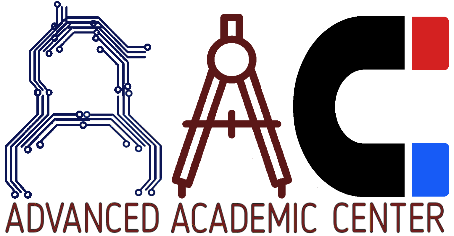
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**A CENTER FOR INTER-DISCIPLINARY RESEARCH 2018-19**

**MINI FPV RACING DRONE**

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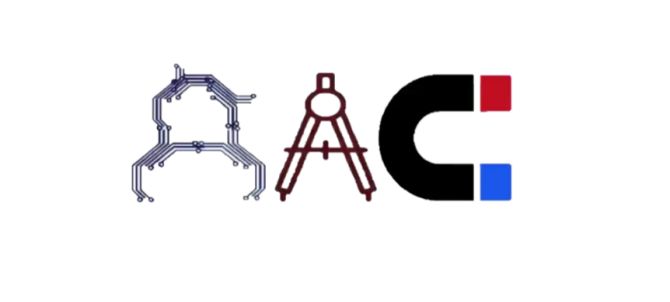
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This is to certify that the project titled

**“FPV MINI RACING DRONE”**

is a bonafide work carried out by the following students in partial fulfilment of the requirements for Advanced Academic Center intern, submitted to the chair, AAC during the academic year 2018-19.

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SYNOPSIS

Mini fpv racing drone of size 14-15cm used for racing purposes or surveillance purposes . It has a camera to give its front view which makes easier for the driver to control the drone at a steady position.

The drone we made is of size 140mm and can be used to record the videos for surveillance or any events . So it will be easier to control the drone due to its mini (small) size. The video can be streamed through the goggles or an app using the vtx. The main purpose of the video is the pilot of the drone should be able to see what the drone sees .In this way pilot can control and fly the drone accordingly and avoid obstacles in its way.

This drone can also be used to learn how to fly and control a drone. The size makes it weigh a little less so the consumption of the power is also less. In this way the battery will also last longer.

Since it is basically a racing drone ,it can be used for racing purposes to use the good

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1.INTRODUCTION

FPV (first person view) flying means that pilots only see what the drone sees. This is accomplished by

live streaming footage from a camera mounted on the nose of the drone. The image is

transmitted via radio waves (typically 2.4 GHz or 5.8 GHz frequency) to goggles or monitor

worn by the pilot. The remote control, drone, and goggles are all connected via radio and

must transmit with sufficient speed and reliability to allow effective control. This technology

is very new and is constantly being improved.

Our project mainly deals with the video casting or recording (based on the necessity)

through the camera which is mounted upon the nose of the racing drone. It is so called a

racing drone because the main purpose of this type of drones is to monitor the surroundings

and make the drone move as fast as possible. So as a whole one need such a drone which is

agile and capable of transmitting the video.

2.REQUIREMENTS

**2.2 Hardware**

**FRAME:::**

140mm 3 Inch DIY Version FPV Racing Frame Kit 3mm Arm Carbon Fiber:::

Just as important as good electronics, multi-rotors depend on sturdy, lightweight hulls

for mounting components. There are countless frame designs of varying shapes,

dimensions, and materials. Stiffer frames confer better flight characteristics, since less

warping and bending can occur. If a frame is too brittle, though, your inevitable crashes

will result in more frequent repair sessions. Frames need to be both strong and stiff,

whilst being light enough to hop around in the sky with ease.

One of the most common materials for multi-rotor frames is carbon fiber. A great many

of its physical properties are perfectly suited to the hobby. The only catch is that carbon

fiber is known to block radio signals, which is obviously not ideal for a hobby that

depends on multiple transmissions. It can be used though, and is often. Just be aware

that blocked signals are a possibility.

The frame which we used has the following specifications to achieve a good flight with

minimum disturbances.

Wheel base: 140mm

Frame arm thickness: 3mm

Upper plate thickness: 1mm

Side plate thickness: 1mm

Frame kit material: 3K carbon fiber &amp;

CNC 6065 aluminium

**MOTORS:::**

1607 2800KV 2-4S Brushless Motor:::

The motors are the main drain of battery power on your quad, therefore getting an

efficient combination of propeller and motor is very important. Motor speed is rated in

kV, generally a lower kV motor will produce more torque and a higher kV will spin

faster, this however is without the prop attached.

There are many aspects to motor performance aside from raw thrust, high among these

is how much current the motor draws from the battery. It’s better to check the specs of

your motors for their maximum amp draw, and ensure that your ESC’s are rated to

withstand this amperage.

Practically all the latest drones use a brushless electric “out-runner” type, which is more

efficient, more reliable, and quieter than a brushed motor.  Motor design is important.

 More efficient motors save battery life and give the owner more flying time, which is

what every pilot wants.

The motors which we used are of the following specifications:

KV: 2800KV

Lipo cell: 2-4S

Weight: 17.8g (includes wires)

Output shaft length: 14mm

Maximum pull: signal 630g (4S 3030 4-blade propeller)

Maximum power: 350W

Configu-ration: 9N/12P

Mounting holes distance: 12\*12mm

Mounting holes: φM2

Bearing: NSK

Recommend propeller: 3 inc

**Electronic speed controller:::**

Electronic Speed Controllers (ESC) are an essential component of modern quadcopters (and all multirotors) that offer high power, high frequency, high resolution 3-phase AC power to the motors in an extremely compact miniature package. These craft depend entirely on the variable speed of the motors driving the propellers. This wide variation and fine RPM control in motor/prop speed gives all of the control necessary for a quadcopter (and all multirotors) to fly

**Function**

ESC controls the speed at which the motor must rotate for the throttle applied. This throttle signal is provided by the flight controller to the ESC spinning the motor.It may also provide reversing of the motor and dynamic braking.

**ESC Firmware**

ESC firmware is the software running on every ESC, which determines the ESC’s performance, which protocols are supported, and what configuration interface can be used. The firmware that an ESC can use is dependent on the hardware.

Here is a list of the different ESC firmware available for mini quad:

• BLHeli

• BLHeli\_S

• BLHeli\_32

• SimonK

• KISS

**Esc protocols**

An ESC Protocols is the “language” that the flight controllers and ESC use to communicate, one of the most basic task is to tell how fast the motor should be spinning.

Here are all the ESC protocols available for a mini quad, and their respective signal width – the time it takes to send one data packet:

• Standard PWM (1000us – 2000us)

• Oneshot125 (125us – 250us)

• Oneshot 42 (42us – 84us)

• Multishot (5us – 25us)

• Dshot

o Dshot150 (106.8us)

o Dshot300 (53.4us)

o Dshot600 (26.7us)

o DShot1200 (13.4us)

• ProShot

**BEC(battery elimination circuit)**

The type of battery and number of cells connected is an important consideration when choosing a battery eliminator circuit (BEC), whether built into the controller or as a stand-alone unit. A higher number of cells connected will result in a reduced power rating and therefore a lower number of servos supported by an integrated BEC, if it uses a linear voltage regulator. A well designed BEC using a switching regulator should not have a similar limitation.The function of a BEC is to provide constant current at a specific voltage. Airplane ESC usually have BEC as they provide power for the planes needs like powering the electronics. The ESC’s lacking a BEC tend to be much less noisy, lighter and smaller in size.

**Specifications of ESC we used**

*Continuous current: 20A*

*Peak current: 25A (10S)*

*BEC output: no*

*Input voltage: 2-4S*

*Main control chip: 48mhz EFM8BB2*

---All EFM8B2 family members have the following features:---

•CIP-51 Core running up to 50 MHz

•Three Internal Oscillators (49 MHz, 24.5 MHz and 80 kHz)

•SMBus

•I2C Slave

•SPI(Serial Peripheral Interface)

•2 UARTs

•3-Channel Programmable Counter Array (PWM, Clock Generation, Capture/Compare)

•5 16-bit Timers

•2 Analog Comparators

•12-bit Analog-to-Digital Converter with integrated multiplexer, voltage reference, and temperature sensor

•16-bit CRC (Cyclic Redundancy Check)Unit

•Pre-loaded UART (Universal Asynchronous Receiver/Transmitter)bootloader

*Firmware upgrade: Supports Dshot600/BLHeli\_S/Oneshot125*

*MOS: 3\*3*

*MOS type: vs3610ae 30v64a*

**F4 Flight Controller:::**

The F4 flight controller gives you all the features you need for the heart of your aircraft, whether you&#39;re

into FPV racing, acrobatic flying or aerial photography it&#39;s perfect.

Supports a variety of aircraft, tricopters, quadcopters, hexacopters, octocopters, planes and more.

Before getting into the features let us know about the specifications:::::

->36x36mm board with 20mm mounting holes

->Weight 24 grams

->STM32F411 main control chip

->High-Capacity Flash

->MicroUSB socket

->2x 8pin JST-SH sockets (PPM, PWM, SERIAL RX, GPIO, ADC, 3V, 5V, GND)

->8x 3pin though-holes for pin headers for ESC/Servo connections

-> 2x 4pin though-holes for pin headers for 2x serial ports

->1x 2pin though-holes for pin headers for battery voltage

-> 1x 2pin though-holes for pin headers for buzzer

->1x 4pin JST-SH socket for I2C

-> 1x 4pin JST-SH socket for SWD debugging (serial wire debug).

Let’s discuss all the features about f4 flight controller ::::::

1. flight performance:

The F4 flight controller builds on tried and tested software, processor and sensor technology to make

your aircraft fly like it&#39;s on rails.

2. No-Compromise I/O

Use all the features all the time; e.g. Connect your OSD(on screen display) + SmartPort + Sbus(serial bus)

+ GPS + LED Strip + Battery Monitoring + Sonar + 8 motors – all at the same time!

3. Configurable

The F4 runs Cleanflight which can be configured to suit your needs using a cross-platform GUI

(Windows/OSX/Linux).

4. Tiny and lightweight

The F4 has a standard 36x36mm form-factor with 20mm mounting holes and weighs just 24 grams.

1. flight Logging

On-board high-capacity black box flight log recorder – optimize your tuning and see the results of your

setup without guesswork.

1. Next-Generation CPU

The F4 has an STM34F411 main control chip with Math co-processor (FPU-floating point unit) for

efficient flight calculations that gets more done in less time.

Loop times up to ~2x as fast as previous-generation STM32F1 based boards. Also it comes with a

ICM20602 6-axis sensor.

1. OneShot ESC

Full support for OneShot ESCs for easy PID tuning and a sharper response.

 Is a special mode for ESC&#39;s running the Blheli firmware that allow your supported flight

controller to communicate very quickly with yourESC, enabling your motors to react much faster

than standard PWM(pulse width modulation) communication protocols used on most ESC&#39;s

8. Broad RC receiver Support

Supports Sbus, CrossFire, Spektrum1024/2048, Xbus/Ibus, SumH, SumD, Fport, PPM, PWM receivers &amp;

more. No external inverters required (built-in) (RC TX RX PROTOCOLS).

9. Programmable LEDs

Dedicated output for multi-colored LED strips – great for FPV racing, line-of-sight flying orientation and

night flying.

**Propellers:::**

3030 4-blade propeller:::

The purpose of your quadcopter propellers is to generate thrust and torque to keep

your drone flying, and to maneuver. The upward thrust force generated by the

propellers is usually measured in pounds or grams. To keep your drone flying at a

hover, the upward thrust needs to equal the weight of your drone. The thrust to weight

ratio TWR (thrust divided by weight), indicates how much thrust your drone generates

relative to its weight. Typically, quadcopter propellers produce more thrust the faster

they spin. They are also influenced by the flight dynamics of your quadcopter. Some

propellers produce much more thrust when the drone is stationary, as opposed to when

it is flying. Other props perform much better at higher speeds.

The propellers that we used for our drone are of the following specifications:

Material: PC (poly-carbonate)

Mounting hole: 5mm

Center thickness: 6mm

Quantity: 2 pairs

Color: black, red, yellow, green

Weight: 5g a pair

**Camera:::**

700TVL CMOS Camera::☹TVL stands for TV lines)

What pilots see while flying drones is the low-latency analogue video from a first-person

view (FPV) camera. FPV cameras are compact and lightweight module mounted on the

drone that broadcasts real-time video back down to the pilot with the help of a

dedicated video transmitter module. First-person view, also called video piloting, means

flying the drone from the perspective of a true pilot by using an onboard video camera

and wireless downlink. FPV cameras use either an inexpensive complementary metal-

oxide-semiconductor (CMOS) or a bit pricey charge-coupled device (CCD) image

sensor. The image sensor of the camera fundamentally affects its performance. Also

note that a camera with a wide input voltage range offers flexibility when wiring the

FPV system.

The camera which we used for podcasting or recording purpose is of the following

specifications:

Case size: 19mm\*19mm

Weight: 9.5g

Total pixels: PAL: 1020H×596V (0.61MP); NTSC: 1020H×508V (0.52MP)

Effective pixels: PAL: 976H×582V (0.57MP); NTSC: 976H×494V (0.48MP)

Resolution ratio(horizontal center): 700TVL

Video output: 1.0Vp-p/75Ω

Electronic shutter: 1/50(1/60) – 1/100000 S

Camera lens: standard 2.1mm

Lens operating voltage: DC 5-12V

Working current: 70mA (low power consumption)

Working temperature: -20℃~-60℃

Humidity: 0%~98%

**Battery:::**

FPV racing drones are lectro by LiPo batteries, they are able to store and deliver large amount of power.

Lithium polymer batteries, more commonly known as LiPo, have high energy density, high discharge rate and light weight which make them a great candidate or RC applications.

->LiPo batteries exist in cells, each LiPo cell has a nominal voltage of 3.7V. If higher voltage is required, these cells can be connected in series to form a single battery(S).

1S = 1 cell = 3.7V

2S = 2 cells = 7.4V

3S = 3 cells = 11.1V

4S = 4 cells = 14.8V

5S = 5 cells = 18.5V

6S = 6 cells = 22.2V

->Voltage affects brushless motors RPM directly. Therefore use higher cell count batteries to increase your quadcopter’s speed if your motor/ESC and other lectronics support

higher voltage. (here is a discussion about the differences between 3S and 4S on a mini quad)

But a battery with more cells of the same capacity is heavier since it contains more cells. To make a 4S 1000mah battery, you could simply combine two 2S 1000mah, or one 3S 1000mah with an 1S 1000mah.

->The capacity of a LiPo battery is measured in mAh (milli-amp hours). “mAh” is basically an indication of how much current you can draw from the battery for an hour until it’s empty.

Increasing your battery capacity might give you longer flight time, but it will also get heavier in weight and larger in physical size.

Higher capacity could also give you higher discharge current.

->Lipo batteries for quadcopters these days all come with a C rating. By knowing the C

rating and capacity of a battery, we can in theory calculate the safe, continuous max

discharge current of a LiPo battery.

Maximum Discharge Current = C-Rating \* Capacity

Some batteries come with two C-ratings: “continuous” and “burst” ratings. The Burst rating is only applicable in short period of time (e.g. 10 seconds).

If C rating is too low, the battery will have a hard time delivering the current to your motors, and your quad will be under powered. You could even damage the battery if current draw exceeds safety rating.

When C rating is higher than what’s required, you won’t gain much performance improvement. Instead the battery would be heavier and you will be carrying extra weight that reduces your flight time.

->the battery connector should match the one you are using on your copter.

All Lipo batteries come with 2 sets of wires/connectors: a balance lead and a main lead or discharge lead (Except for 1S batteries which only have a main lead). There are quite a few different connectors used in LiPo batteries. The main differences are shape, weight and current rating.

->Internal resistance (IR) can be used to measure how good a LiPo battery is. The lower the value, the better. Higher internal resistance reduces the max current the LiPo can produce, and voltage sag becomes worse. More energy is wasted as heat, and therefore the battery is also more likely to overheat.

LiPo Internal resistance increases over time and usage, and it’s inevitable and irreversible. That why when a LiPo battery gets older or overly used, you would find it losing the “punch” or power.

IR is different in each cell of the same LiPo battery, and the highest value bottlenecks the performance.

The battery which we are going to use for our drone Is of the following specifications::

Type:-LiPo

Cell:- 3s

Capacity:- 450-650mah

**RC transmitter:::**

Picking the right radio is one of the hardest choices a beginner must make.A radio control system is made up of two elements, the transmitter you hold in your hands and the receiver you put inside your drone. Dramatically simplifying things here, your drone transmitter will read your stick inputs and send them through the air to your receiver in near real time. Once the receiver has this information it passes it on to your drones flight controller which makes the drone move accordingly. A radio will have four separate channels for each direction on the sticks along with some extra ones for any auxiliary switches it may have.

->A Radio Controller needs to bind or pair with a receiver when it’s first setup.From then on it will always link and hop over various frequencies in the 2.4Ghz band to ensure a solid link with theoretically hundreds of pilots operating at the same time.

The limit of range is normally where the receiver can no longer clearly hear what the transmitter telling it and typically falls in the 1km range in normal conditions.

->The range of your radio link will be dependent on a few factors:

1.The output power of your transmitter – Many run just below the legal maximum to be compliant with international standards.

2.The sensitivity of the Receiver – A more sensitive receiver is like having better hearing, the signal will travel further however it may pickup more noise in certain conditions

3.The quality of your antennas at both ends – Antennas could be an entire article on their own but basically a larger antenna will send and receive a better signal. Often optimising your antenna placement will make a huge difference to the performance to the system.

**FLYSKY FS-i6:::**

->The radio is powered by 4 AA batteries.

->The radio comes equipped with digital trims for the 4 flight axes. It has 3 2-position switches, 1 3-position switch and two knob inputs.

->The configuration menu is very well filled out with features. It includes all the basics like reversing, EPA adjustment, dual rates and expo, mixing, throttle curves, etc. You can use this radio for any aircraft – RC helis, airplanes and of course quadcopters.

-> the radio comes with a telemetry option. You would need to buy some iBUS-compatible sensors to get anything special but by default you get an “error” feed (similar to RSSI) and receiver voltage.

->The binding process –Simply plug in a bind plug on the RX and power it up. The indicator light should flash red. Next, power up the FlySky FS-i6 while holding down the Bind Key. The indicator light on the RX will turn solid red and binding is done.

**Switchable VTX:::**

Video transmitters (aka VTX) are devices that transmit videos from your drone to your FPV Goggles or ground station.

Specifications:

->Supports TBS SmartAudio.

SmartAudio is a communication protocol between the FC (Flight Controller) and VTX (Video transmitter). SmartAudio has been invented by TBS in 2015. It is called SmartAudio because primarily it was intended to share the Audio signal input of the VTX together with the control line from the Flight controller. Later SmartAudio got separate dedicated input pin in the VTX, but the word Audio remained in the name.

->Transmitting power: 0mW/25mW/100mW/200mW switchable

->Channel: 40CH

->Full video format: NTSC/PAL

NTSC(National Television System Committee) and PAL(Phase Alternation by Line) are two types of color encoding systems that affect the visual quality of content viewed on analog televisions and, to a much smaller degree, content viewed on HDTVs. While NTSC delivers a frame rate of 30 frames per second (fps) at an aspect ratio of 720x480, PAL uses a frame rate of 25 fps and a 720x576 aspect ratio. The PAL system offers automated color correction compared to NTSC’s manual color correction.

->Input voltage: 7V~24V

->Power dissipation: +12V/600MW

->Size: 25×20×6mm

->Weight: ≤3.2g (except antenna)

2,2 Software

3.Building and flying the drone

4.Conclusions

5.References