Introducción a los drones DIY

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24 de octubre en ***EL EVENTO*** UC3M

Diapositivas originales:
“Drone 102” por Bob Forooghi de Rhubarb Studios
Descargar en: http://tinyurl.com/charladrones

Basic History

Efficient flight
Some control

NOT efficient
EXTREME precision

Funny mixes...variable range of control

Quadcopters are simple!

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¡Examen sorpresa!

Saca el móvil y abre la siguiente URL:

http://kahoot.it

https://play.kahoot.it/#/k/5af14eea-bfa9-4e78-8189-13398eee6fab

¡Los drones molan!

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Parte 1

¿Qué necesito para construir un dron?

Herramientas y habilidades

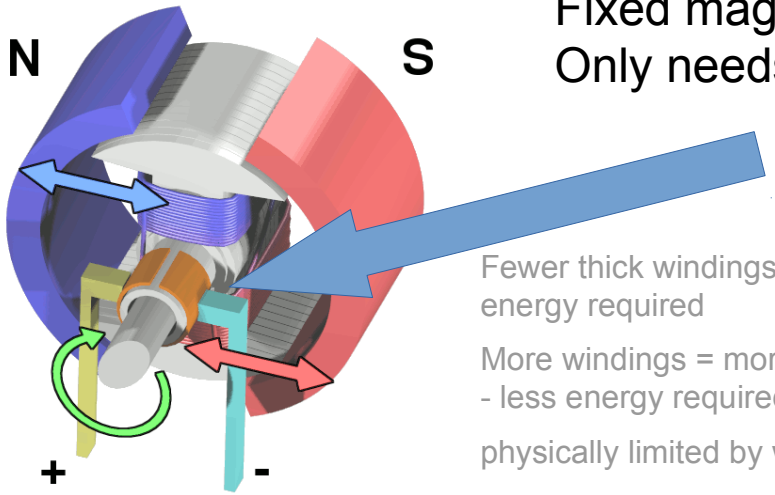
- **GAFAS PROTECTORAS**
- Taladros
- Llaves Allen
- Destornilladores
- Tijeras
- Alicates
- Ordenador con Chromium o Google Chrome
- Cable micro USB
- **Soldador**
- **Tubo termo-retráctil (heat-shrink tube)**

Build the frame! ~45min

Assemble your frame

Motors

Traditional - inrunner



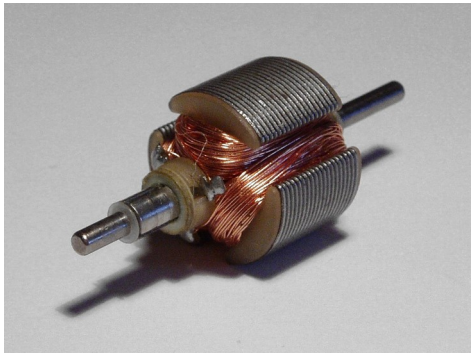
Alternate current inside motor
Push/pull magnetic fields produced
Fixed magnets to push/pull against
Only needs an analog voltage/current to run

¡Con escobillas!

Fewer thick windings = more power - more energy required

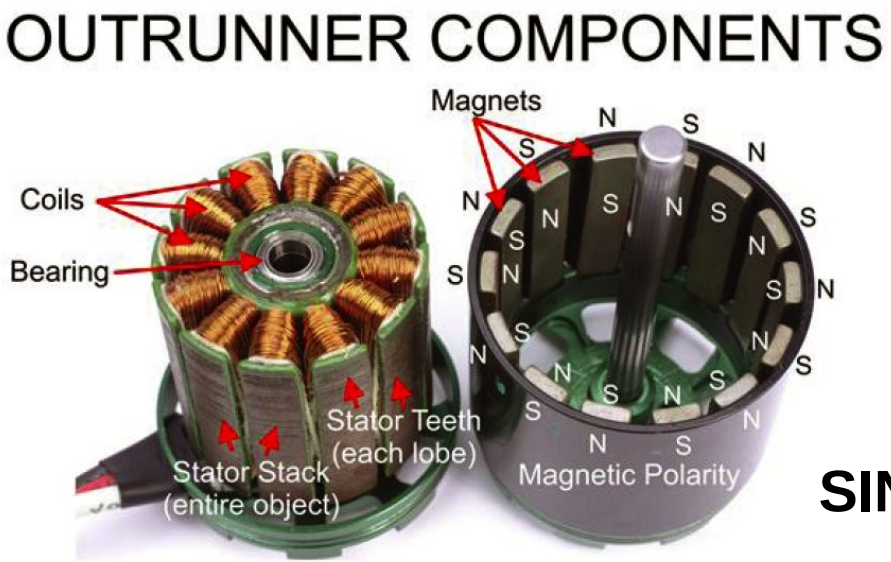
More windings = more efficient/less power - less energy required

physically limited by windings



Motors

Modern Brushless



No brushes
Windings on inside, fixed magnets on “bell”
Bell weighs less than “stator”, better response
Fewer moving parts, only two bearings
Waterproof but not immune to corrosion
Better ventilation
Requires delicate controller to operate
Tesla uses an inrunner brushless

SIN escobillas → menor desgaste

Electronic Speed Control (ESC)

Alternates currents in coils in a very careful manner to increase/decrease speed of spinning bell. VERY delicate control.

Traditionally would take an analog input and output 256 or 512 steps with slow ramp up/down response

Too slow for the extreme control we require for solid multirotor flight

Special firmware designed to drastically improve response and accuracy.

1024 or more steps with quick sync speed

Much much smoother; near analog response quality

Las baterías.

Quizás lo más peligroso del dron.

(Aparte de poder impactar contra alguien, a gran velocidad y con hélices que giran a 20,000 RPM)

Lithium Ion Batteries

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Liquids(old)...corrode...but that's how they work...ions through liquid
Lithiums are solid state with an ion friendly substrate
Modern lithiums are happy to provide more POWER but:

- The chemistry goes bad past a carefully regulated range
- If shorted, will dump all power in an instant and "can" burst into flames
  - Requires careful circuitry to manage.
- No battery is very environmentally friendly (Sorry Prius, Tesla, others…)

These are the cells in laptops and thousands used in each Tesla car (this exact cell model). These are typically NOT the cells used in hobby items because they don't release their energy fast enough...

Lithium Polymer - for hobbies

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Used in various applications including **ALL** your devices...phones, watches, mp3, everything
Hobby variant is a little different.

- Ionic substrate allows for **EXTREME** ion movement which is required
- Downside - makes them significantly larger
- “LiPo” hobby cells are NOT protected and require **VERY CAREFUL** management

Cells have a main power lead
And a “balance” charging lead

Cada celda LiPo proporciona entre 3 y 4.2 voltios.
Ponemos varias en serie, para obtener mayor capacidad y potencia (2S, 3S, 4S...)
Conectarlas en paralelo, es malo para la salud

LiPo Charge Rate

You can safely charge your battery at 1C

This means it will take ONE hour to charge the battery

Most chargers take an additional ~5min to balance properly

Higher charge rate will deteriorate battery

~50min total charge time

Cargar a 1C quiere decir:
Una batería de 600mAh
carga a 0.6 amperios

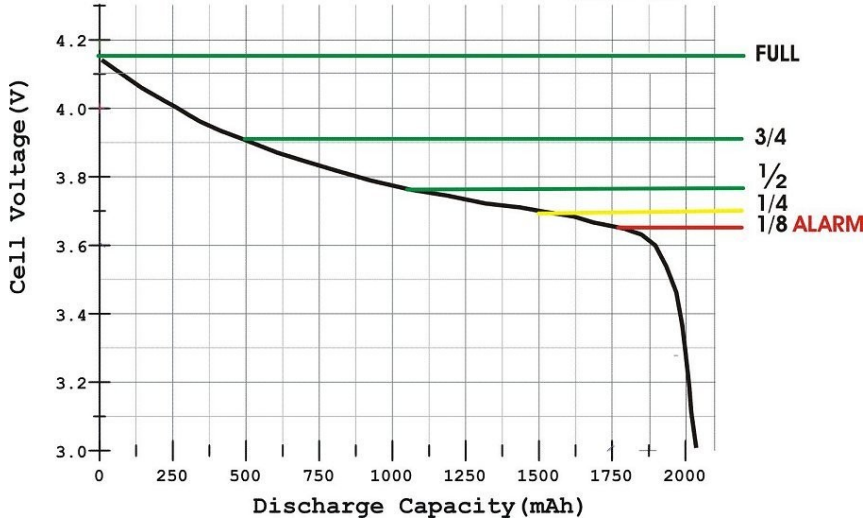
No conviene cargar
varias en paralelo

LiPo Management

The typical lithium cell lives in a voltage range from 3.3-4.2v and average 3.7v

- “Empty” at 3.3v
- “Full” at 4.2v
- Outside this range, the cell will deteriorate exponentially faster
- If taken too low/high, chemistry will begin to exhaust gasses

Multirotors operate at higher voltages so we stack cells in series to achieve 11.1v avg or higher.



Flight Controllers = AWESOME

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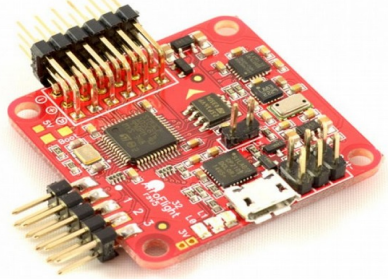
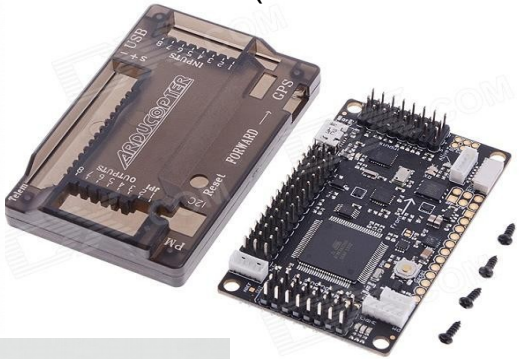
KK Board

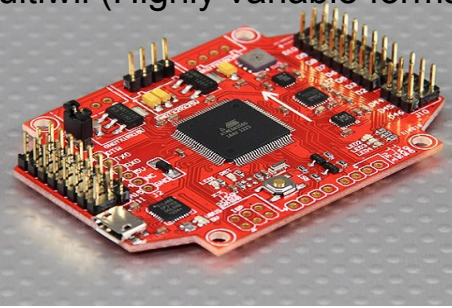
Naze32



APM (standard size shown)



Multiwii (Highly variable forms)



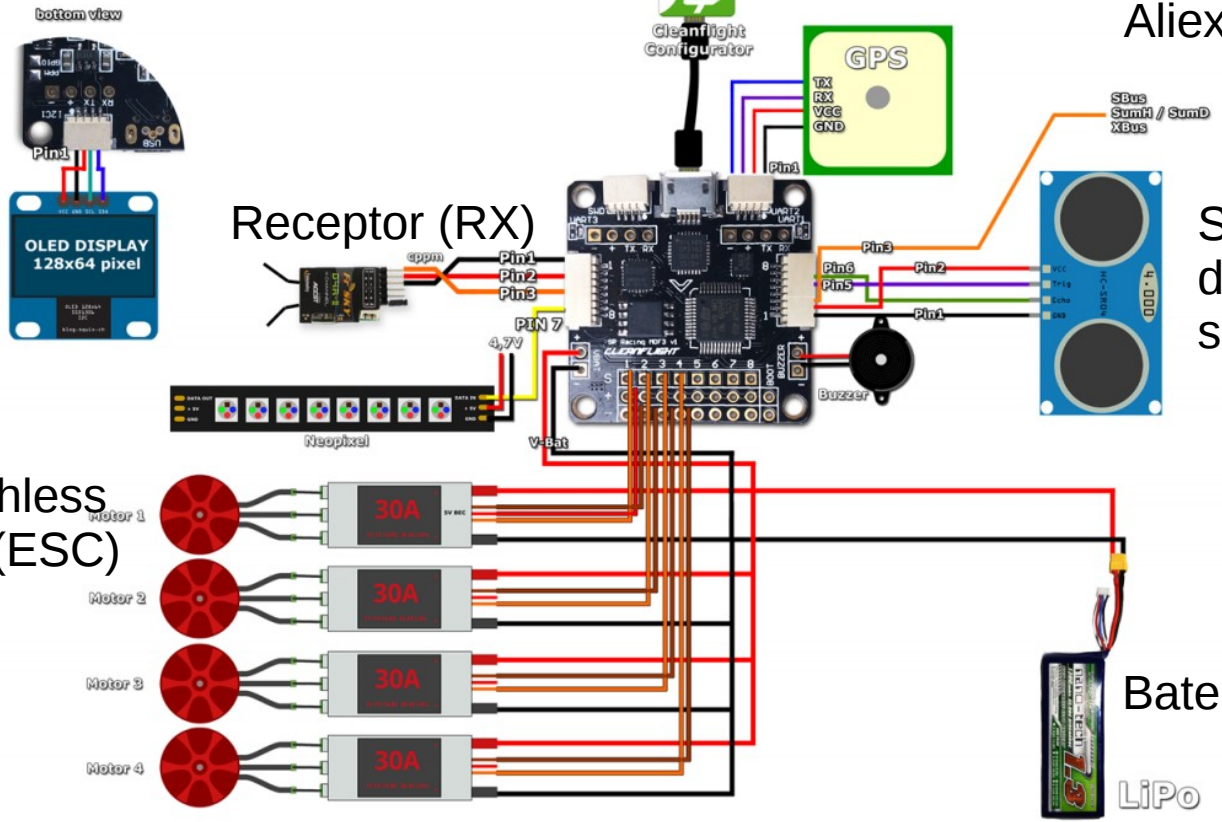
Naza

Pixhawk

SP Racing F3

CLEANFLIGHT

¡Ya disponible en su tienda online mas cercana!
Banggood, Gearbest, eBay, Aliexpress...

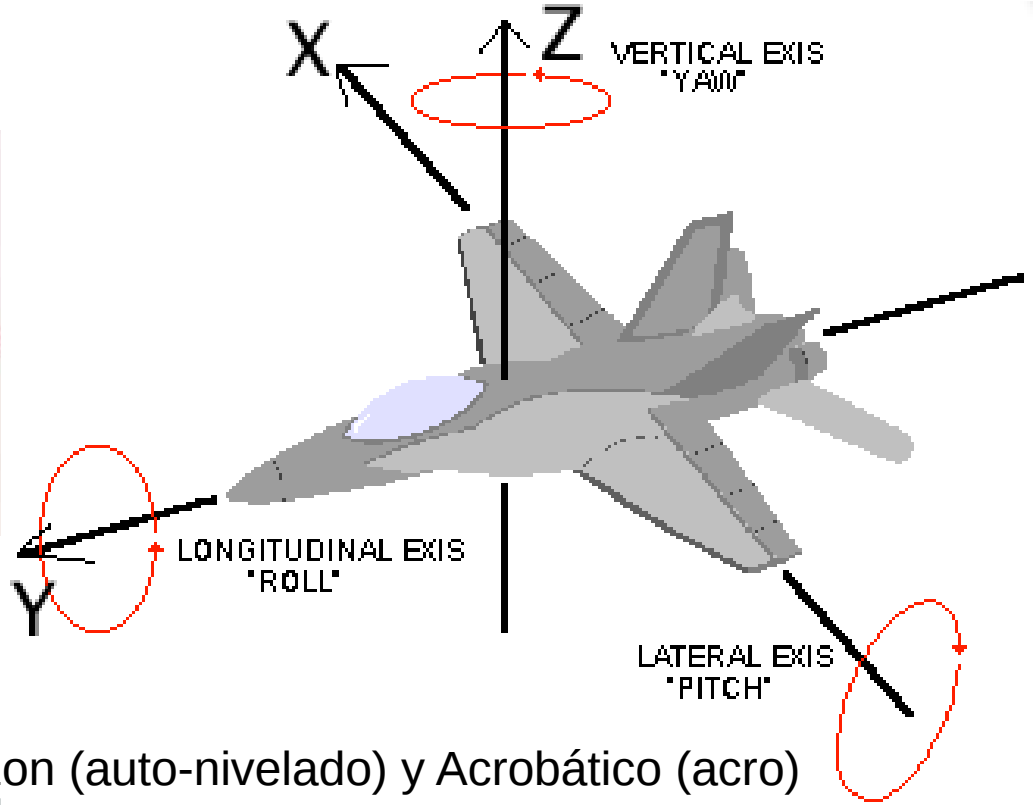


Sensor de distancia al suelo

Motores brushless y variadores (ESC)

Batería

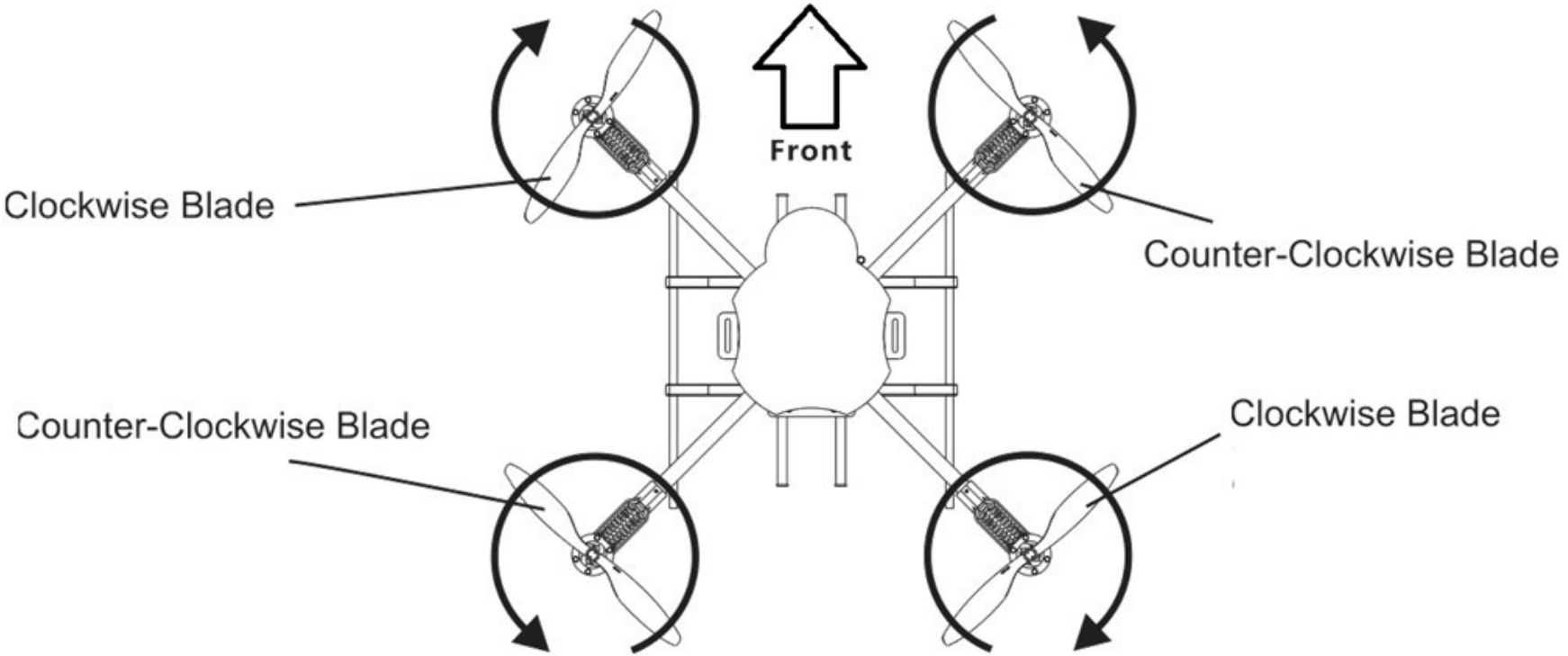
Los drones son fáciles de pilotar



La parte delantera de un dron, normalmente se identifica con hélices de color rojo

Modos de vuelo: Horizon (auto-nivelado) y Acrobático (acro)

Montaje de las hélices



Sistemas de radio

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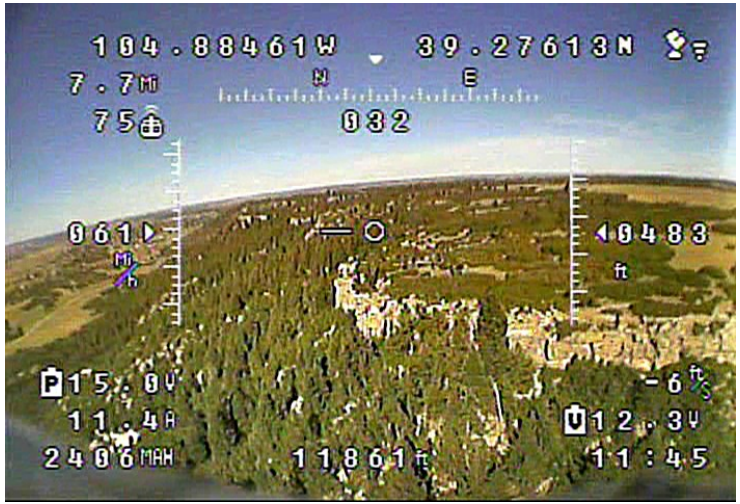
Funny things that are affected by more than just objects and reflection...even wind
- Some frequencies are vastly saturated
  - 850/900/1800/1900 are ATT frequencies, anything close to them is pretty much screwed
  - 2.4ghz is used for almost everything (wifi, bluetooth, security systems, you name it)
  - Many others are used for air traffic control which is relatively light use
  - 1.3ghz is the GPS band but because of the nature of the signal, it's not very saturated
  - No transmitter is 100% clean. Particular nodes interfere with other signals...1.3/2.4, 433/1.3
- Ways to overcome these issues
  - increase broadcast power - 1/r^2 - Not a good way
  - enhanced antenna design - Significantly more difficult but more effective
  - Place antennas far from each other...

Normalmente las emisoras van a 2.4ghz. El vídeo a 5.8Ghz
Con salto automático de canal (channel hopping) para reducir interferencias
Rango de control en torno a 1000m. Pero el rango del vídeo es mucho menor.
- Depende de muchos factores
- Approved bands for public use: 433mhz, 900mhz, 1.3ghz, 2.4ghz, 5.8ghz

Vídeo FPV (First Person View)



OSD = On Screen Display
(Superposicion de datos en la pantalla)

El sistema FPV es independiente del resto del dron.
El vídeo FPV tiene muy poca resolución. Para HD, se pone otra cámara.

¿Qué necesito para construir un dron?

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Vitaminas (Electrónica)

4x motors / Motores
2x CCW propellers / Hélices
2x CW props / Hélices (otro sentido)
4x ESC's / Driver de los motores
1x PDB / Power Distribution Board
1x Flight Controller /
"Cerebro" del dron
1x LiPo Battery /
Batería de polímero de litio
1x RX / Receiver / Receptor
1x FPV Camera / Cámara
1x Video TX / Transmisor de vídeo

Comunicaciones

1x TX / Transmitter / Emisora / Mando
1x FPV goggles / Gafas "First Person View"

Otros componentes

- 1x Battery voltage monitor / Voltímetro
- 1x LiPo Charger / Cargador baterías
- Frame / Marco del dron
- Screws / Tornillería
- zip ties / Bridas

Coste total: ~300€ ¡Fenomenal!

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Parte 2

Programando un dron
Opciones de software libre
(¿Hay otras?)

Espera ¿Fenomenal?

¡Son 300€!

Pero ya me he gastado mis ahorros en una impresora 3D :'(

¿Fenomenal?

=

¿Fenomenal?

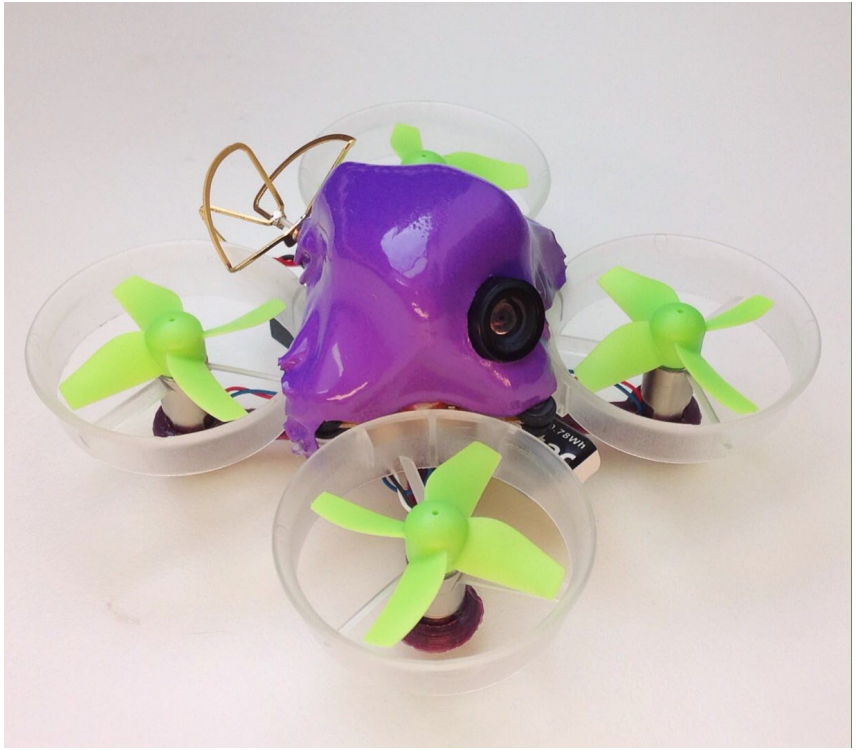
=

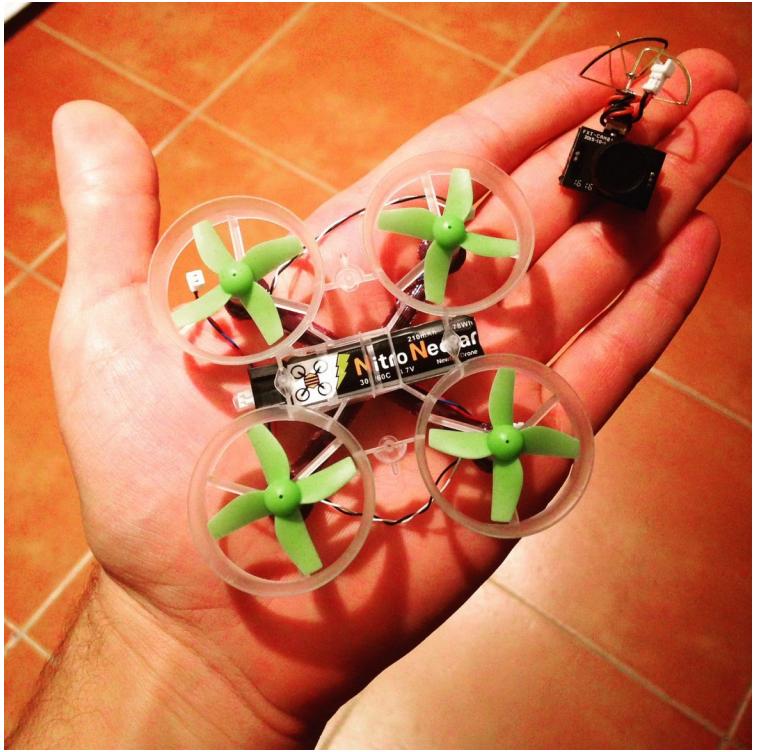
Ahora sí, ¡Fenomenal!

=

300€ = ¡6 micro drones!

¡Los micro-drones sí que molan!





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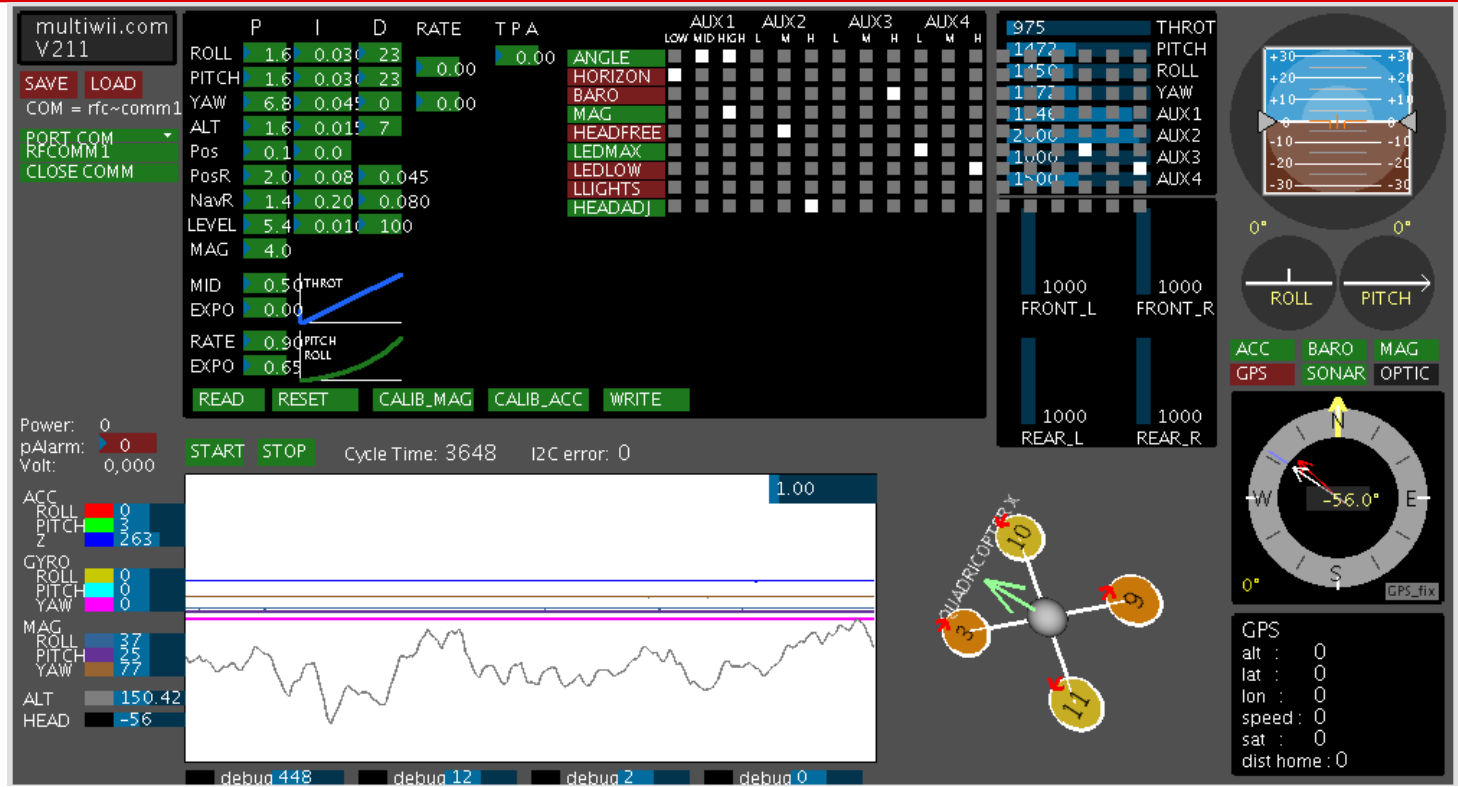
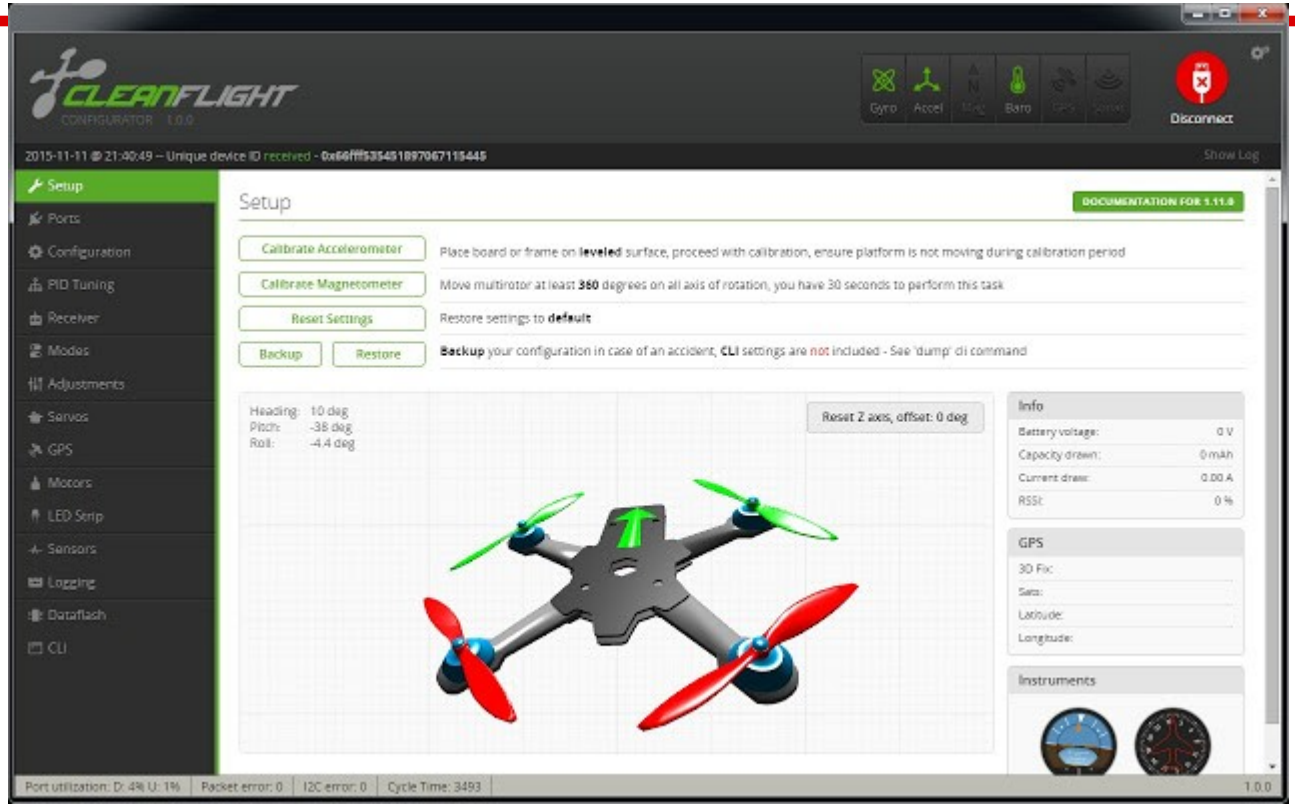
Programando un dron
Opciones de software libre
(¿Hay otras?)

Firmware. MultiWii



Firmware. CleanFlight



Firmware. BetaFlight, RaceFlight

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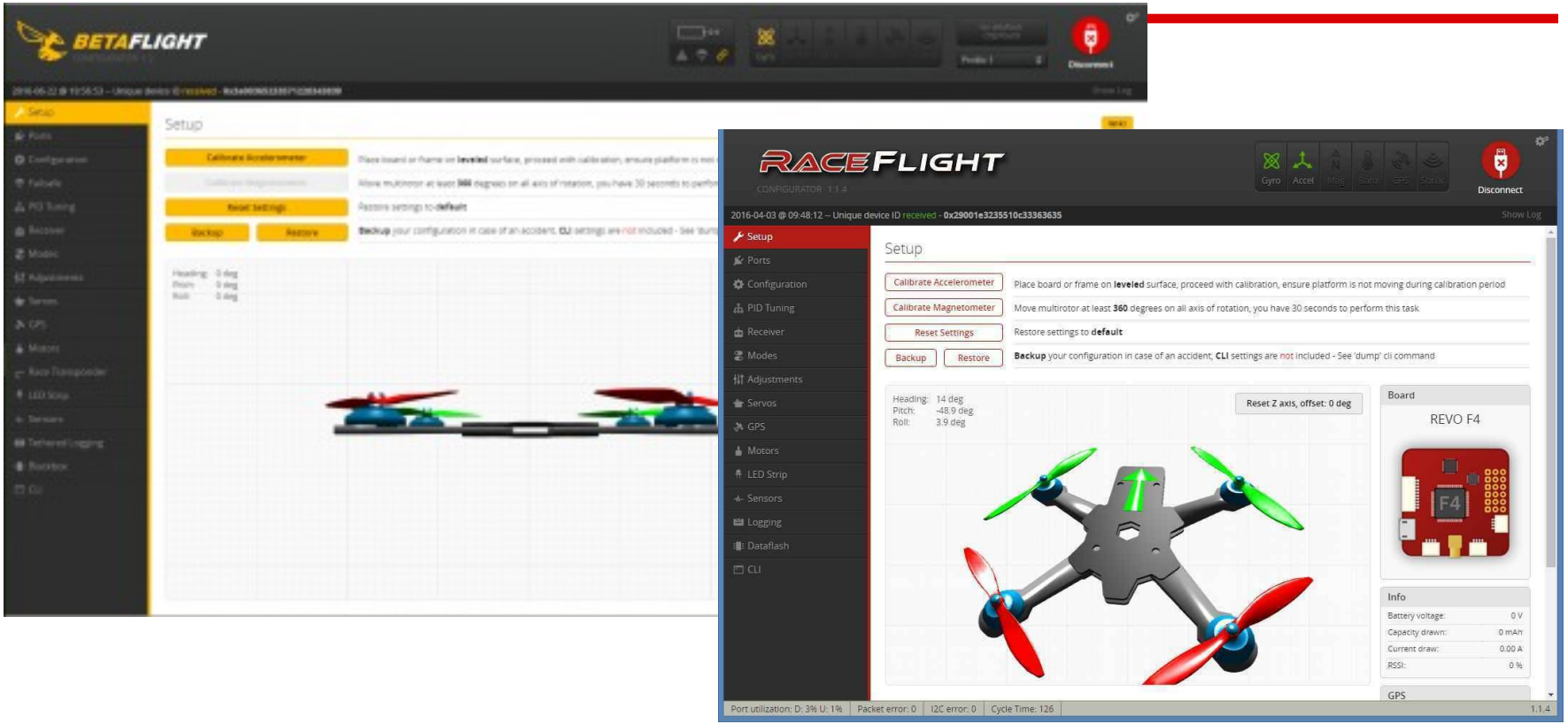

Firmware. INAV

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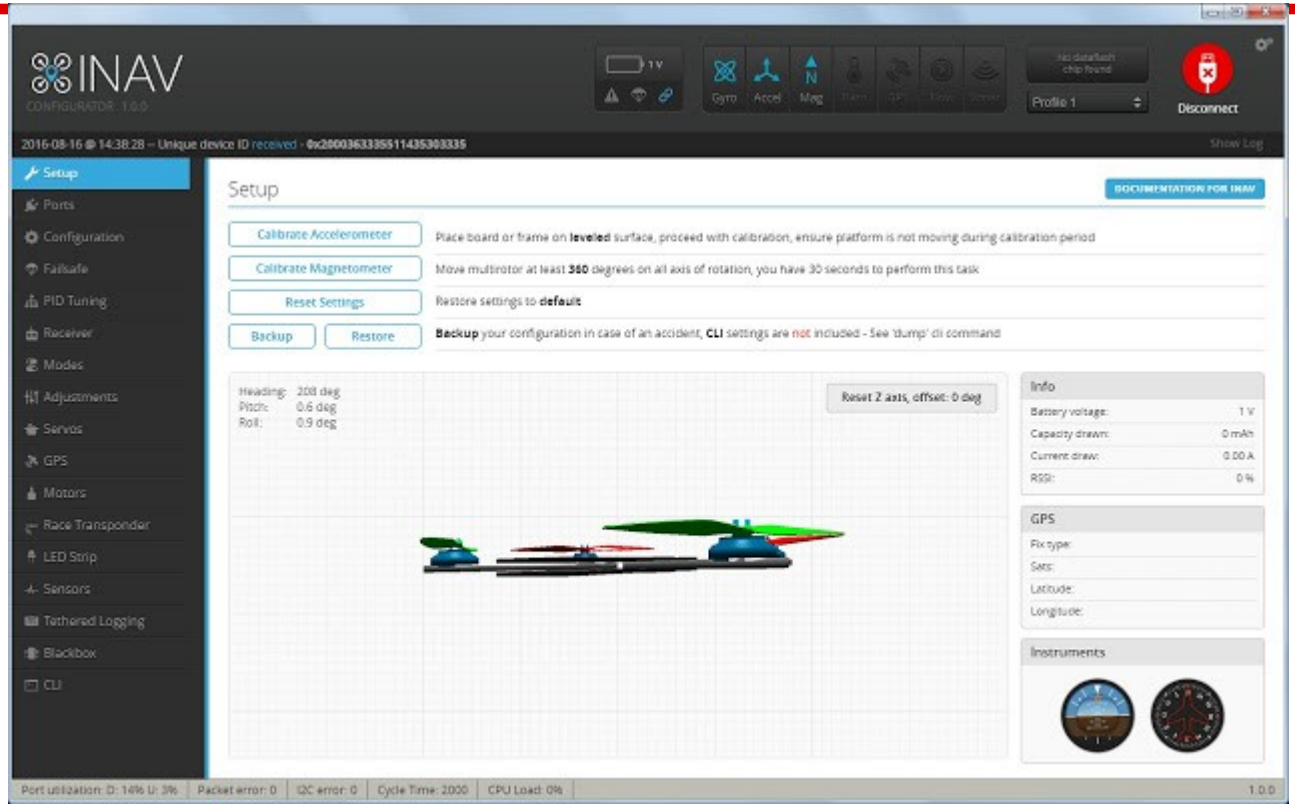
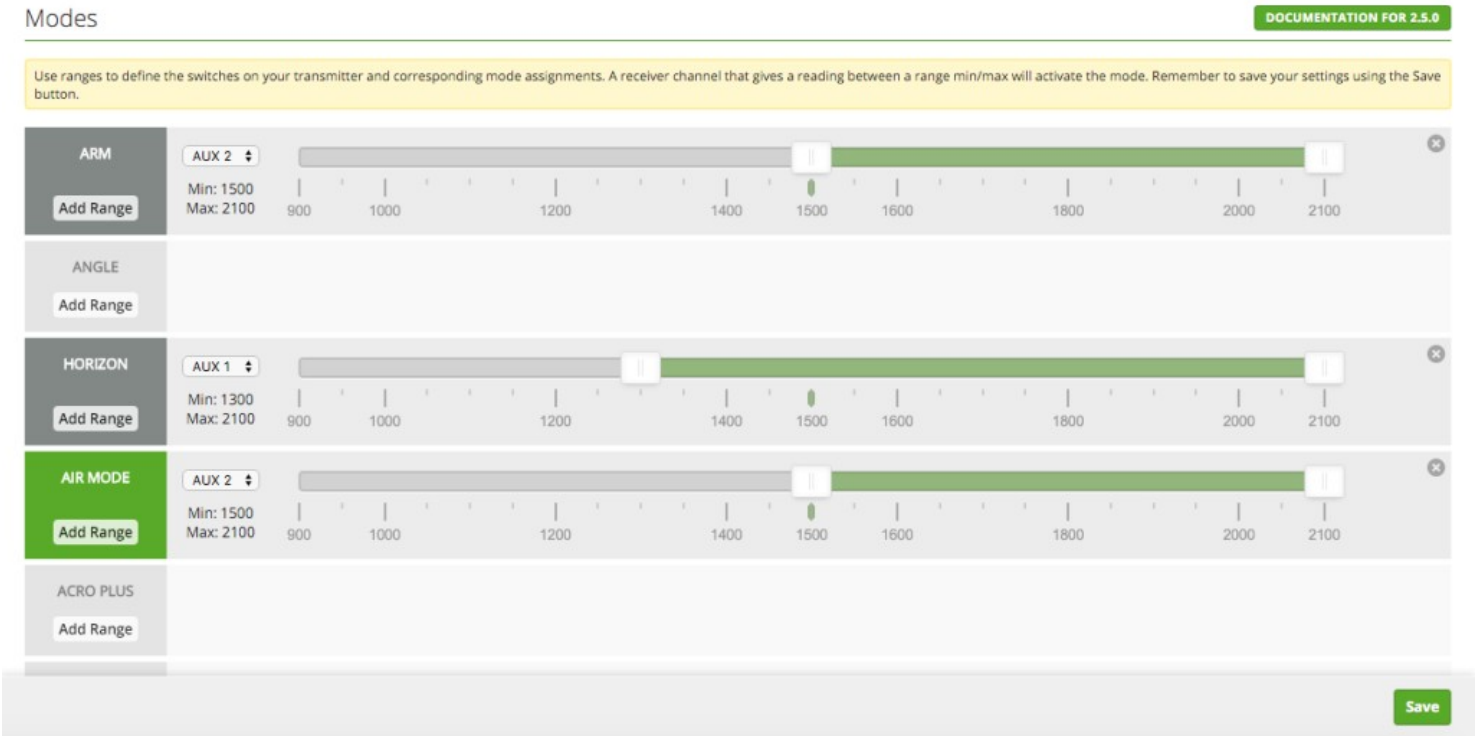
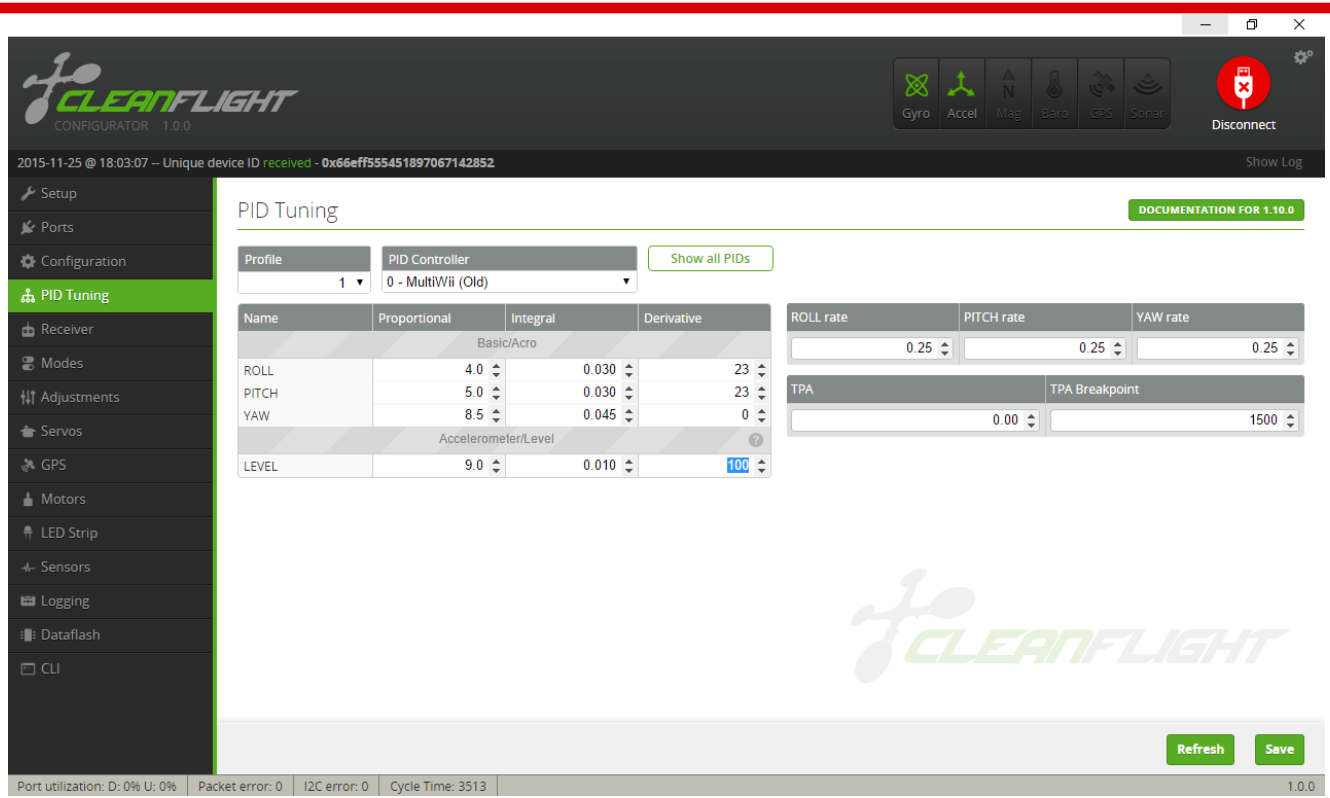


Interruptores del mando



Calibrado de los PIDs



Have a LOT a LOT a LOT of FUN!

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TONS OF UNIMAGINABLE FUN!

Develop your awesome skills!

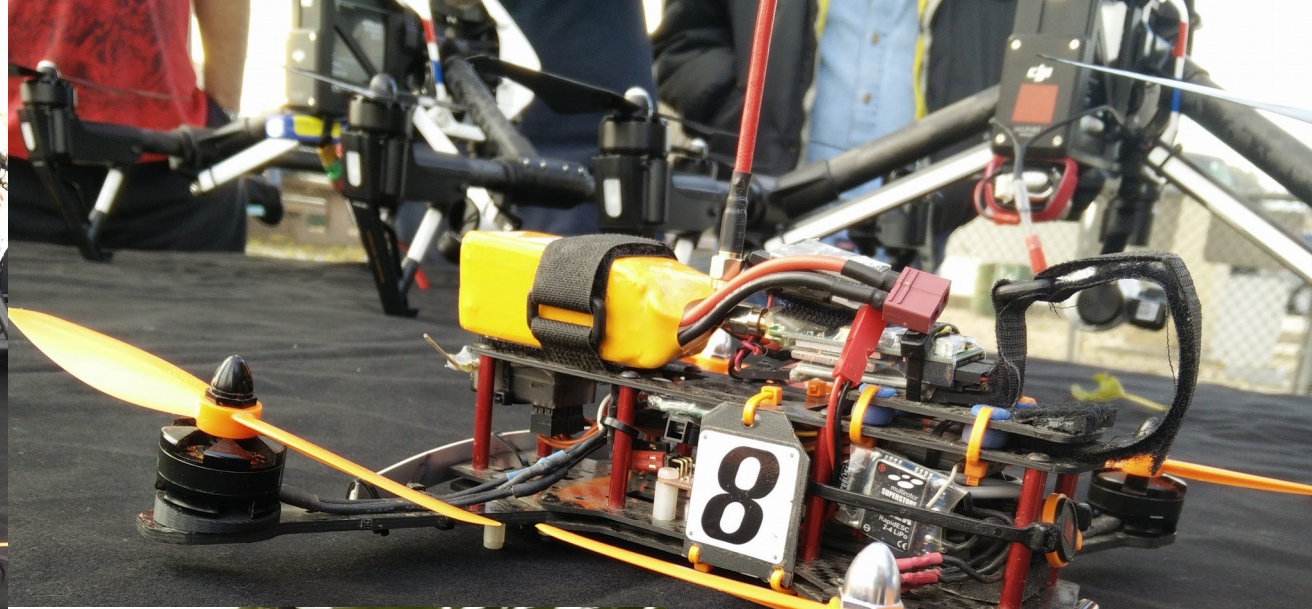
DANGER

You will be addicted...see you soon

Mini Racers

Mini - Sub 300mm


2
7
8
5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¡Muchas gracias! ¿Alguna duda?

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Motors

KV rating is how many RPM you get per volt of power (arbitrary; historical)
S rating is safe operating voltage

More volts spin faster, higher power requirements, more heat, less efficient

Limiting factor: Motor temp
Too much heat and you'll melt the enamel off your motor windings…
Otherwise, as long as the magnets don't fly off and your bearings don't melt, all is fine.

Motor quality plays a HUGE factor

High Quality: T-motor, Avroto, SunnySky, Cobra, KDE
Mid Quality: DYS, E-Max, RCTimer

http://www.pcbheaven.com/wikipages/PID_Theory/
http://www.ni.com/white-paper/3782/en/

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Proportional-Integral-Derivative

PID Theory

the most common control algorithm used in industry and has been universally accepted.
A way to get a computer to do what humans/animals do intuitively
Numbers have NO units; are COMPLETELY ARBITRARY! Do not try to give them units.

P - How much power/force/responds to use for corrections
I - A corrective term that explains when to 'let go' of the initial force so as to not over/undershoot
D - A corrective term 'over time'; makes minor general overbearing adjustments

Example (not perfect example):

You're cruising in your car and you want to stop at a red light. How hard/fast do you initiate pushing the breaks (P)? When/how do you start to ease off the breaks so as to not over/undershoot where you want to stop (I)? As you're going through the motions of this simple action, you make constant regular adjustments based on your eyes/sensory inputs (D).
Your Flight Controler is doing this at least 400 times EACH second. Still not as good as your intuition

Prop/motor matching

How a wing works...
Wing/prop efficiency
- Large props have less drag
- 2 blade props have the highest efficiency
- Prop pitch is very important for multirotors
- Paddle
- Speed
- Work per rotation