

# Why Drones?

*We've all heard about drones on the news, seen toy drones in the store, and have seen the iconic white and red striped DJI Phantoms filming and taking pictures from afar. But why are drones so important for the STEM community? Why should we be so excited about drones? Why are they any different than a robotics kit? Continue reading to have these questions answered, and more!*

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Drones, or to be more specific, “quad-copters” have recently been becoming the focus of many STEM programs around the world. Everyone seems to know that “drones are in,” but not many people know why, other than the obvious fact that they are a new technology becoming widely available to the consumer. We saw a similar type of excitement between 2010-2012 when Maker-bot started selling the first commercially available 3D Printers for in home use. While I love 3D printers, and agree that they are an incredible technology, they have nothing on these enigmatic flying machines.



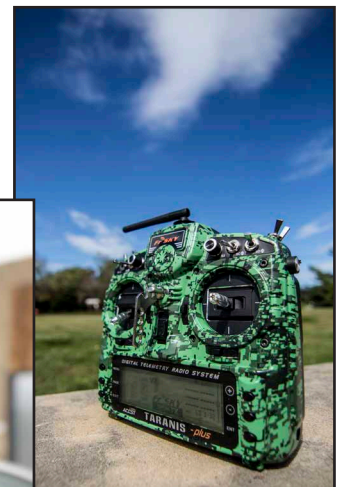
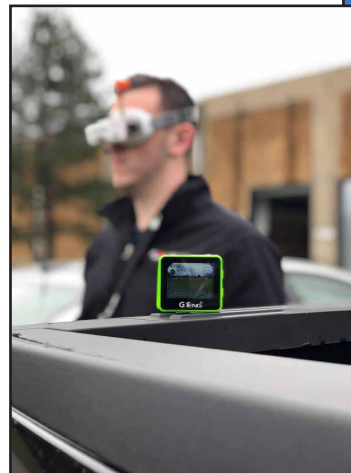
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## Part 1: More matter with less art

*So all of that sounds good right? You can just take my word for it if you'd like, or you can continue reading to really discover the true value hidden between the wires and carbon fiber.*

Time to get down to the details. First off, the specific genre of drone that we are talking about are referred to as “FPV Racing Drones”. FPV, an acronym that you will surely hear more of, stands for “First Person View,” and describes how these Racing Drones are flown - in the first person. “Pilots” of these crafts see what the drone sees, as if they are actually inside of it. These goggles are similar to VR (Virtual Reality) goggles, except in this case they are... well, simply - “Reality goggles”. There is a small camera built into the front of these drones, which in conjunction with a video transmitter, allows the user to navigate the drone wirelessly through its surroundings. The navigating itself is also done wirelessly, but this isn't your grandfather's RC remote. These remotes are computers disguised as RC remotes. They can be tweaked and upgraded to fit each pilot's style.

Flying a drone through FPV goggles with a monitor in the foreground showing what I see.



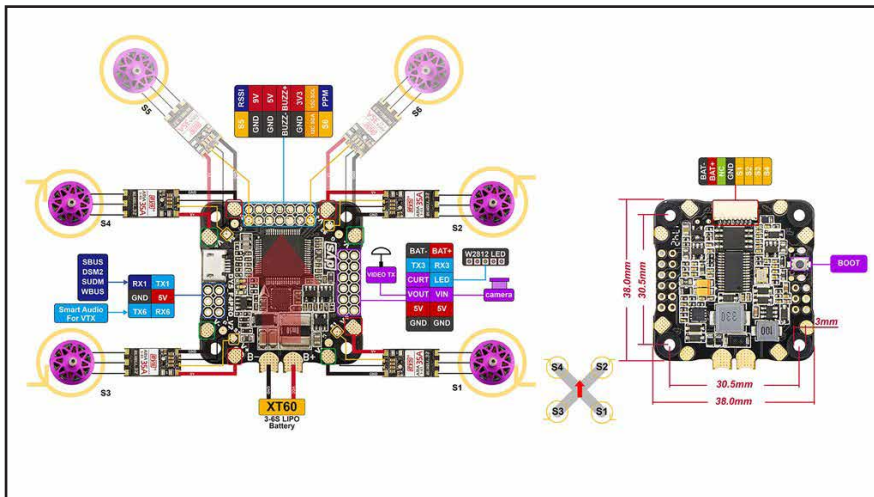
My personal remote which I upgraded and customized

## Part 2: Technical Insights

*This is where we really start to get into the metaphorical “Meat and Potatoes” of what the drone platform has to offer us. We’ll go over several important topics that are essential to building and operating an FPV Racing Drone.*

Mechanical Assembly- While this is a small part of building a drone, it is a very important phase where students will learn what goes into designing products made from new and exotic materials such as carbon fiber, and 3D printed TPU. (carbon fiber frame shown to the right)

Reading Electrical Schematics- 90% of building a drone incorporates soldering wires between electronic components for power and communication. Students will become well versed in reading schematics for the many different components that make up a racing drone. (below is a the scematic for the flight controller we use)

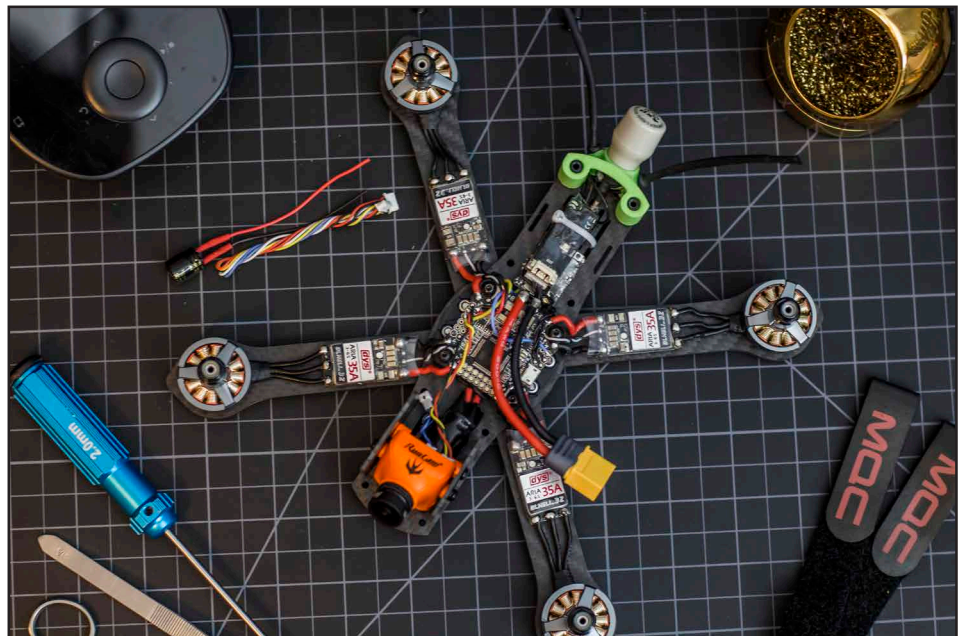


As you can see, these drones are made up of an entire system of parts. Just pictured in the diagram to the left alone are the flight controller, electronic speed controllers, brushless DC motors, camera, video transmitter, serial protocol receiver, several power and ground pads and a few “UART” pads (universal asynchronous receiver transmitter) for custom serial protocols if you are feeling adventurous.

### Soldering & Wire Manegement-

What good is being able to read a wire diagram if you can’t solder? A single drone can have over 100 soldering connections. It is safe to say that anyone who decides to build a drone is going to become proficient in soldering whether they’d like to or not.

Proper wire management is also required when building a drone. Loose wires can get caught in the props resulting in a cut connection. Eventually students will be able to design and 3D print parts to which they can mount otherwise loose components and wires.



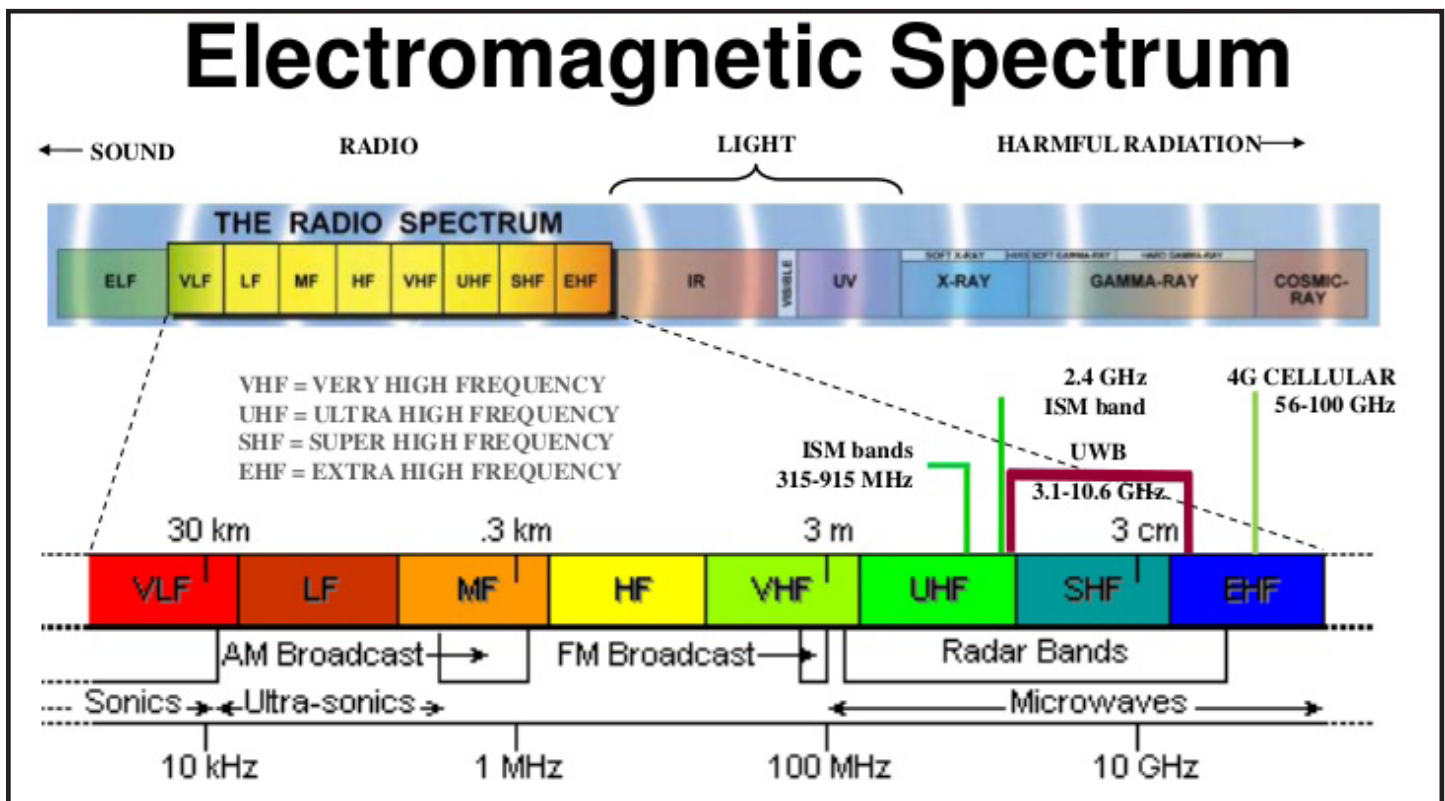
The green piece in the rear of the drone is a 3D printed part that I designed which positions the radio receiver and video transmitter antennas in the optimal position for sending and receiving signals.

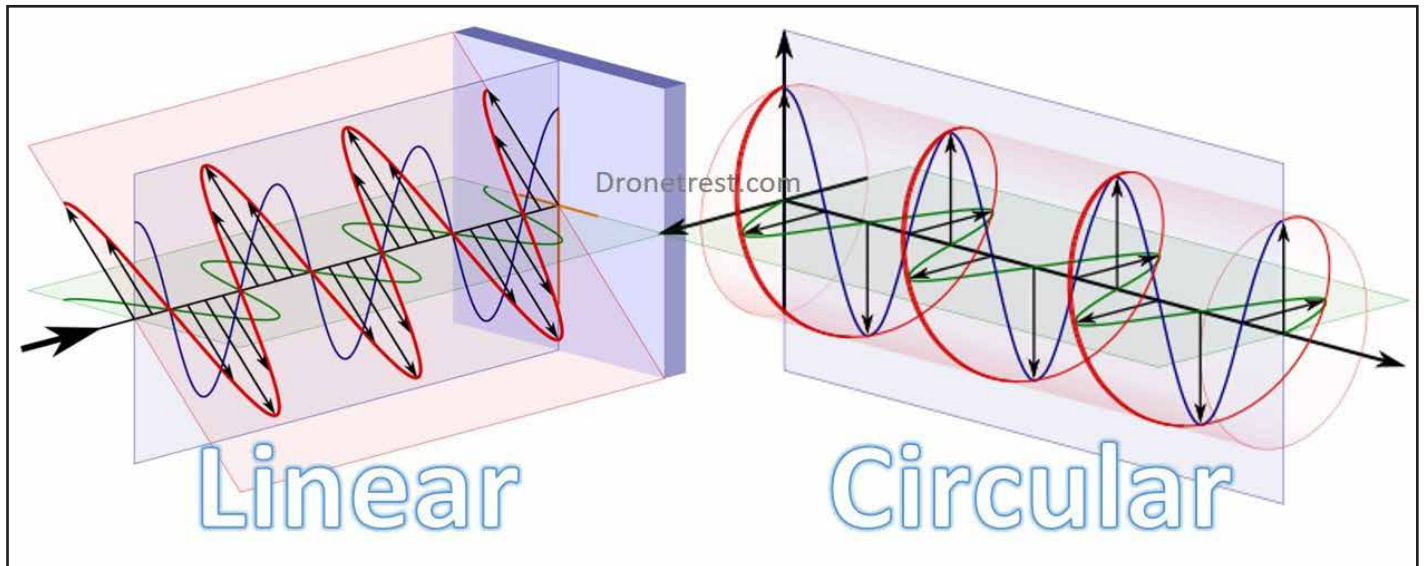


Battery Technology- Batteries are the single most important thing for these drones. Without current Lithium Polymer (LiPo) battery tech, we would need batteries many times the size of the drone in order to supply the required current. Students will learn about all different kinds of battery chemistries and variations. LiPo, NiCd, Li-ion and Lead acid to name a few. The most important battery in our case is the LiPo battery (several pictured right). Their magic lies in the fact that they can discharge energy faster than any battery available on the market. Without going into too much detail, I will simply state that learning how to use LiPo batteries is the perfect way to introduce the most important fundamentals of electricity. Voltage, current and power are all necessary factors for battery selection.



Antennas and Radio Frequencies- Drones use two different RF (Radio Frequency) “bands” for sending and receiving data: 2.4GHz and 5.8GHz. The RF transmitter sends commands via 2.4GHz, while the video transmitter on the drone sends the video feed over 5.8GHz. RF tech and the electromagnetic spectrum has never had a place in high school, but with drones we can have students discussing the range advantages of 2.4GHz over the higher frequency 5.8GHz band. Not a day goes by that we aren’t affected by RF. Do you have a cell-phone? The current 4G wireless cell phone system is transmitted in the 700, 1900 and 2100MHz bands. The wifi in your house is transmitted over 2.4GHz and some routers even have a second 5GHz band. Bluetooth, Car keys and even some kitchen appliances use Radio waves too. Pictured below is the electromagnetic spectrum as we know it, along with some of it’s current applications.





Not only will students learn about the RF Spectrum, they will learn about the different types of antennas and signal polarizations that we have available to us. Above are two examples of signal polarizations from a Di-pole antenna and a cloverleaf (circular polarized antenna).

### Part 3: The Key Ingredient

*So drones tie together most of the major fields of engineering into one affordable platform right? So what makes it different from a robotics team or any other stem program?*

This final point is the most important part to the entire drone equation. Why are drones better than any other STEM related platform that has ever existed before? Simple, they are FUN. Now this may seem like an extremely underwhelming point, but really think about it. When students are on a robotics team, what is their main goal? Finish the robot and try to win a school competition right? This in itself may be motivating enough for many students but for the majority it is just another school activity. Let's take a minute and think about sports and exercise. Why do kids play pickup basketball games over the summer? or go swimming in a friends pool? Is it because they think that they need to work on their cardiovascular health? No, its because it's FUN. Drones are to science and engineering as summer evening games of tag are to exercise.

The driving factor behind kids learning about these FPV Racing Drones is not from them having to get a good grade or perform well in a school competition, but because they want to get back in the air and fly! I can tell you first hand how incredibly fun these drones are. When I first got into this style of drone I was instantly obsessed, and had to spend every minute combing the internet for information on how to fix my latest broken part. This is going to change the future of STEM programs in schools forever. No longer will these classes and programs be for the select few talented students who want to learn how to program and design robots. Drones are opening the doors to a new group of students that want to fly these 90+ mph miracles of technology with their friends.

