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HOW TO CHOOSE FPV CAMERA FOR QUADCOPTERS AND DRONES

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What drone pilots see while they are flying, are the low latency analog video from FPV cameras. To choose the best FPV camera for your multirotors, there are a few things to consider which we will discuss in this post.

FPV camera is one of the most important parts of a quadcopter FPV setup. Real-time image is broadcast from the camera through a video transmitter. Regardless how good the video transmitter is, the image quality on your FPV display is only as good as your FPV camera.

For recommendation, here are the top 5 best FPV camera voted by our FPV community. Check out this post for a full list of FPV Camera for mini quad.

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Before we begin, it's important to know the difference between FPV cameras and HD cameras. Those HD videos you normally see on Youtube are captured using HD cameras like the GoPro or Runcam 3, which is an additional camera pilots mount on their multirotors.

Although some of these HD cameras provide "video out" capability, which you can hook up to a video transmitter and use that for FPV. But the latency is too big (normally over 100ms) for FPV flying.

CCD and CMOS – Type of Imaging Sensor

CCD and CMOS are two main types of imaging sensors used in FPV cameras, each has unique characteristics and advantages. Most HD digital cameras uses CMOS sensors. For FPV cameras, CCD used to be better a few years back, but not the case anymore. Here are a summary of the pros and cons, check out this post for more detail.

CCD

- Less jello effect in footage
- Less noisy in low light
- ~~Better light handling and WDR~~ (not necessary true anymore)
- ~~Lower latency~~ (no longer the case)

CMOS

- Higher resolution
- Better colour
- Higher frame rate
- Consume less power
- Generally cheaper to make

CMOS cameras can perform just as good as CCD cameras these days. It's very important that you check example footage of the cameras before buying, see how they perform in bright daylight, low light, facing the sun and overall wide dynamic range.

Latency is just as important as image quality. CCD generally has a lower latency than the CMOS.

Wide Dynamic Range (WDR)

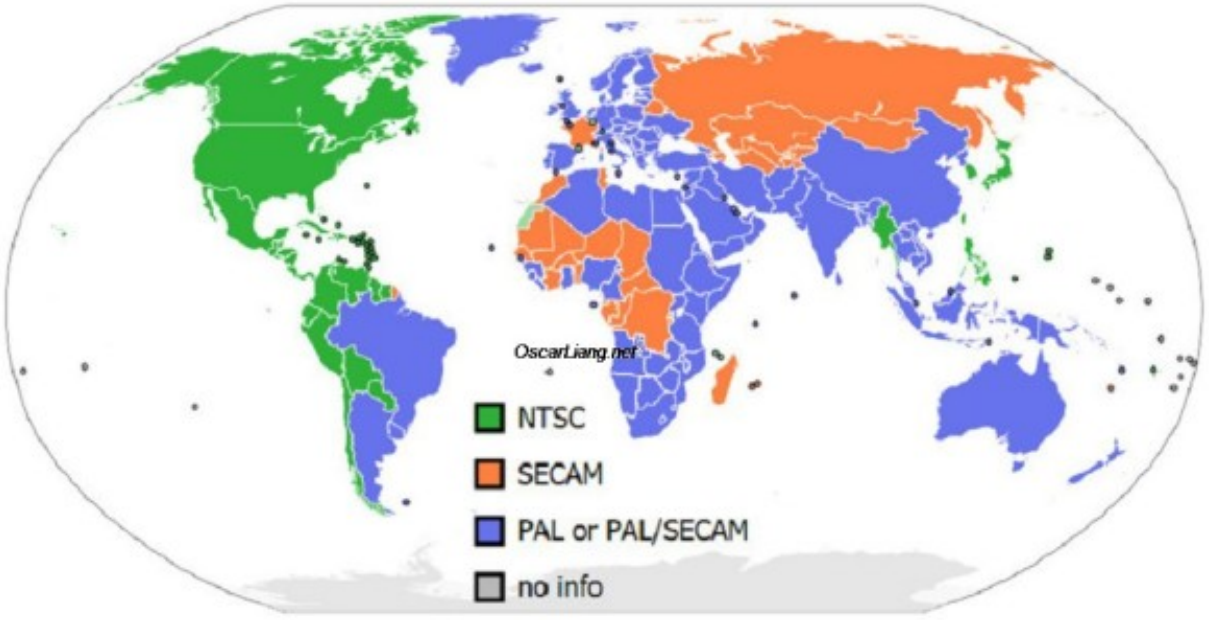
In this picture we have an under exposed image on the left, you can see the tree and bushes behind the sun is all dark. While on the right we have an image that is over exposed, the trees are all visible now but the sky around the sun is all blown out and white.

And this is where “Wide Dynamic Range” would shine. WDR can capture both bright and dark areas in extreme lighting conditions in the same frame. And as you can see in the middle image, the clouds in the bright sky and the trees behind the sun are all visible.

Once you understand the concept you will be able to recognize WDR capability in FPV cameras. Dynamic range is important to FPV flying as it allows you to see better when flying. One negative impact of WDR though is lower contrast in the image, sometimes it might appear as “washed out”.

NTSC and PAL – Video Encoding Format

It really isn’t a big issue whether to use PAL or NTSC nowadays, as they are both supported by most FPV equipment. NTSC is used in North America, Japan and South Korea. PAL is used in most of Europe, Australia and large parts of Africa and Asia. It’s a good idea to stick with the standard in your country. But I don’t think it would be a huge problem if you decide to use the other format.



The main different is that PAL offers better resolution, while NTSC allows more frame rate. So if you want to have good picture, PAL is good. But if you want more fluid footage, NTSC does a better job.

- PAL: 720 x 576 @ 25fps
- NTSC: 720 x 480 @ 30fps

For a more detail comparison, check out this post.

FPV Camera Field of View (FOV) – Lens Focal Width

When selecting a FPV camera, you usually have an option of different lens focal width, which give you different field of view (FOV). Common FPV cameras usually use 1/3″ screw-in lenses which is replaceable.

As a general guideline:

Lens Focal Length	Approx. FOV
2.1mm	160° – 170°
2.3mm	145°
2.5mm	130° – 140°
2.8mm	120° – 130°
3.0mm	110° – 125°

So knowing what FOV you like is more important than knowing what focal width when you are buying a camera/lens.

The wider FOV, the more environment you can see. But it's not always a good thing though as you will start to notice the "fish eye" effect. The objects in the middle will appear smaller and further away than it really is, and the edges of the image will appear curved and distorted. However when FOV is too small the image will appear zoomed in.

I personally find 130-140 degree more comfortable for FPV (normally 2.5mm lens).

This is a good example of different FOV (from narrower to wider).

Some cameras allows replacement lenses of different FOV and image quality. You can get these screw-in lenses and try them, instead of buying a whole new camera. For example I was experimenting different lens for the Runcam Swift.

I think it's all down to personal preference and what type of flying you do. For instance if you tend to fly proximity or through places with lots of close obstacles, wider FOV might be better. If you fly high altitude in clear open space, narrower FOV might be better. For FPV racers, wider FOV are popular

TVL – FPV Camera Resolution

TVL (TV Lines) is what manufacturers use to measure analogue FPV camera resolution. The number is based on how many alternating black and white lines can be displayed in the image horizontally. A 600TVL camera means it can display 300 black lines and 300 white lines alternately in one picture. The more TV lines, the better definition image you can get out of the camera. Commonly seen FPV cameras TVL are 380, 480, 600, 700, 800, 1200 etc.

However higher TVL or resolution comes with a price: it costs more $$ and usually comes with higher latency because of the extra image processing! 600TVL has been the most popular choice for FPV for many years now and it's more than enough for FPV.

Furthermore, higher TVL doesn't always give you better image due to the limitation of analog 5.8Ghz video transmission, as well as your monitor or FPV goggles. For example, 1200TVL is not going to be twice as sharp comparing to 600TVL in an analogue FPV system.

Latency

Latency of a camera can be a deciding factor if you are into drone racing or high speed flying. Imagine if you are flying at 100Km/h, a 50ms (0.05s) delay means you quad can travel 1.4m before you can react on the sticks, which could mean the difference if you hit or miss the obstacle.

Delay of a camera is often associated with the number of TVL and the image processing. Most 600TVL CCD cameras only have 20ms to 30ms of lag, such as the Runcam Swift and Foxeer HS1177. Higher TVL cameras tend to have higher delay due to more image processing. But of course it also depends on the image processing and algorithm.

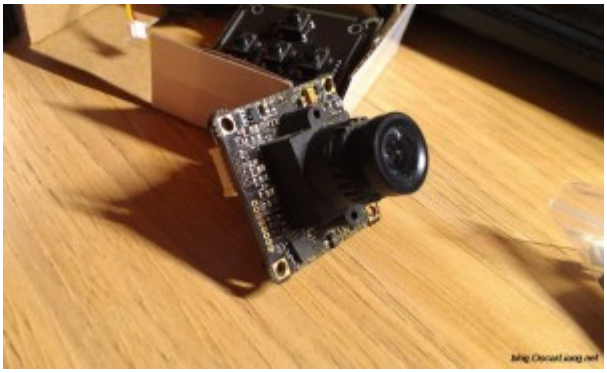
Latency is not something announced by manufacturers, so I try my best to test and provide this info in this article: FPV Camera Latency Testing.

Aspect Ratio

There are 2 aspect ratio to choose from, 4:3 and 16:9. It all comes down to which ratio your FPV goggles or display supports. If you have a 4:3 camera but 16:9 display, the image will appear stretched. If you have a 16:9 camera but 4:3 display, the image will appear squashed.

Next thing to consider would be the size and shape of the camera. This determines how easily the camera can be mounted on the multirotor frame of you choice.

In the old days FPV cameras were built on a square 32x32mm PCB without any protection and they are called “Board Cameras”. Board cameras can get damaged in a crash easily, therefore later on the electronics is put inside a 26x26mm case and that became the standard of today.



A FPV cameras could weight somewhere around 10g to 30g. There are also micro FPV cameras available for micro quads which can only be 1g-5g.

Input Voltage and Wiring

The electrical connections are very simple, we usually just connect 3 cables. The red wire is the positive voltage power, black is the ground, yellow is the video signal. Sometimes you might also get an extra withe wire which is the audio (if there is a built-in microphone).

Most cameras these days have a wide range of input voltage, e.g. 5V to 17V. This allows you to power them either from a regulated power source or directly from LiPo batteries (2S-4S). I also prefer to run a

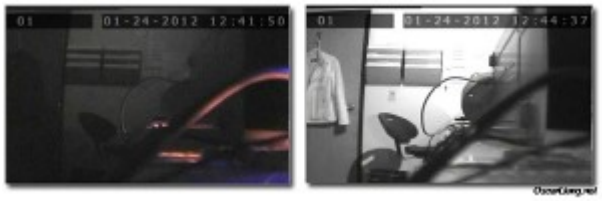
IR Block VS IR Sensitive

FPV cameras might or might not offer two versions, one is IR Block and the other IR Sensitive. IR block gives you more vivid colour, while IR sensitive works better in low light condition. Most cameras only offer IR-Block as we hardly fly at night or low light.

If you mainly fly during the day, stick with IR Block which will give you much better image quality IMO. For a wider range of lighting conditions but sacrificing some quality in colour, you can consider IR sensitive.

> *The IR filter could be applied on the lens or it could be directly on the sensor.*

Here is a more detail comparison of the two.



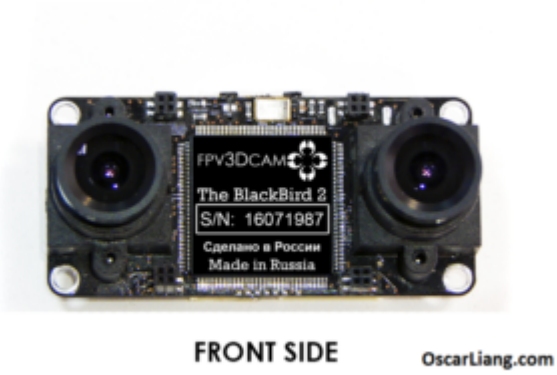
Night Cameras

IR sensitive cameras work fine at low light, but if you want to fly at night where there is very little light then you might want to consider a “Night FPV Camera”.

These are normally CMOS cameras with special algorithm that work great at extremely dark environment. For example the Night Eagle and the Owl 2.

Some good cameras allow users to change settings using an OSD control module (on screen display). There are so many settings on these cameras, it could be overwhelming for the first time. To understand some of the useful features, take a look at this post about how I set up my Sony Super HAD 600TVL Camera.

3D FPV Cameras



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There are 3D cameras designed for FPV, which consists of 2 cameras. Each of your eyes sees the image of one camera and that gives you the illusion of seeing an 3D image.

Here is the Blackbird 2 3D camera we reviewed previously.

Can I use HD cameras as FPV camera?

Some HD cameras offer “live video out” features which allows you to use them as your FPV cameras, such as the GoPro and mobius. It’s not uncommon to see people do that, in order to simplify their multicopter setup to save weight and costs.

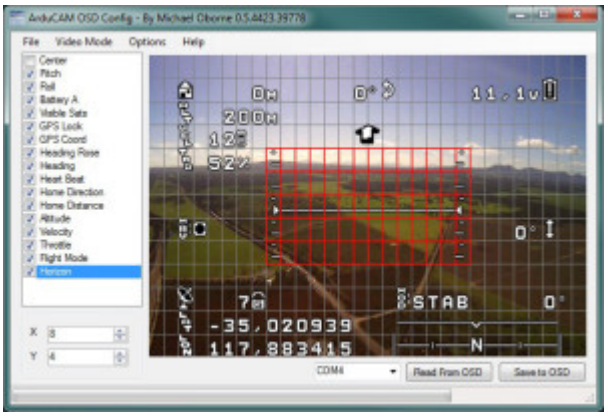
However there are some disadvantages using HD cameras for FPV, as I have already pointed out in

- Lag – there is a obvious delay, especially when recording at the same time
- Battery dependent – You don't have video feed if the GoPro battery dies. You can power the HD camera with external power source but it will consume large amount of current
- Recording locks up – If for some reason the recording freezes, your might also lose video feed

Therefore I always use a dedicated FPV camera alongside with a HD recording camera. It's also important that you don't put the FPV camera on a gimbal, so it doesn't mess up your orientation. You can also consider having video feed from the GoPro as well at the same time, and use a video feed switcher. You can switch between cameras with your radio transmitter, and see what the Gopro is filming.

Adding On Screen Display Data – OSD

This is a bit off the topics, but i am sure there are still people wondering what an OSD is. Basically, an OSD (on screen display) is a device that overlays text/data onto your camera footage. The video feed from the camera enters the OSD, and the OSD output goes into your video transmitter.



OSD is an useful tool to have as you can display many types of data on your FPV screen: RSSI, current, flight speed, altitude, compass heading, and distance, etc. For people like me who doesn't fly

You made it!

I hope this article gave your some ideas and understanding how to choose a suitable FPV camera.

Don't hesitate to leave me a comment/question, and happy flying!

Edit History

- Dec 2014 – Article created
- Nov 2016 – Updated info

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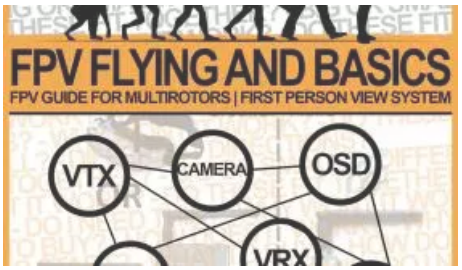

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Sudarshan
26th November 2017 at 3:22 pm

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If so how can we connect it?

Lon Ratley
1st May 2017 at 2:23 am