In this Tutorial I will show how to make a full 360° Panorama with the whole sky with a drone! We will see the difference between a few iPhone APP’s and their method to take the pictures.

For this Tutorial I had made a YouTube video too. You can find it on my channel.

https://www.youtube.com/c/KilianEisenegger

In this Tutorial we will learn how it is possible to make an intelligent grid configuration for a full spherical panorama. With only 24 images it is possible to make a full size panorama with the whole sky implemented. And you can do this entire automatic with a mission code program.

Before we start it is important to set the right camera settings in your DJI GO APP and to read the security points.
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1 Security with missions

Before you use missions for your drone you have to read this carefully.

A mission takes fully control of your drone. For the Phantom 3 Pro and the Inspire 1 you have always the possibility to stop the mission going from F to P mode. For the MAVIC you have to switch to Sport mode. I implemented a security into the mission code. When the drone comes down for landing, it stops at 10 feet’s, hoover for 5 seconds and land. During the landing command you can hear a beep-beep from the drone. At this moment you have full control on the MAVIC.

For the first use you have to choose a big field. The Phantom 3 Pro landed full automatic in a range of 1m. The MAVIC not! Choose a place with minimum 5 m² to test the mission. If you know to handle the landing procedure you can choose smaller places.

Use this mission without a lot of wind the first time. I checked the mission with the MAVIC in very windy conditions but then you have to train the landing procedure first.

I use the school place to test all my new drone missions. As you can see I have a lot of security place.
If you consider these points you will have no problem with your drone.

2 Camera parameters
Always use manual camera settings if you take a panorama! Set the white balance to sunny or cloudy for external shootings.
3 DronePan

DronePan uses a simple up down method to take the pictures. A lot of drone pilots use this APP for free. It is developed by Dennis Baldwin and his team.
The APP is simple to use. You start the drone with the DJI GO APP put it on some place where you like to make a panorama picture. Then you start the DronePan APP and start the shooting.

### 3.1 APP Settings

There are always questions about the optimum settings for this APP’s. I calculated a sheet with the optimum parameters for 20% and 25% overlapping. These settings are valuable for all APP’s.

![DronePan up down MAV 8x4](image)

### DJI DRONES CAMS

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The issue with this actual DronePan APP is that from the first to the last picture the drone drifts. A drone is very unstable for yawing “yaw shooting” but very stable for pitching “pitch shooting”. So it would always be better to work form left to right to left...
4 Litchi
Litchi works similar to DronePan. There is one big difference that Litchi let us the freedom to choose between up down up or left right left.

4.1 Yaw shooting

4.2 Pitch shooting

5 Optimized spherical shooting (yaw shooting)
Ordinary panorama tripod gears or gimbal uses easy square grids to shoot full panoramas. I have developed a spherical grid algorithm to
optimize the number of pictures and to have better stitching results.

5.1 Drone horizon
A drone with a gimbal takes pictures from +30° down to -90°. You cannot take a picture above 30° you would simply shoot a picture from the drone.
A spherical grid would look like this for the DJI 3 Pro with 20% overlapping (CUT)
DRONEBLOCKS Optimized spherical shooting (yaw shooting)

The same for the DJI Inspire Zenmuse 15mm

As you can see the result has fewer images than ordinary grid procedures.
6 Spherical algorithm

In the special algorithm we have to calculate the number of pictures behind the horizon. The horizon needs the most of pictures. If we simply take the circumference as 360 the above circumferences are logical smaller.

If I take a picture on +30° the horizon is cosine (view angle) smaller. For +30° that means 0.866 x 360 and so on.

To calculate the number of pictures per row you have to know the horizontal focal length angle. (4:3 od 3:2 ccd size)

6.1 Phantom 3 Pro linear and sperical

To calculate a linear panorama we can use the FOH angle from the lens.

DronePan up down up P3P 3.53mm, 35mm=20mm,
grid=linear gimbal=drone
6x3 +1 nardir
FOH 82.3° 17496
FOV 65.6° 8231
CUT 25% real H 32% V 39%
FOH% 55.5° PB 360°
FOV% 40.0° PH 185°
  30 30 -10 -50
  90 30 -10 -50
 150 30 -10 -50
 210 30 -10 -50
Litchi up down up  P3P 3.53mm, 35mm=20mm, grid=linear gimbal=drone
6x3 +1 nardir
FOH   82.3° 17496
FOV   65.6° 8231
CUT   25% real H 32% V 39%
FOH%  55.5° PB 360°
FOV%  40.0° PH 185°
 30 30 -10 -50
 90 -50 -10  30
150 30 -10 -50
210 -50 -10  30
270 30 -10 -50
330 -50 -10  30
-90

Litchi left right P3P 3mm 35mm=20mm, grid=linear gimbal=drone
6x3 +1 nardir
FOH   82.3° 17496
FOV   65.6° 8231
CUT   25.0% CUT_HR 32% CUT_VR 39%
FOH%  55.54° PB 360°
FOV%  40.0° PH 185.6°
 30
 30 90 150 210 270 330
-10
330 270 210 150  90  30
-50
 30 90 150 210 270 330
-90
330

Litchi left right  P3P 3mm 35mm=20mm, grid=spherical gimbal=drone
6x3 +1 nardir
FOH  82.3° 17496
FOV  65.6° 8231
CUT  25.0% CUT_HR 32% CUT_VR 39%
FOH%  55.54° PB 360°
FOV%  40.0° PH 185.6°
30
  36 108 180 252 324
-10
  330 270 210 150 90 30
-50
  45 135 225 315
-90
  315
Number of pictures 16

With a spherical grid we need always fewer pictures. I use this method for my self-made tripod gear.

6.2  LUMIX GF6 example 25mm
The Lumix GF6 has the same CCD size like the Zenmuse X5 from DJI Inspire Pro. The result is a full 360° x 180° panorama.
If we have a look on the Zenmuse grid it will look like that. (25mm focal length)

For X5 45mm you need 2 to 3 batteries to take all the pictures.
Let’s get to the point how we do that with a drone!

7 DroneBlocks
With DroneBlocks we have finally a tool to make this spherical shoots. Today DroneBlocks works not with positive pitching. But that will come soon enough I still hope. But for smaller focal length there is a trick for that issue. We can start the drone with 0° pitch angle and move the gimbal to +30° during starting.

I will not explain how DroneBlocks works in this Tutorial. Please refer to the homepage from Dennis Baldwin to have more details how it works. I will only explain how the Panorama Mission works.

DroneBlocks is a program to write missions for drones. Today P3P, I1 and Mavic are supported.

7.1 X3 Phantom 3 Pro 20mm

I have added some squares to the simulation to visualize the intersection between the +30° pitch shots and the 2 zenith shots. For the P3P we can see full intersection for the 2 zenith images. For the P4P, MAVIC and
the X5 15mm we have less intersection. It is possible for all 4 drones to correct the resting holes with the intelligent fill method in PS and PSE.

7.2 Phantom 4 Pro 20mm
The Phantom 4 Pro is actually not supported from DroneBlocks. The P4P or Inspire 4 4XS grid looks like this. We have a little bit more gab with 24mm.

![DroneBlocks X4S 7x4 25% 24mm](image)

7.3 MAVIC PRO 28mm
The MAVIC PRO has a 28mm focal length. The sky hole with 2 zenith shots is a little bit bigger as the P4P. The MAVIC Pro missions looks like this.
7.4 **Inspire X 30mm (15mm focal length)**
The Inspire X5 30mm is similar to the MAVIC 28mm (35mm format focal length). The sky holes is small enough to fill it with the intelligent fill function from PS or PSE.
7.5 The Panorama Mission
DroneBlocks missions starts and lands automatic. Choose always a great surface for your drone to land automatically. You can stop the mission for the P3P going from F to P mode. This is not possible with the Mavic. Use DroneBlocks only if you know to handle a drone and aboard missions!

Today a DJI mission can only use 15 commands per position. I change the altitude during the different pitch angles about ±2 feet’s to have more commands. We couldn’t make a drone panorama with only 15 commands. Between each pitch angle I change the number of images.

7.6 Start section
We take off the drone at about 30m. The pitch angle before starting is 0°. You have to manage that your own with the remote control. During the start turn the gimbal to +30°

At 100 feet the drone begins to turn the yaw angle 60° 6 times and take 6 pictures.

Now we change the altitude 2 feet’s to have new 15 commands for the mission. We pitch the gimbal at 0° and we set the yaw angle to 52°. For 7 pictures we need 360°/7 = 52°. We take 7 pictures in the other direction.
In the final section we take 1 nardir shot. We set the gimbal to the initial position. You can see why in my YouTube video. Then we hover at about 3m for 5 seconds. That’s the last moment to abort the mission or to correct the automatic landing.
7.7 The full program.

8 The Shooting

Load the DJI GO APP for your drone and set the camera parameters. GPS Mode has be enabled green for your drone. For the MAVIC it is very important to set the focus correct. You will not have sharp images if the focus is not correct. You see a green square. Put it on a point far away and click until you hear a beep.
Start DroneBlocks and load your mission. Put the drone on the start and landing place and turn the drone in the right direction. Remember the orientation for the 2 zenith shots.

### 8.1 Start the mission

Touch Preview Mission

Now you see the Google Map with your location.

Press Start Mission
You have to confirm.

During the start you have to set the gimbal at +30°

You will see the gimbal position in the small window.

Now the mission will do the rest full automatic.
In the last image you will see the bottom. Before the drone lands the mission will reset gimbal to 0°.

When the drone is about 10 feet’s high you have to take control for landing.

9 Mavic missions parameters
As we have no drifting issues with the spherical left right method we can minimize the overlap. If we take only 7 pictures for the horizon we are at the limit of 20% overlap.

Another reason for only 7 pictures is that we can use only 15 mission commands. If we will take 8 images per row or more it will complicate the mission code. I have already a solution for the Inspire but that’s out of the reason be of this tutorial.
9.1 The MAVIC code

takeoff to 200 ft
set altitude to 200
set yaw_angle to 60
set zmov to 2
repeat 6 times
do take photo
    yaw right yaw_angle degrees
change altitude to altitude + zmov ft
pitch gimbal to 0 degrees
set yaw_angle to 52
repeat 7 times
do take photo
    yaw left yaw_angle degrees
change altitude to altitude - zmov ft
pitch gimbal to -30 degrees
set yaw_angle to 60
repeat 6 times
do take photo
    yaw right yaw_angle degrees
change altitude to altitude + zmov ft
pitch gimbal to -60 degrees
set yaw_angle to 90
repeat 4 times
do take photo
    yaw left yaw_angle degrees
change altitude to altitude - zmov ft
pitch gimbal to -90 degrees
take photo
pitch gimbal to 0 degrees
change altitude to 10 ft
hover for 5 seconds
land
9.2 The MAVIC improvement

Please see the video on my YouTube channel how to fix this sky. [www.youtube.com/c/KilianEisenegger](http://www.youtube.com/c/KilianEisenegger)

10 The 2 zenith shots for the Phantom 3 Pro
At the end of the shooting you have to add 2 zenith shots. One in the mission start direction and one turned at 90°. You can see that in the YouTube video too.
We need a XML script to import this mission into Autopano. At the end I added 2 zenith shots.
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<lens type="rectilinear">
  <focal>3.53</focal>
</lens>
<preset>DroneBlocks X3 6 7 6 4 +1 Nardir +2 Zenith 3.53mm CUTH 32% CUTV 39%</preset>
<shoot>
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</pict>
12 XML MAVIC PRO

The MAVIC Pro can use the same code with the exception that the camera settings are different.

<?xml version="1.0" encoding="iso-8859-1"?>
<papywizard version="c">
<header>
<general>
<title>DroneBlocks X3 6 7 6 4 +1 Nardir +2 Zenith 28mm</title>
<gps> Koordinaten </gps>
<comment> generated from hdrpano Panogear 1.0 (C) K.Eisenegger 2016 </comment>
</general>
<shooting mode="preset">
<headOrientation>up</headOrientation>
<cameraOrientation>landscape</cameraOrientation>
<stabilizationDelay>0</stabilizationDelay>
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<endTime>2016-12-25_14h47m32s</endTime>
</shooting>
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</camera>
<lens type="rectilinear">
<focal>4.94</focal>
</lens>
<preset> DroneBlocks X3 6 7 6 4 +1 Nardir +2 Zenith 28mm </preset>
</header>
<shoot>
<!-- >>>>>>>> left to right >>>>>>>> -->
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</papywizard>