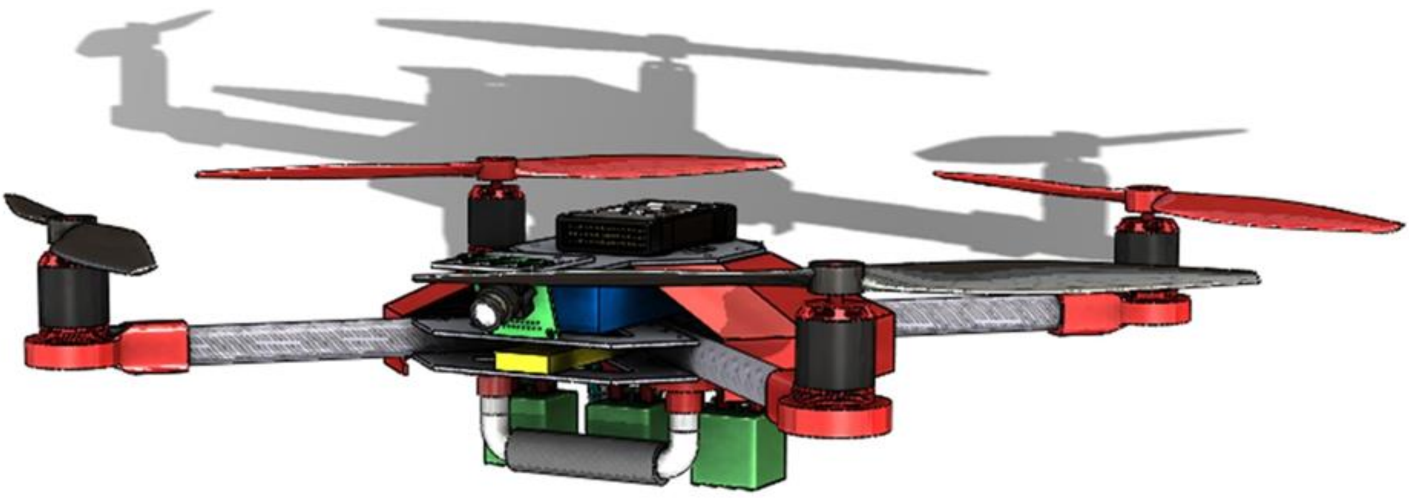
PIKS



CONCEPTUAL DESIGN REPORT

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Vechile Name : 407S
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1.EXECUTIVE SUMMARY

This report summarizes the conceptual design of the Piks team's 407S Unmanned Aerial Vehicle (UAV) for the TUBITAK UAV competition 2017. The Team aims to produce an UAV that is going to complete missions provided by the competition organizers in fastest way and maximize the team score. There are two missions in the competition – image processing and air drop. Teams must finish the first mission successfully in order to proceed to the second mission.

1.1 DESIGN PROCESS

The general objective for the 407S is gaining good results. This would be achieved through analysis of the competition rules. We all agreed to go with multicopter type UAV. At the beginning we considered several different configurations such as tricopter, quadcopter, octocopter and coaxial rotor. However, because of the great capabilities of quadcopter and team's interest in this vehicle, we concluded in classic quadrotor type UAV for the competition. The design was then further analyzed to reflect important mission variables. This included stability, weight, reliability, fail safe, autonomous flight, airdrop, image processing and manufacturability. Then we found out lightness, reliable airdrop and speed was most important mission variables for which the drone needs to be optimized. The team researched, applied payload release mechanisms. This is the phenomenal theme for today's transportation companies. We finally decided that servo triggered shift-rod mechanism is the best choice for completing airdrop mission.

1.2.1 KEY MISSION REQUIREMENTS

TUBITAK UAV Competition 2017 missions are categorized as primary and secondary. Teams have to perform primary mission first in order to proceed to the secondary mission.

- Primary mission aims to test autonomous flight and image processing capability of the UAV by recognizing colors of cells of 4x4 matrix. The cells can take 3 different colors. The UAV must specify the colors of matrix elements and save them in its memory during autonomous flight.
- Secondary mission aims to test the capability of payload release with proper sequence. in addition to the primary mission. First, the UAV must save color sequence in the matrix, then it must release the cubes every 5 second according to color sequences in the matrix.
- Besides these, The UAV must fly autonomously but it can take off manually by the pilot.

1.2.2 DESIGN FEATURES

For performing these missions, **quadcopter** type UAV was chosen because of its hover capability, high stability and smaller area requirement for testing. Electronics of quadcopter consists of naze_32 flight computer, Neo_6m Ublox GPS receiver, STM32F4 MCU and OmniVision7670 camera module.

- The crucial point for primary mission is recognizing the matrix colors quickly and then save them. STM32F4 MCU will process images captured by OV7670.
- For payload release, we designed **shift-rod** mechanism. This mechanism is extremely reliable and simple to build which nearly meets the requirements.

1.3 PERFORMANCE CAPABILITIES OF THE SYSTEM

The chosen quadcopter is X configuration to be lightweight quadcopter frame will be made from carbon fiber. Some parts will be 3d printed such as release mechanism parts and electronic casing. Carbon fiber frame ensures complete system rigidness and operativeness during mission execution. The drone will fly autonomously which is controlled by naze32 on-board controller and neo 6m Ublox GPS module, but take off and landing will be executed by the pilot. Images will be captured by OV7670 Camera and processed in STM32F4. Loads will be released by 3 servo motors by checking the color sequence in the matrix. Safety and reliability ensure mission success thus every parameter of the system was designed by checking satisfaction of mission requirements.

2. MANAGEMENT SUMMARY

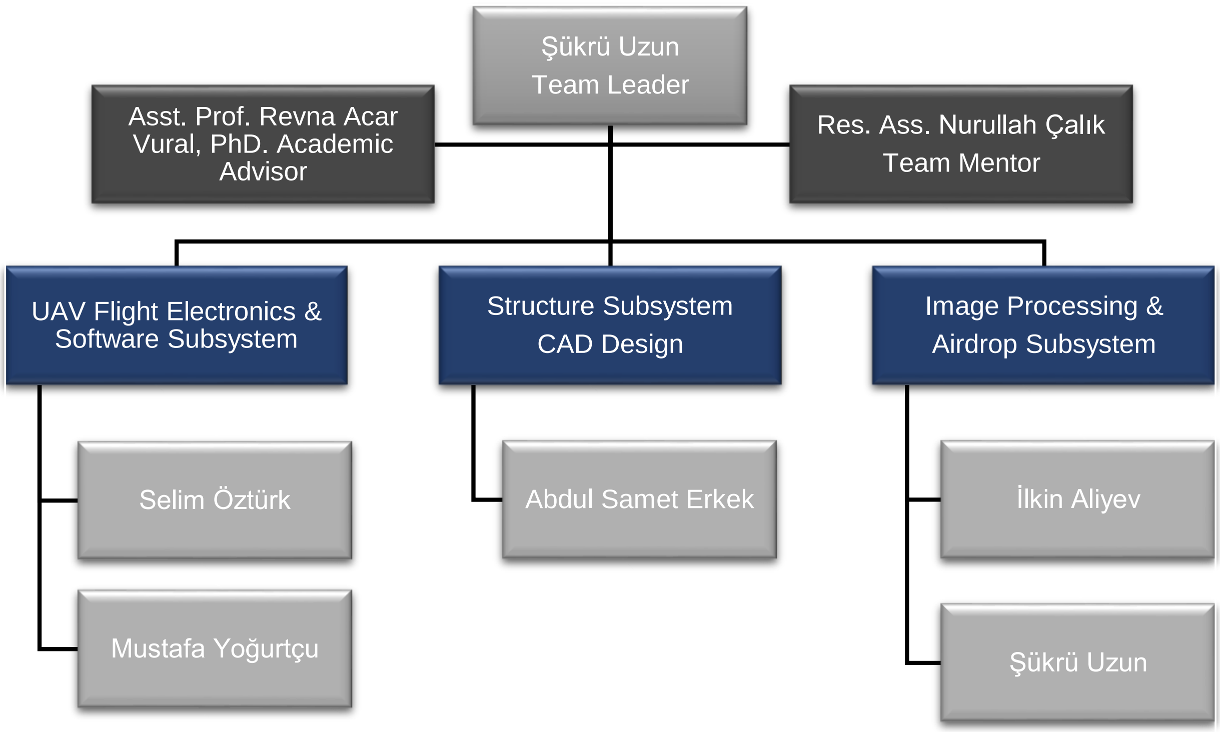
Team Piks is targeting to attend the international UAV competition. The team consists of 5 multidisciplinary undergraduate students, which has their own knowledge of their field. All members are juniors, 4 of Electrical & Electronics Faculty and 1 of Mechanical Engineering Faculty.

2.1 TEAM ORGANIZATION

The UAV system was separated into 3 subsystems

1) Structure subsystem design
2) UAV flight electronics & software subsystem design
3) Image processing & Airdrop subsystem design.

Although every member in the group is responsible for certain tasks, the members are interrelated among each other



2.2 MILESTONE CHART

Some of Piks team members have their separate ongoing projects, thus going with Schedule acting according to program is a crucial point in terms of project robustness. Therefore, each of us shared our Schedule for second term and made a final decision about weekly meeting days, certain days of working on the tasks.

	February			March			April			May			June			July		
	1	15	28	1	15	30	1	15	30	1	15	30	1	15	30	1	7	14
DESIGN																		
Conceptual Design																		
Preliminary Design																		
Final Design																		
MANIFACTURING																		
Prototype Construction																		
Payload Mechanism																		
Final Construction																		
TEST																		
Optimizations																		
Structure Test																		
Material and Rigidity Test																		
Drop Mechanism Test																		
Flying Test																		
IMAGE PROCESSİNG																		
Read Raw Data																		
Get Image on the Screen																		
RGB Detecting																		
DROP MECHANİSM																		
Design Drop System																		
Comm. with Servos																		
FAİL-SAFE MODE																		
Fail-Safe Mode																		
Tests and Last Config.																		
COMPONENT SELECT.																		
Calculation of Total Mass																		
Selection of Component Motors→ESCs→Battery																		
Selection of Flight Cont.																		
ELECTRONICAL SYS.																		
Design of Radio Control																		
Design of Electronic Sys.																		
PID Tuning																		
Autonomous Flight Sw.																		
DEADLINES																		
			R						R		V							F

Model 1	Model 2	Final Model	Payload Mechanism

3. CONCEPTUAL DESIGN

Conceptual design phase aims to research and review possible and feasible solutions for provided rules. Trade studies have significant impact on the design process. The team carefully analyzed scoring formula and found that it is initially important to take off quickly so the drone must be lightest possible, then recognizing many of the cells of the matrix as possible and finally the drone must drop correct colored loads according to pattern sequence.

Total score = 30 (report) + 30 (mission 1) + 40 (mission 2)

3.1 MISSION REQUIREMENTS

The **general objective** of the competition is to design an UAV system which is capable of performing autonomous flight, image processing and airdrop mechanism. In general, feasibility of drone components such as motor, ESC, LiPo battery and flight controller maximizes the team's score. Besides feasibility planning right mission for cell recognition and dropping right colored loads increases the total score. An overview of mission requirements is presented below.

No	Requirement	Rationale
1	High speed	Low weight Good aerodynamic characteristic Suitable motor selection
2	Image Processing	Stable in the air Good camera view Long flying time
3	Payload Capacity	Drone must handle extra weights Good motor selection Should have take-drop mechanism
4	Autonomous Flying	Should have GPS.
5	Stability	Good aerodynamic characteristic Correct component selection Correct Frame Structure
6	Fail-Safe Mode	Fail safe mode should be added

3.2 TRANSLATION INTO DESIGN REQUIREMENTS

To fulfill the key system requirements, we plan to design our UAV with below features.

- UAV's was decided to be quadcopter as it performs very stable flight with minimum propellers and fast flight.
- The frame of the quadrotor/quadcopter was planned to be carbon fiber as it will ensure vehicle lightness as well as its strong and rigid characteristics.
- The brain of autonomous flying system was planned to be naze32. Because it has a nice interface software which allow any modification to the vehicle flight.

- For image processing, we have two options Raspberry Pi with PiCam and STM32F4 ARM cortex m4 based low cost and extra fast microcontroller with OV7670 camera.
- We chose second one which is STM32F4 because we have a base experience with this MCU and we want to expand our knowledge. Its specifications are highly enough for image processing and drop mechanism.
- For airdrop mechanism shift-rod triggered by servo was chosen among all because of its reliability and suitability to our vehicle.

No	Requirement	Rationale	Reflections in Design
1	High speed	Low weight Good aerodynamic characteristic Suitable motor selection	Carbon fiber plates and tubes Good air flow through the system Flexible motor holder design
2	Fail-Safe Mode	Competition challenge	Naze32 will be planned to switch to fail safe
3	Image Processing	Stable in the air Good camera view Long flying time	Simulated design Designing modifiable camera angle Suitable LiPo selections
4	Payload Capacity	Drone must handle extra weights Good motor selection Should have take-drop mechanism	Thrust must have extra room for payloads Optimized motor selection Suitable design for mechanism
5	Autonomous Flying	Flight Electronic will be equipped with GPS sensor. Autonomous flight most probably will be realized utilizing GPS coordinates	GPS located on the top of the design because of carbon fiber's distortion capability
6	Stability	Good aerodynamic characteristic Correct component selection Correct Frame Structure	Optimized aerodynamic characteristic Most suitable parts should be detected Low weight frame

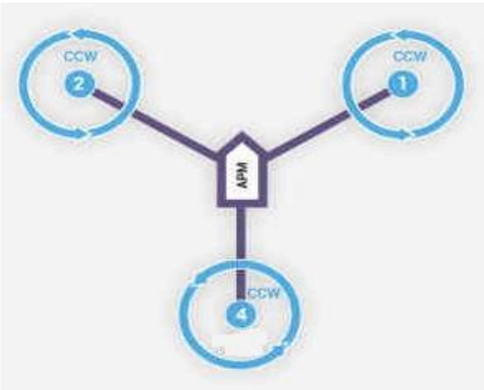
3.3 CONFIGURATIONS CONSIDERED

There are two main categories in UAVs as like in our competition that are fixed wing and rotary wing. As comparison between these two configuration rotary wings can hover and stay stable in air at a constant location. The system can protect its location and this brings certain advantages for taking image of a location. Fixed wings cannot stay at a point, they must coil up the location. Taking image from rotary wing is easier than fixed wing. On the other hand, rotary wings have advantages in agility. Since suitability for missions and our teammates' interest, we chose a rotary wing configuration.

Also, there is rotary wing configurations variety. Main property of these configurations is frame shape and rotor number. The configurations listed below.

Criteria	Tricopter	Quadcopter	Y6	Hexacopter	Octocopter	X8
Motor	3	4	6	6	8	8
Frame variations	Y , T	X, +	Y	Hexa X, Hexa Y	Octo X, Octo Y	X
Cost	Lowest	Low	Normal	More expensive	Expensive	Expensive
Camera view	Good	Good	Good	Good	Good	Good
Stability	Low	Good	Good	Better	Best	Very good
Agility	Low	Good	Better	Good	Good	Good
Payload capacity	Low	Good	Better	Higher	Best	Higher
Manufacturability	Hardest	Easy	Hard	Normal	Normal	Hard
Mechanical simplicity	Low	High	Low	Normal	Normal	Low

1. Tricopters

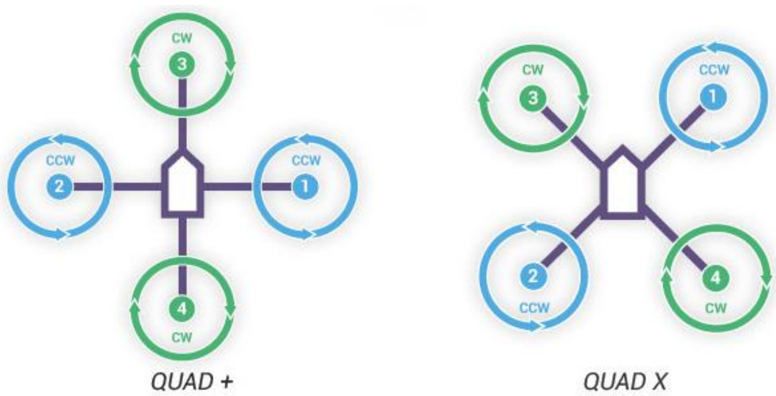


Tricopters has 3 motors that are usually 120 degrees apart and generally in Y configuration. Two propellers at the front sides and other propeller at the rear center. Rear motor has a servo mechanism to enable yaw motion of the system.

This configuration is the cheapest configuration because of motor number, but it has lowest stability. Also, it is hard to build a yaw mechanism in this configuration. So it is not suitable for our team.

2. Quadcopters

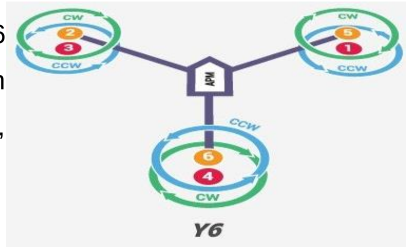
The most popular multirotor configuration is quadcopter thanks to its cost performance character. Quadcopters are fully symmetrical frame which gives simplicity to analyze the characteristics of the system. It has good stability and agility. Mainly there are two main structures of the frame; X, +. X4 configuration gives better view for the camera as design can keep the propellers out of the screen.



We chose X4 (QUAD X) configuration due to its low cost and good property characteristics as in the table that we gave earlier pages.

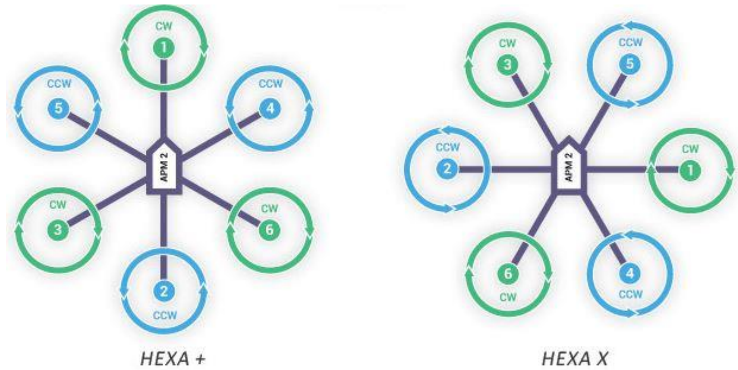
3. Y6

Y6 configuration is similar to tricopter but difference is that, Y6 has two motor coaxial per arm. It has similar character with hexacopters in many ways, such as payload capacity. However, it is less efficient due to the coaxial motor arrangement.



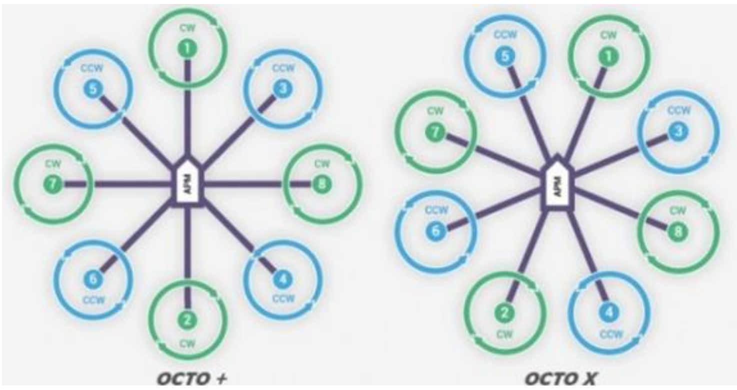
4. Hexacopter

Hexacopters have six motors that are mounted on six arms symmetrically. Mainly there are two configurations as quadcopters which are Hexa X and Hexa +. They are very similar to quadcopter, but it provides more lifting capability thanks to extra two motors. The disadvantage of this configuration is being large in size and they have more expensive cost.



5. Octocopter

Octocopters are basically doubled quadcopters. They have eight motors on the eight arms. The advantage of this configuration is even more payload capacity than hexacopters. They are very stable in the air even if one of the motors, propellers or ESCs fail, they can still be able to land safely. But these features make octocopters most expensive in rotary wing UAVs.



6. X8

X8s have similar properties as octocopters. The difference is that, X8 has eight motors at four arms that are mounted coaxial. It has a more compact body than octocopters but the disadvantage of the high cost still continues.

3.4 COMPONENT WEIGHTING AND SELECTION PROCESS

Selected Components	Weight	Pcs	Total Weight	Price
Emax GT2210/13	55 g	4	220 g	95x4=380 TL
Emax BLHeli-30A ESC	28 g	4	112 g	80x4=320 TL
Gemfan 9047 Carbon Propeller CC-CCW	18 g	2	36 g	16x2=32 TL
11.1V 4200mAh LiPo	400 g	1	400 g	207 TL
Naze32 + Camera + Stm32	90 g	1	90 g	170 TL
Servo + Accessories	25 g	3	75 g	20x3 = 60 TL
Payloads + Parachutes	50+15 g	3	195 g	560 TL
Frame	612 g	1	612 g	
Extra	160 g	1	160 g	
TOTAL			**1900 g**	**1729TL**

FRAME MATERIAL

As our team aimed in mission requirements, we should choose lightest and cost effective frame material. Here our comparison of frame weights

PART NAME	Weight	Material	Note
Drop Mechanism Base	40 g	3D Printed - PLA	%50 – 4 – 4 – 3 – 0,3
Landing Gear Part	7 g X 4	3D Printed - PLA	%50 – 4 – 4 – 3 – 0,3
Motor Holder	25 g X 4	3D Printed - PLA	%50 – 4 – 4 – 3 – 0,3
Plate 1	150 g	Aluminium	2mm Aluminium Plate
Plate 1	106 g	G10	1,9mm G10 Plate
Plate 1	88 g	Carbon Fiber	2mm Carbon Fiber Plate
Plate 2	150 g	Aluminium	2mm Aluminium Plate
Plate 2	106 g	G10	1,9mm G10 Plate
Plate 2	88 g	Carbon Fiber	2mm Carbon Fiber Plate
Plate 3	60 g	Aluminium	2mm Aluminium Plate
Plate 3	43 g	G10	1,9mm G10 Plate
Plate 3	35 g	Carbon Fiber	2mm Carbon Fiber Plate
Camera Holder	20 g	Aluminium or 3D	
Arm Tubes	30 g X 4	Aluminium	Aluminium Profile
Arm Tubes	17 g X 4	Carbon Fiber	Carbon Fiber Tube
Fasteners	25 g		Bolts, nuts
U Profiles	20 g X 2	Aluminium	
Landing Gear	80 g	Not specified	
TOTAL	**333 + 480 = 813 g**		**With Aluminiums**
TOTAL	**333 + 375 = 708 g**		**With G10 Plate + Aluminium Profile**
TOTAL	**333 + 323 = 656 g**		**With G10 Plate + Carbon Fiber Profile**
TOTAL	**333 + 279 = 612 g**		**With Carbon Fibers (SELECTED)**

FRAME COST TABLE		
MATERIALS	**DIMENSIONS**	**COST**
2mm Carbon Fiber Plate	400x500 (mm)	350 TL + Manufacturing Cost(?)
16-13mm Carbon Fiber Tube	1m	135 TL + Manufacturing Cost (?)
3D Printed Parts	-	50 TL
Fasteners	-	15 TL
Aluminium U Profile	1m	10 TL
TOTAL		**560 TL+ Manufacturing Cost(?)**

MICROCONTROLLER

Features	Products	
	STM32F429ZI (Selected)	Raspberry Pi 3
Cost	90 TL	162 TL
Weight	68 gr	42 gr
Difficulty	Hard	Normal
Peripherals Supports(Related to image processing)	UART, SPI, I2C, DCMI, FSMC, DMA	UART, SPI, I2C, CSI
Memory Size	2 MB	1 GB
Clock Frequency	180MHz	1.2GHz
Size	115mm x 65mm x 14mm	85.60mm × 56.5mm × 17mm
Power Consumption	44 mA (145.2 mW)	800 mA (4.0 W)

STM32F429ZI is so powerful microcontroller. In our situation STM is used for image processing and drop mechanism. Executing servos is little bit easier than image processing and needs less cpu power in that process. The important thing is image processing. We need to get a microcontroller which process the image got from the camera. Our camera has 480x640 pixels that makes nearly 4 kilobytes each image. This is not so big data but microcontroller's clock frequency, cpu power, FİFO, DSP and like those options must be required. Microcontroller is communicated camera via SPI and I2C interfaces (depends on user choice) so that SPI and I2C interfaces should be fast to not get any delay. STM32F429ZI'spower consumption is 120 µA typical and has 1.7V to 3.6V application supply voltage that makes 432 µW in any case this situation is so efficient. Also there is a 2 MB Flash Memory for transferring the image data if needed.

- Core: ARM 32-bit Cortex-M4 CPU with FPU, Adaptive real-time accelerator (ART Accelerator) allowing 0-wait state execution from Flash memory, frequency up to 180 MHz and DSP instructions
- Memories
  - Up to 2 MB of Flash memory organized into two banks allowing read-while-write
  - Up to 256+4 KB of SRAM including 64-KB of CCM (core coupled memory) data RAM
- Clock, reset and supply management
  - 1.7 V to 3.6 V application supply and I/Os
  - 4-to-26 MHz crystal oscillator
  - Internal 16 MHz factory-trimmed RC (1% accuracy)
  - 32 kHz oscillator for RTC with calibration
  - Internal 32 kHz RC with calibration
  - Sleep, Stop and Standby modes
  - V_{BAT} supply for RTC, 20×32 bit backup registers + optional 4 KB backup SRAM

- General-purpose DMA: 16-stream DMA controller with FIFOs and burst support
- Up to 168 I/O ports with interrupt capability
  - Up to 164 fast I/Os up to 90 MHz
  - Up to 166 5 V-tolerant I/Os
- Up to 21 communication interfaces
  - Up to 3 × I^2 C interfaces (SMBus/PMBus)
  - Up to 6 SPIs (45 Mbits/s), 2 with muxed full-duplex I^2 S for audio class accuracy via internal audio PLL or external clock
- 8- to 14-bit parallel camera interface up to 54 Mbytes/s

CAMERA MODULE

Features	Products		
	OV7670 (Selected)	**Pi Camera**	**Logitech Webcam C100**
Cost	26 TL	140 TL	48 TL
Weight	13 gr	19 gr	77 gr
Difficulty	Hard	Normal	Easy
Maximum Resolution	640x480	2592 x 1944	640x480
Frame Per Second(FPS)	30	90	30
Power Consumption	0.02 mA	0.014 mA	0.12 mA
Output Format (RGB)	✓	✓	✓
Connection Type	SPI, I2C	SPI, I2C	Corded USB

The OV7670/OV7171 CAMERACHIPTM is a low voltage CMOS image sensor that provides the full functionality of a single-chip VGA camera and image processor in a small footprint package. The OV7670/OV7171 provides full-frame, sub-sampled or windowed 8-bit images in a wide range of formats, controlled through the Serial Camera Control Bus (SCCB) interface. This product has an image array capable of operating at up to 30 frames per second (fps) in VGA with complete user control over image quality, formatting and output data transfer. All required image processing functions, including exposure control, gamma, white balance, color saturation, hue control and more, are also programmable through the SCCB interface. In addition, OmniVision CAMERACHIPs use proprietary sensor technology to improve image quality by reducing or eliminating common lighting/electrical sources of image contamination, such as fixed pattern noise (FPN), smearing, blooming, etc., to produce a clean, fully stable color image.

- Optical size 1/6 inch
- Resolution 640x480 VGA
- Onboard regulator, only single 3.3V supply needed
- Standard 0.1inch (2.54mm) pin pitch header connector
- Mounted with high quality F1.8 / 6mm lens
- Output support for Raw RGB, RGB (GRB 4:2:2, RGB565/555/444)
- High sensitivity for low-light operation
- Low operating voltage for embedded portable apps
- Standard SCCB interface compatible with I2C interface
- Supports image sizes: VGA, CIF, and any size scaling down from CIF to 40x30

MOTORS

Features	Products		
	Emax XA2212 1400Kv	Emax GT2215/09	Emax GT2210/13 (Selected)
Cost	60 TL	120 TL	95 TL
Weight	50 gr	70 gr	55 gr
Stator Dimension	22 mm x 12 mm	22mm x 15mm	22 mm x 10 mm
Shaft diameter	3 mm	4 mm	4 mm
Maximum Current	21A	26A	17A
Li-xx Battery (cell)	2-3	2-3	2-3
Power	205W	280W	188W
Maximum Thrust	940 gr	1250 gr	970 gr
RPM / V	1400	1180	1270

Features:

- Easy to revert output shaft direction.
- Adopts 0.2mm silicon steel, ensures high performance and low temperature.
- GT Series motors have a better compatibility with more different speed controllers and propellers.
- GT Series utilizes imported bearings.
- Compare to other series motors, the GT Series are more precise, lighter in weight and higher in efficiency.

ESCs

Features	Products		
	Hobby wing Skywalker 20A	Emax BLHeli-30A (Selected)	Hobby wing Skywalker 30A
Cost	57 TL	80 TL	61 TL
Weight	19 gr	28 gr	37 gr
Dimension LxWxH	42 x 25 x 8 mm	52 x 26 x 7 mm	63 x 25 x 8 mm
Continuous Current	20A	30A	30A
Burst Current (10sn)	25A	40A	40A
Li-xx Battery (cell)	2-3	2-4	2-3
BEC Mode	Linear	Linear	Linear
BEC Output	2A/5V	2A/5V	2A/5V
Programmable	Yes	Yes	Yes

Features:

- Based on BLHeli firmware, further optimized to the perfect drive performance.
- Low-voltage protection, over-heat protection and throttle signal loss protection.
- Separate power supply for MCU and BEC, enhancing the ESC’s ability of eliminating magnetic interference.
- Parameters of the ESC can be set via program card or transmitter.
- Throttle range can be set to be compatible with different receivers.
- Equipped with built-in linear BEC or switch BEC.
- Max speed: 210,000 rpm for 2-pole, 70,000 rpm for 6-pole, 35,000 rpm for 12-pole.

PROPELLERS

In order to get the desired efficiency from the motors, we will use the 9047 sized propellers as suggested by the manufacturer company. At first we will buy the affordable gemfan 9045 model. We can use more robust propellers made from carbon fiber to improve its stability during the development phase.

SERVOs

We will use MG90 servos for separating loads. The servo weight is 14 gr. The servo torque is 2.50 kg-cm that is enough.

BATTERY

We selected a 3S 4200mah 25C Lipo battery. This battery can provide 105A continuous current. Maximum 78A current required for our quadcopter. This battery provides 6 minutes flying time. This time is sufficient for missions.

FLIGHT CONTROLLER

Features	Products		
	Naze32 (Selected)	**Pixhawk**	**CC3D**
Cost	83 TL	436 TL	76 TL
Weight	6 gr	38.4 gr	5.7 gr
Difficulty	Normal	Normal	Normal
Autopilot Support	✓	✓	✓
Microchip and Clock Frequency	STM32F3/F4 32-bit, 72 MHz	STM32F427 32-bit, 168 MHz	STM32 32-bit, 72 MHz
Usage area	Monitorizing ground (for image processing)	Autonomous	Racing
Power Consumption	0.02 mA	0.014 mA	0.12 mA
Size	36mm x 36mm	81.5mm x 50mm x 15.5mm	36mm x 36mm
Supported Sensors	Accelerometer, Barometer, GPS	Accelerometer, Barometer, GPS	Accelerometer , Barometer

Designed for use with small indoor or small to mid-sized outdoor multirotor crafts, or as a standalone camera stabilizer. The Naze32 Acro rev6 flight controller is extremely simple to setup, with configuration based on the familiar “MultiWii” software.

At the heart of the Naze32 is a 32bit ST micro work horse of a processor, with untapped memory and cpu power and a host of equally impressive sensors. The Naze is also matched up with some of the nicest GUI programs and features to get the most out of your configuration.

This “Full” version is the same as the acro Naze32 board except the full version comes with the MS5611 barometer and a magnetometer.

- 36×36 mm (30.5mm Mounting)
- 5.3 grams (no headers, 7.3 grams with)
- 2000 degrees/second 3-axis MEMS gyro + accelerometer (MPU6500)
- Input voltage: Max 16V on input rail and up to 35V 6s on the voltage sense line
- STM32F103CBT6 32-bit ARM Cortex M3 processor (72MHz, 3.3V)
- Invensense MPU6500 MEMS accelerometer + gyro STM32F103CBT6 32-bit ARM Cortex M3 processor (72MHz, 3.3V)

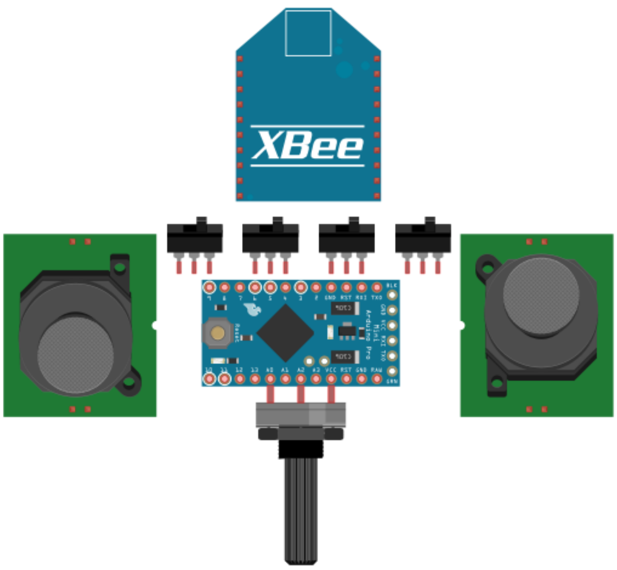
GPS SENSOR

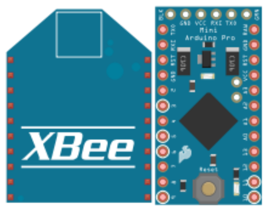
Features	Products	
	Neo-6m (Selected)	Adafruit Ultimate GPS V3
Cost	50 TL	146 TL
Weight	12gr	8.5 gr
Difficulty	Normal	Normal
Range	-161 dBm sensitivity	-165 dBm sensitivity
Accuracy	5Hz,50 Channels (Fair)	10 Hz updates, 66 channel (Good)
Size	16.0 x 12.2 x 2.4 mm	25.5mm x 35mm x 6.5mm
Power Consumption	67 mA	20 mA

The NEO-6 module series is a family of stand-alone GPS receivers featuring the high performance u-blox 6 positioning engine. These flexible and cost effective receivers offer numerous connectivity options in a miniature 16 x 12.2 x 2.4 mm package. Their compact architecture and power and memory options make NEO-6 modules ideal for battery operated mobile devices with very strict cost and space constraints. The 50-channel u-blox 6 positioning engine boasts a Time-To-First-Fix (TTFF) of under 1 second. The dedicated acquisition engine, with 2 million correlators, is capable of massive parallel time/frequency space searches, enabling it to find satellites instantly. Innovative design and technology suppresses jamming sources and mitigates multipath effects, giving NEO-6 GPS receivers excellent navigation performance even in the most challenging environments.

REMOTE CONTROLLER

Remote controller will build with XBee Pro S2C modules. The modules can communication maximum 3200m outdoor range. Handheld control will include toggle switches, joystick button and potentiometer. The data will be processed by Arduino pro. XBee will be transmit to quadcopter. Then Other XBee will receive data that will convert to ppm or pwm signals by Arduino pro.

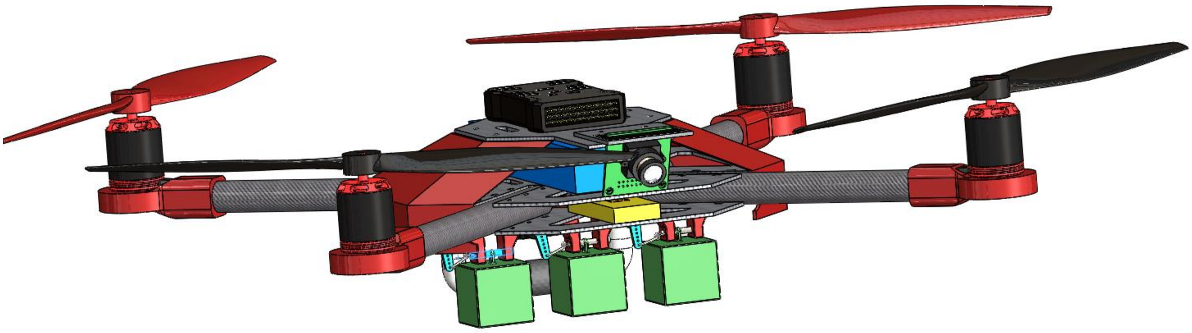




3.5 FINAL CONCEPTUAL DESIGN CONFIGURATION

1) Universal Design

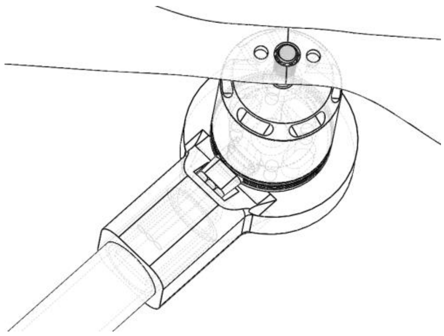
Drone structure includes three main plates and four circular tubes. Design is compatible with every kind of components. Every LiPo, motor, ESC, FC or other components can be used in this design. Many components are researched and designed universal.

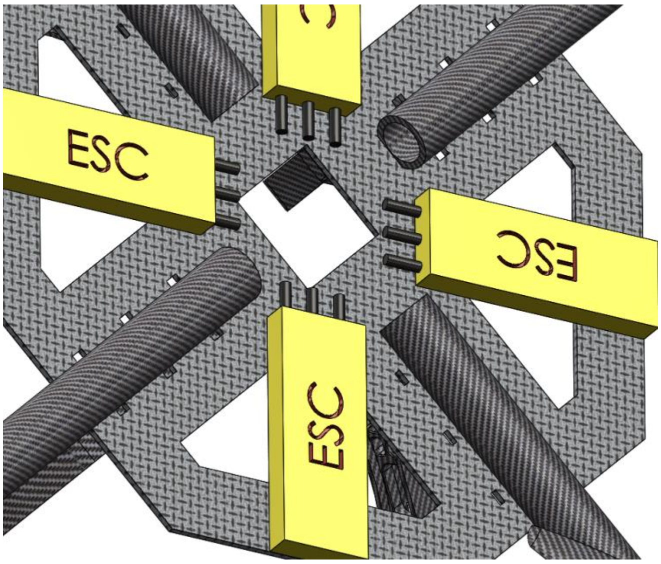


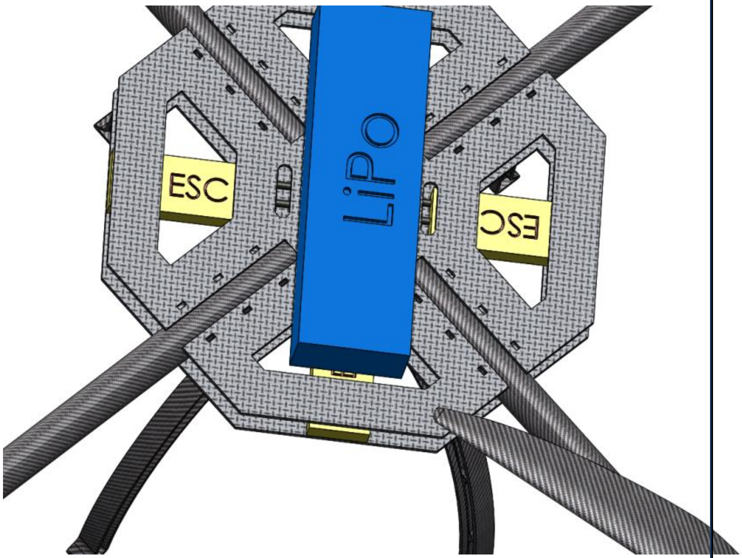
2) Good Planned Multiple Floors

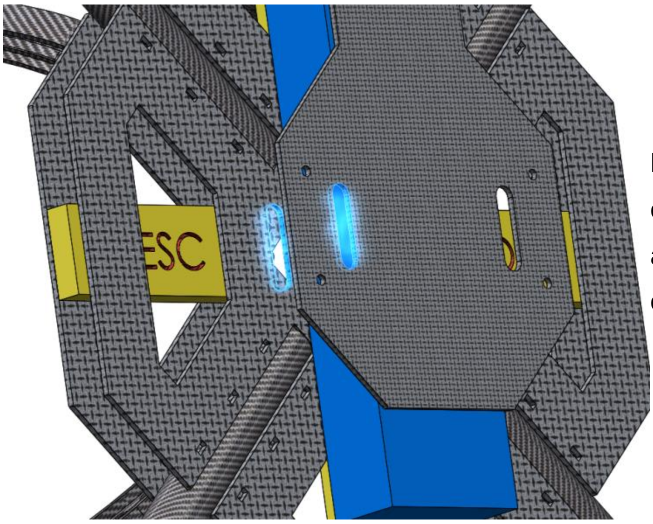
Three main plates hold all electronics. Air is canalized to ESC's floor (bottom plate) to cooling. Motor cables are coming to this floor and connecting to the ESCs. The center plate holds LiPo, thus all power connections are made here. Top plate holds FC, GPS in order to avoid distortion capability of carbon fiber.

First floor is the motors and ESC's floor and it includes their connections. Motors cables
are moved in the tube. Connections are at the center.





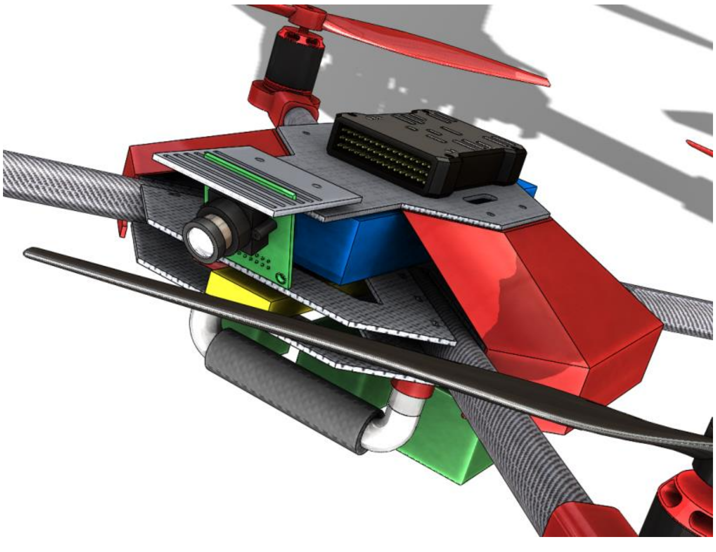




Plate’s places where ESC’s center is mounted is empty. The reason is cooling. Frame has openness at the front and air enters and circulation is completed through ESCs.

3) Modifiable Camera Mounting

The angle of the camera can be easily changeable. It gives certain flexibility to take a good view from the camera.

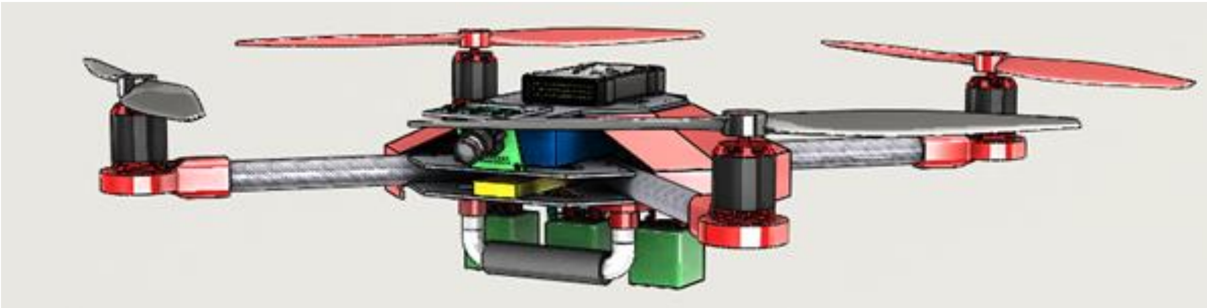


4) Low Inertia

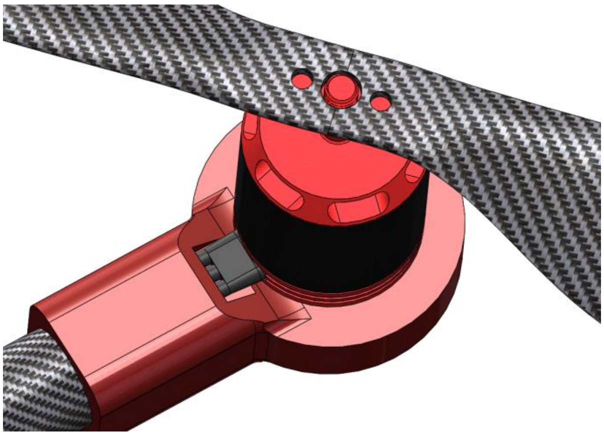
All heavy components are in the middle in order to reduce the inertia in each axis. The heaviest part "LiPo" is at the geometric center of the design.

5) Natural Air Flow – Cooling

Air flow is turned to advantage to cooling electronics and air flow provides better aerodynamic characteristic.



6) Changeable Motor Mounts



In order to have modifiable design motor holders are easily changeable and suitable for every kind of motor.

7) Air Drop Mechanism