDC Site-IV, Behind Grand Venice, Greater Noida, 201308

Contact Person: Tarun Khurana
Contact No.: +91-120-2342010-11/4296878

E-Mail: iiprd@iiprd.com, info@khuranaandkhurana.com
Website: www.iiprd.com | www.khuranaandkhurana.com