

## Tech Notes – FPV

In response to the request for “Tech Notes” content I would like to submit the following on the subject of FPV. FPV stands for “first person view” and refers to broadcasting a live video feed from a remote controlled vehicle and viewing that video from a monitor or goggles that are worn by the pilot and / or spectators. Probably the most commonly used vehicle for FPV today is the Multi-rotor helicopter but these light weight cameras / transmitters can also be used with planes, cars and buggy's, boats, submarines and even model rockets.

So why do we want pilot our vehicles from an FPV perspective? The #1 reason has got to be that it is FUN. You get the thrill of flying from the cockpit perspective without the risk and expense of flying a full scale plane or helicopter. The #2 reason based on popularity would have to be racing. FPV racing has taken the world by storm and is being organized world wide. Flying your quad-copter through a series of low gates and turns can be challenging to learn but the thrill of competition can be a very rewarding motivator, not to mention the financial rewards. Prize money in many of these races is big with the ultimate prize of a cool one million dollars awarded to the winner of Drone Prix in Dubai last year. Or maybe photography is your goal. An FPV connection to your RC plane or quad-copter can help immensely if you want to frame a shot or video from an aerial perspective. And finally, perhaps you just want to have a look around. You may want to see whats on the other side of a hill without having to climb over or around it. Or maybe you want to see just how many big bass and bluegill's are swimming around in a pond before you commit to a fishing trip. Just grab your FPV submarine and have a look.

Aren't they illegal? is a question I get asked a lot and it is a good question. Laws regarding where you can operate drones, as well as what kind of equipment you can use, vary from country to country, state to state. Even cities and county's are regulating them and the laws are changing all the time so it makes good sense to check before you fly. But the truthful answer is that you are not a criminal for flying your drone in a responsible manner as long as you follow the rules and use common sense. Don't fly over people, don't fly over private property without permission, don't invade other peoples privacy and above all don't fly any model that has not passed your most stringent safety inspection. Unlike a model plane that can usually still be navigated at least to some extent during a mechanical failure, a quad-copter is most likely going to fall from the sky in the event of any breakdown of its operating system. And this type of failure will always happen just when you have ever so slightly crossed the boundary between your property line and your neighbors resulting in your having to go knock on a door, fess up and ask permission to go and retrieve the model. This is not only embarrassing but it also represents our hobby in a negative way so don't let it happen in the first place. Play by the rules and check your model out carefully before you fly.

“If I bought it from a local store or trusted on-line company than it must be legal to operate?” is another question I have heard frequently. Sadly, the answer is no. Just because you purchased your drone legally does not make it OK to fly it in first person view. As most of us are aware of by now, any radio controlled model aircraft weighing between 55 grams and 55 lbs. requires registration of the pilot with the FAA and if you are going to operate in FPV than you will likely also need a Technicians License from the FCC. There are exceptions for some very low powered FPV systems as well as some that only broadcast the video signal via WiFi networks but generally speaking, unless the model you bought has a FCC sticker stating that it meets Part 15 requirements than you are required to have a Technicians License to operate it.

More information from the AMA can be found here:

<http://www.modelaircraft.org/files/FPVFCC.pdf>

And further information from the FCC can be found here:

[http://wireless.fcc.gov/services/index.htm?job=licensing\\_2&id=amateur](http://wireless.fcc.gov/services/index.htm?job=licensing_2&id=amateur)

The good news is that getting a license is not really that difficult. Gone are the days when you had to learn Morse code to acquire one. There are free on-line study sites that can prepare you to pass the license exam with a minimal investment of time spent studying. You will know when you are ready to take the exam as the on-line study sites have sample tests using the same questions that you will have in the real test. When you can consistently get a passing score you are ready for the real thing.

What do I need to get started? This is the most difficult question to answer because it depends on where you want to go with FPV. Do you want to race quad-copters, try your hand at photography or just get up in the air and have a look around. Or maybe you want to use drones as a means of making a lot of money. That will require a Part 107 license from the FAA. But lets say you just want to try it out, maybe take a few aerial photos or videos without spending a lot of money or time getting licenses. You can get a basic FPV drone from a Chinese on-line distributor for around \$40.00. It will be a WiFi type that sends a live feed back to your cell phone, requires no special license other than the FAA pilots registration that you should have already and will allow you to take photos and videos that you control through your phone or a small plastic transmitter. At this price point it will probably claim to be a “720 HD” camera quality and while it can take some reasonably good quality photos and videos much will depend on the daylight conditions as you will not have adjustable aperture, shutter speed, white balance, image stabilization or a rotating gimbal. It will also suffer from vibration induced effects as quads in this price range usually have poorly balanced propellers and minimal isolation between the camera and the vehicle. The live down feed from these WiFi based FPV systems will also exhibit moderate latency (a delay between the live action and the image reproduction on your phone or monitor). This really is no big deal if you are just doing photography but can be more important if you want to pilot the model by FPV.



Illustration 1: a \$40.00 drone with video and photo capabilities

If you are serious about photography you will need to step up to a much higher price range to get the features mentioned though prices have dropped dramatically in the last couple of years.



Illustration 2: a \$300.00 drone with high quality video and photo capability

If FPV racing is your goal then you better be ready to immerse yourself into the culture. The good news is the price of the equipment has never been lower, especially if you are going to build a quad yourself. The bad news is the technology is changing quickly and by the time you figure out what you should get there will be someone telling you that it is out dated and they will be correct. When I built my first quad it used a KK2 flight control board, a dinosaur by today's standards. It had no barometer, no magnetometer/compass, no programmable LED feature, no GPS capability, no Sonar capability, no black box or flight recorder capability, no telemetry etc. and cost more than boards today that have it all. But if your willing to learn there is a wealth of information on the internet to help you wade through all the technical stuff and decide what you will need for the type of racer you want to build. And loads of good videos to help you configure and tune your board so it will communicate through your receiver from your transmitter and to your goggles. Or you can go the easy way and buy a ready to fly racing model. It will cost more but many have the advantage of being modular in their design so if you break it in a crash you can simply unplug the broken part and plug in a new one. At one time it would have cost more for the video gear than it did for the drone. That has changed. You can now build a nice 250 size racing quad for around \$125.00 and the video camera and transmitter will cost less than \$25.00. Add a video receiver and goggles for around another \$75.00 and your off to the races. Of course you can spend a lot more on goggles and the quality goes up accordingly. The point is you don't need them to get started racing.

Another new and exciting aspect of FPV flying is the trend to small, indoor models. This started when someone figured out that if you upgraded the brushed motors on a small indoor quad you could make it carry a camera and video transmitter and so began what has become known as the "tiny whoop" revolution. You can pop on the goggles and race all over your house or even outdoors if the wind is calm. A bind and fly Inductrix Tiny Whoop FPV model will set you back \$99.00 and there are cheaper knock offs available from on-line stores. Because they are so small and light they are nearly indestructible and that's what makes them such a good platform to learn to fly FPV. The small, single

cell batteries they use are also inexpensive so the amount of fun you can have with these on a rainy day is endless. Flying these tiny models will help you hone your skills should you decide to go on to 250 class outdoor racing. And when it comes to honing your skills lets not forget the value of a good simulator. Most of them now include several multi-rotor models to practice with and many can be flown from the FPV perspective.

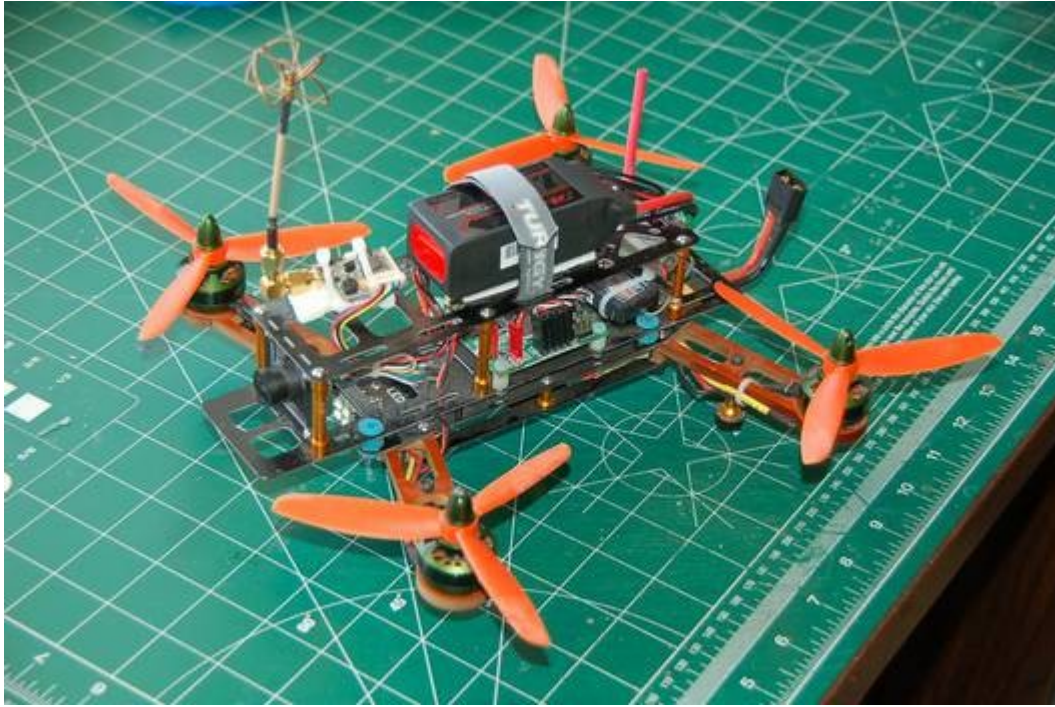


Illustration 3: one of the first 250 size FPV quads I built



Illustration 4: a Tiny Whoop knock off available from BangGood.com for \$55.00



Illustration 5: You will also need goggles to view FPV. These range from \$40.00 to \$300.00

It is beyond the scope of this article to show you how to build an FPV model from scratch but if you are inclined to build rather than buy a ready to race model I would encourage you to do so. It will cost less than a ready to fly and you will gain valuable information that will come in handy when the need for repairs happens (you notice I said when, not if, the need for repairs happens). Rather than trying to tell you what you would need to build your own FPV Multi-Rotor I am going to include the following links to build video's that will walk you through the process step by step. The two web links that I have included are ones that I personally have found to be very good however there are many others you can choose from. The first link will also include source links for all the specific bits you will need

The first link will also include source links for all the specific bits you will need to order at a price of under \$100.00 (not including battery) as well as an improved model at just a little more money. By clicking on the "SHOW MORE" button in the text below the video player you will find that you can link to all the parts you will need to follow along with the build. He even gives alternative parts links in case some of bits and pieces may be out of stock. The source he uses is "BangGood.com", I know, funny name but a reputable company that I have used many times.

<https://www.youtube.com/watch?v=Avp8MurmeEY>

And in this second link you will find a much more technical series of video's, numbering one through nine, that will not only walk you through the build process but will explain a lot of the techy stuff like connecting your receiver by PPW, CPPM or SBUS protocol and using the various configuration software programs like Cleanflight, Betaflight etc. that will make tuning your quad-copter's

proportional-integral-derivative's much easier. (Don't worry if that last sentence sounded like a foreign language, you don't need to understand it to do it)

<https://www.youtube.com/watch?v=kwGj5dX-T-A>

That about wraps it up for this article. I hope that anyone who has been on the fence about trying FPV or quad racing will decide to give it a go, and remember to start small. Smaller quad-copter's are harder to break in a crash and both easier and cheaper to repair if you do damage them. They, along with a simulator will teach you the basic stick movements just as well as a larger, more expensive model would without the cost and heartache when you crash. Hope I'll see you all soon at our nearly finished Clearlake Modelers FPV Race Course.

Until then,  
Tom Inderkum