

INTRODUCTION TO SYSTEM-ON-CHIP AND ITS APPLICATIONS

# TECHNOLOGY DJI/MAVIC PHANTOM COMPARISON



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# 1. Introduction

## 1.1 Introduction Drones

UAV (unmanned aerial vehicle), also called Drone, means an aircraft without any human pilot, crew, or passengers on board. In the field of commercial products, the Quadrotor Aircraft (or quadcopter) is a type of helicopter with four rotors, is the most famous commercial UAV in this era. Nowadays, there have many applications related to drones. For example, real-time video stream for mountain rescue helping, live firewood show with drones, and racing drone.

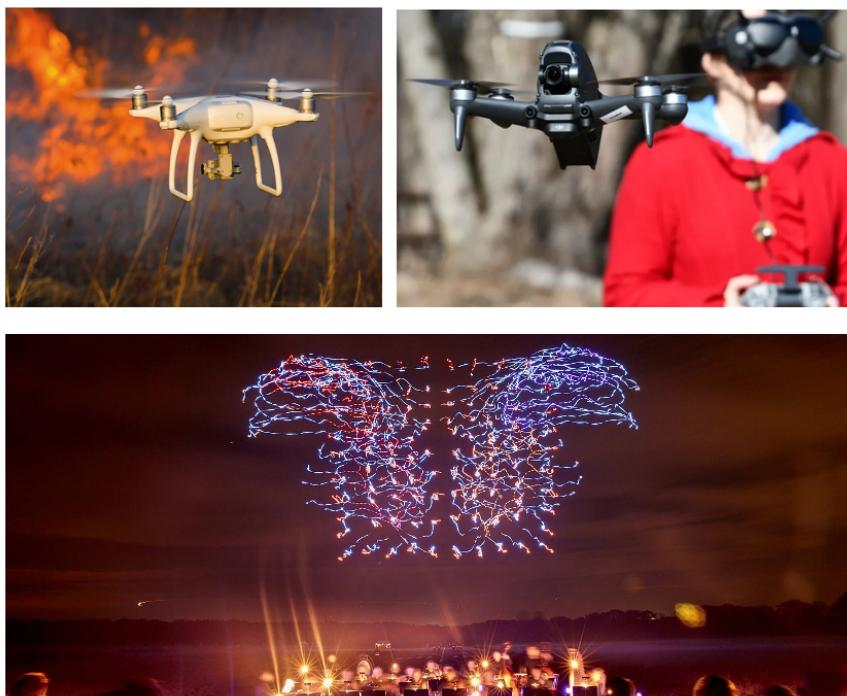


Fig.1: Many application in drones we can have it in this era

## 1.2 Introduction DJI



Fig. 2: DJI Logo

DJI (Da-Jiang Innovations, 大疆創新) is the China technology company that manufactures commercial UAV (drones) for aerial photography and videography. It also designs and manufactures camera gimbals, action cameras, camera stabilizers, flight platforms, propulsion systems and flight control systems. Until 2020/10, DJI has over 80% market share in the global civil and commercial drone market. Ranked No. 1 among global commercial drone companies.

There have many drones product design and manufact from DJI. The most classic and famous drones product is DJI Phantom series. It is the classical commercial drone that have a lot of there are many photographer fans. It can perform extreme great quality on image and video resolution, and it also shows many smart flight assistances on flight control feature. Many aerial photography works is done by DJI Phantom series drones.

In addition to aerial photography, DJI also build many drones for stunt Lovers or FPV lovers. The DJI FPV series is the product line for FPV players. It have the remote controller with low delay and high control capability, that makes DJI FPV more suitable for extreme flight. Also, it

has the DJI FPV Goggles V2 for a better immersion experience.



Fig. 3: above is DJI Mavic 3 Classic and below is DJI Phantom 4 Pro V2.0

In this work will focus on two main DJI product series. First one is DJI Mavic Series, and another one is DJI Phantom Series, These are the most famous commercial drones in the world.



Fig. 4: above is DJI Mavic 3 Classic and below is DJI Phantom 4 Pro V2.0

## 2. Technology Analysis

### 2.1 DJI Mavic

DJI Mavic is the portable consumer-grade aerial photography drone, its highlights feature is non-professional flight controllers, high quality photography, easy to use with smart technology. Its TA (Target Audience) is for aerial photographer and drones enthusiast, it's the commercial level product.



Fig. 5: DJI Macic 3 Product shots.

Following is the spec table of DJI Mavic 3:

Specs	Parameters
Weight	895 g
Size (expend shape)	347.5 mm x 283 mm x 107.7 mm
Speed	<ul style="list-style-type: none"> <li>● Max Ascent Speed: 8 m/s (S mode)</li> <li>● Max Descent Speed: 6 m/s (S mode)</li> <li>● Max Flight Speed (at sea level, no wind): 19 m/s (S Mode)</li> </ul>
Flight time	<ul style="list-style-type: none"> <li>● Max Flight Time (no wind): 46 minutes</li> <li>● Max Hovering Time: 40 minutes</li> <li>● Max Flight Distance: 30 km</li> </ul>
Gimbal	Stabilization: 3-axis motorized (tilt, roll, pan)
<b>Hasselblad Camera</b>	
Sensor	4/3 CMOS, Effective pixels: 20 MP
Lens	<ul style="list-style-type: none"> <li>● FOV: 84°</li> <li>● Aperture: f/2.8 to f/11</li> </ul>
Max Image Size	Main Unit: 5280×3956
Still Photography Modes	Single shot: 20MP Photos
Video Resolution	Apple ProRes 422 HQ, 422, 422 LT 5.1K: 5120×2700@24/25/30/48/50fps

	4K: 3840×2160@24/25/30/48/50/60/120*fps H.264/H.265
Log	10 Bit D-Log
<b>Tele Camera</b>	
Sensor	1/2-inch CMOS
Lens	FOV: 15°  Format Equivalent: 162mm  Aperture: f/4.4
Single shot	12MP Photos



Fig. 6: Hasselblad L2D-20c Camera and Tele Camera

The Hasselblad camera embedding a professional-grade 4/3 CMOS and can shoot with the high-resolution image and video quality. Also, this camera chip has integrated software algorithms that bring image quality to an entirely new level, that is Hasselblad Natural Colour Solution (HNCS). According to DJI's official website, they said the lens adopts rigorous standards and has every pixel of the sensor calibrated, with the HNCS embedded. This delivers vivid, natural colors with the simple press of the shutter, allowing you to capture breathtaking landscapes without complicated editing or color presets.

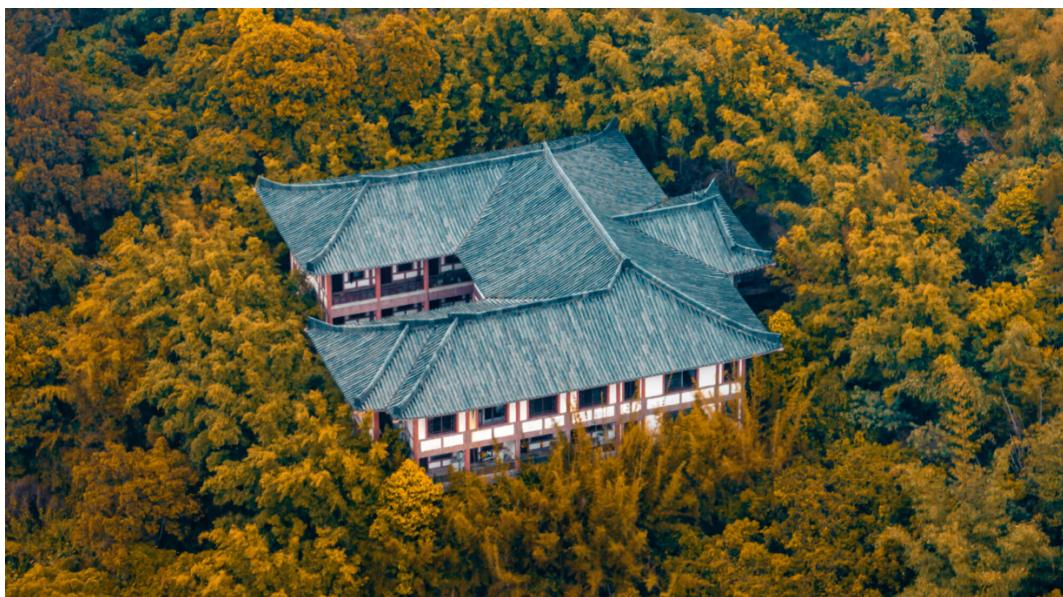


Fig. 7: Showcase of image shot by Hasselblad camera on DJI Mavic 3

## Omnidirectional Obstacle Sensing

As the non-professional user TA, DJI Mavic 3 will help you to enjoy collision-free flight so you can focus on getting the best shots possible. The technology is “Omnidirectional Obstacle Sensing”. There are five infrared sensors embedding on the drone, can provide the full function for multiple smart flight features like automatic obstacle avoidance, Advanced RTH or other automated flight assistance.

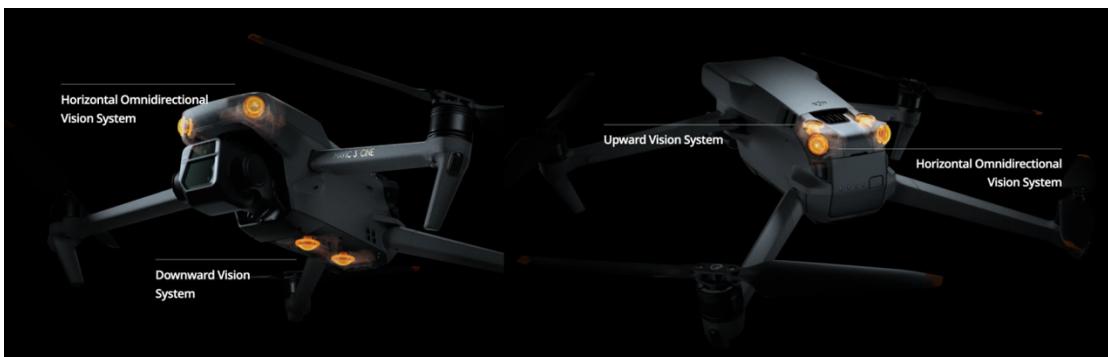


Fig. 8: Infrared Sensors are installed at forward, backward, lateral, upward, and downward

## Advanced RTH (Return to Home)

In fact, the flight security for drone, human and environment is the big challenge in drone industry. But DJI Mavic 3 comes with a new RTH (Return To Home) feature called “Advanced RTH”. It can let Mavic 3 automatically determine the optimal route back to its home point and execute it quickly. Moreover, it can combine the advantages of Advanced RTH and traditional RTH, allowing users to choose the best

option according to their environment. Even the return route have building blocking, Mavic 3 also can execute RTH, and automatic flight the drone back to home location.

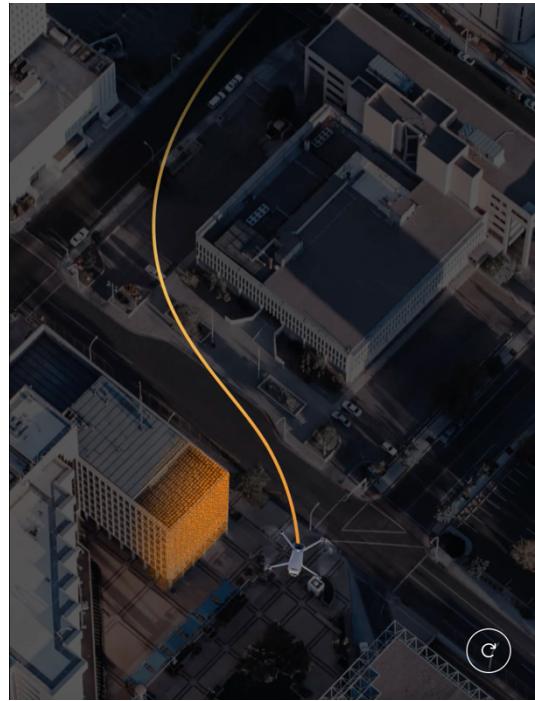


Fig. 9: Advance RTH

## **APAS 5.0 (Advanced Pilot Assistance Systems)**

Before Mavic 3, it is not possible to flight drone deep in the forest because of the flight control cannot ensure the aircraft won't crash into the trees or animal. But right now, DJI Mavic 3 comes with APAS 5.0 (Advanced Pilot Assistance Systems). When flying, Mavic 3 continually senses objects in all directions and bypasses them quickly and smoothly. Unlike the old solution of automatic obstacle avoidance system. APAS will compute the optimal route to avoid the obstacle without hover the

drone. With APAS 5.0, user can enjoy flight in the forest without worry about the crash risk.



Fig. 10: APAS 5.0

## DJI O3+ (OcuSync)

The DJI O3+ brings the world fastest video transmission, and reliable control quality controller of the drones. The video transmission have the 1080p/60fps live feed with the 15KM longest distance. Moreover, DJI O3+ and drones even can connect to 4G cellular, make the flight control more reliable.

Following is the specs of DJI O3+ Controller:

Specs	Parameters
Video Transmission	1080p/60fps live feed. Max reliable

	distance is 15 KM
Operation Frequency	<ul style="list-style-type: none"> <li>● 2.400-2.4835 GHz</li> <li>● 5.725-5.850 GHz</li> </ul>
Max Download Bitrate	<ul style="list-style-type: none"> <li>● 5.5MB/s (with RC-N1 remote controller)</li> <li>● 15MB/s (with DJI RC Pro remote controller)</li> </ul>
4G Cellular	Cellular module can connect to 4G to enhance the safety of flights.



Fig. 11: DJI O3+ Controller with video Transmission

## Automated Flight

DJI Mavic 3 also support many automated flight control for user to shot the creative image or video works. It have the waypoint flight function for automatically plan a flight route based on the waypoints

preset by the user, and can precisely repeat routes. The cruise control can control Mavic 3 to fly in any direction without having to continually press the control sticks. The Active Track 5.0 can automatically track the object and flying with, this can help some sports photography more easily to take a video or image shot. Others like MasterShots, Panorama, Hyperlapse, QuickShots...etc. also provide more powerful, stunning photography experience.

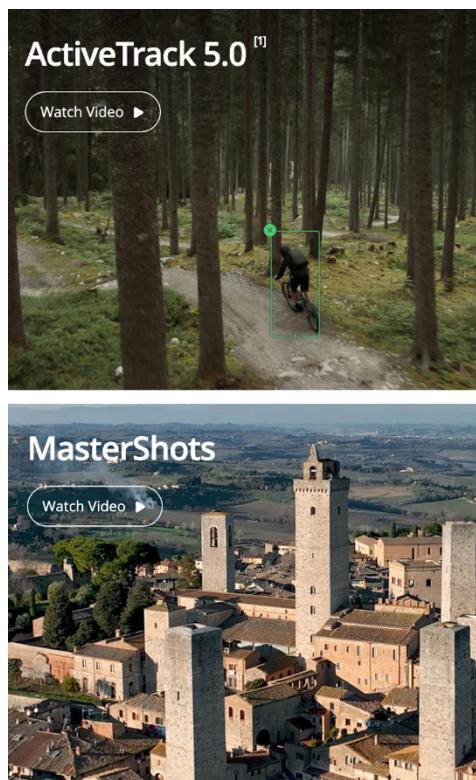


Fig. 12: Preview of the automated flight feature

## 2.2 DJI Phantom

DJI Phantom is the professional photography drone that can bring some Pros stunning and powerful image and video quality just like the movie cinematographic camera. Its TA is for the user that is professional video creator, and professional aerial photographer. Recently, many aerial shot in the movies or videos is shot by DJI Phantom.

This section, I will introduce you the DJI Phantom 4 Pro V2.0.



Fig. 13: DJI Phantom 4 Pro V2.0

Following is the specs of DJI Phantom 4 Pro V2.0:

<b>Shot</b>	<b>Parameters</b>
Weight	1375 g
Size	<ul style="list-style-type: none"> <li>● Max Ascent Speed: 6 m/s (S Mode)</li> <li>● Max Descent Speed: 4 m/s (S Mode)</li> <li>● Max Speed: 72 kph (S Mode)</li> <li>● Max Flight Time: Approx. 30 minutes</li> </ul>
Gimbal	Stabilization: 3-axis (pitch, roll, yaw)
Vision System	<ul style="list-style-type: none"> <li>● Forward, Backward, Downward</li> <li>● Infrared Sensing System</li> </ul>
Transmission	OcuSync 2.0 HD Can connects wirelessly to the DJI Goggles
Camera Specs	
Sensors	<ul style="list-style-type: none"> <li>● inch CMOS</li> <li>● Effective pixels: 20M</li> </ul>
Lens	<ul style="list-style-type: none"> <li>● FOV 84°</li> <li>● 8.8 mm/24 mm</li> <li>● f/2.8-f/11</li> <li>● auto focus at 1 m-∞</li> </ul>
PIV Image highest Size	4096×2160 (4096×2160 24/25/30/48/50p)

Professional 4K Video	<ul style="list-style-type: none"> <li>● Bitrate: 100 Mbps</li> <li>● Frame Rate: 4K/60fps</li> <li>● Color Profile: D-Log</li> </ul>
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Fig. 14: Camera in DJI Phantom 4 Pro V2.0

## Precise Mechanical Shutter

A mechanical shutter eliminates rolling shutter distortion which can occur when capturing fast-moving subjects or when flying at high speed. The electronic shutter features Burst mode, capable of shooting 14 fps at 20 MP to catch the perfect moment.



Fig. 15: The comparison of the mechanical shutter and electronic shutter

## Intelligent Flight Modes

Although the automate flight mode in DJI Phantom is not as much as DJI Mavic 3. But still have some powerful intelligent flight modes, like ActiveTrack, RTH, TapFly, DrawMode and Gesttrue Mode. The reason that DJI Phantom is not smart as DJI Mavic is because of the TA is for professional, they usually flight by themselves. The image quality is more important for the product.

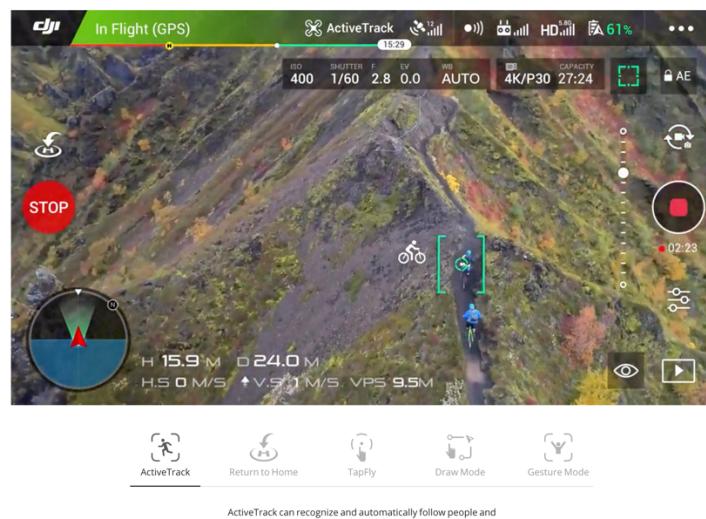


Fig. 16: Screenshot form DJI controller.

## Professional Photography

DJI Phantom is design for the professional aerial photographer, has a great camera module comparable to DSLR. The intuitive remote controller suitable for outdoor environment. As the DJI GO 4 app is built into the screen, a mobile device is not required.

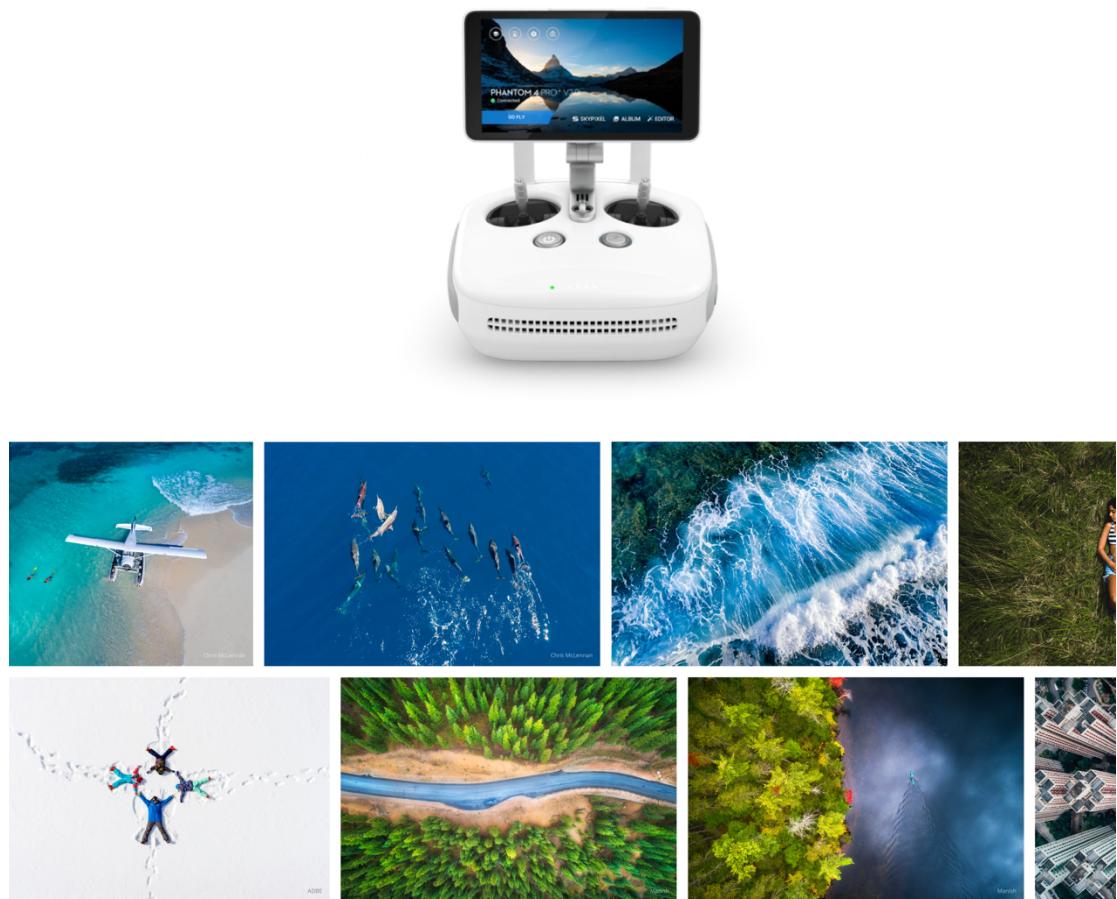


Fig. 17: Intuitive Remote Controller

# 3. Industry Analysis and Competitor Analysis

## 3.1 Drone Market Analysis

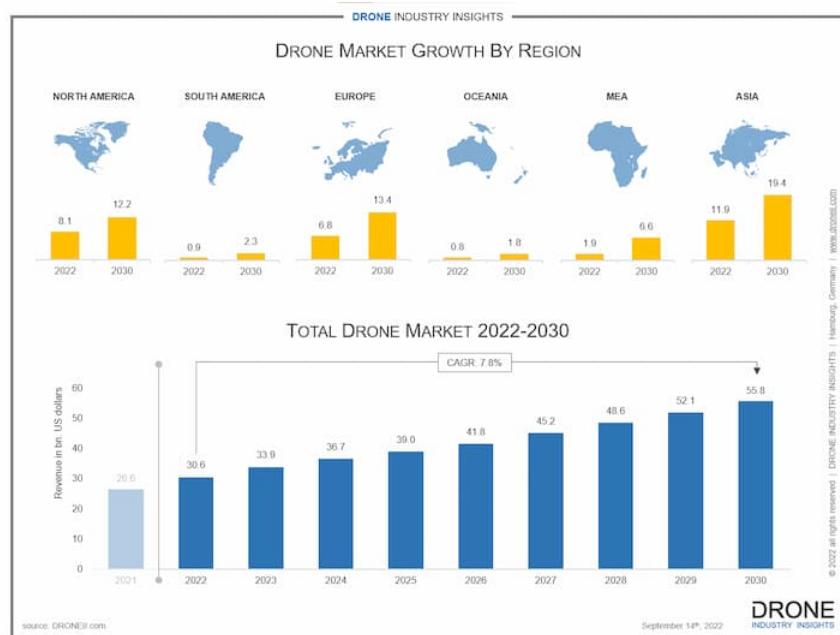


Fig. 18: Drone market growth by region

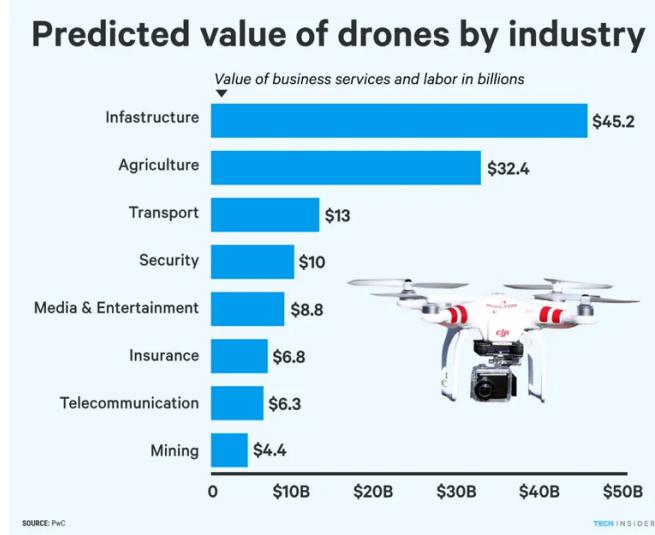


Fig. 19: Predicted value of drones by industry

According to the market and predict data above, we can know the growth of the drone market is very promising. In the future, drones can be used not only for entertainment and photography, but also for public affairs, agriculture, transportation and social security.

### 3.2 Competitor Analysis – Parrot ANAFI Ai

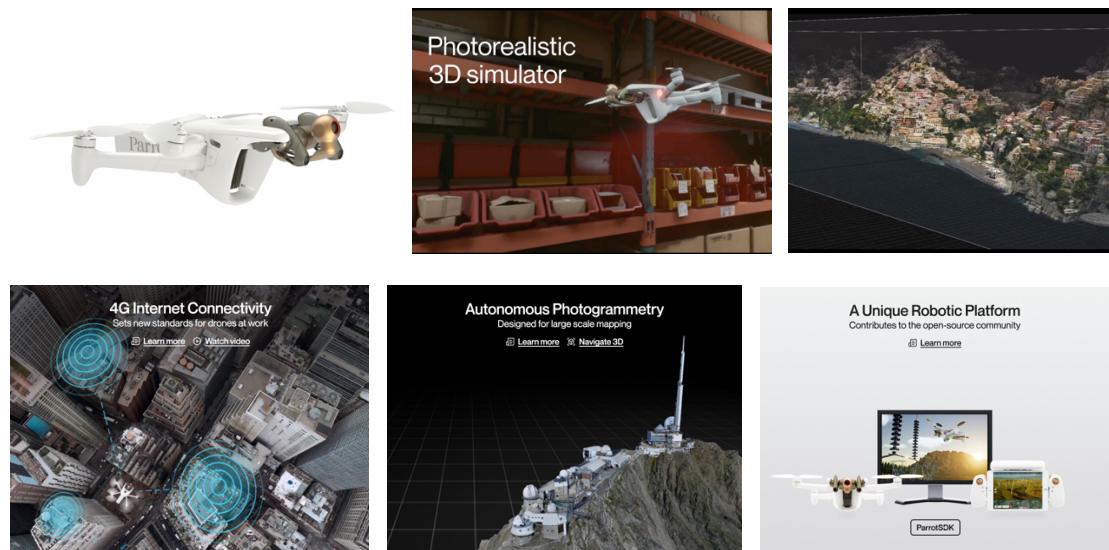


Fig. 20: Parrot ANAFI Ai

Parrot is another UAV company that manufacture the commercial drones. I think it is the most biggest competitor for DJI because of the Parrot drone have more customizable functionality. Like it have the powerful AI vision feature that can do 3D environmental modeling, and it provide much SDK or API for developer to build customized functions. It also have the easy-to-use drone simulator allows developers to develop programs in a virtual environment, and embedding 4G networking

functions.

## 4. Advance Applications

Solutions



Public Safety



Oil and Gas



Electricity



Aerial Surveying and AEC



Firefighting



Law Enforcement



Rescue Services

Fig. 21: Advance use case of DJI drones

The drones not only for entertainment and photography, but also use in many different way and type of industry. In fact, drones have been used in public safety, oil and gas, electricity, or even firefighting, law enforcement and rescue services. DJI have many drone product build for advance and enterprise approach. It also have many module can be install on the drones like infrared, thermal imaging camera, depth camera...etc. for more advance use case in vary Scenes.



Mavic 2 Enterprise Advanced



Matrice 300 RTK

Fig. 22: Drones for Enterprise

## 5. Conclusion

- DJI is a big commercial drones manufacturer in global
- DJI Mavic
  - A portable consumer-grade aerial photography drone with rich automation auxiliary functions in flight safety and photography
- DJI Phantom
  - Professional photography drone that suitable for professional aerial photographer
- Less automation auxiliary functions but has a lens comparable to a DSLR
- Drones has a lot of application like public safety, rescue, agricultural, manufacture
- Drones market has good prospects

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