

# Multi-Functional High Thrust Hexa-Copter with Return to Launch Capability for Fire Extinguisher, Pesticide Spray, Shipping and Delivery with Aerial Footage Capturing Competency

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**Abstract:** *Lightweight Hexa-copter by using aircraft grade aluminum and carbon fiber has design and developed. Proposed heavy lift hexa-copter which can carry a maximum 5 kg payload. It's a long-range RC hexa-copter with Return-to-Launch capability. Our design is a multi-purpose hexa-copter which can carry any kind of object might be solid, liquid or gas. Hexa-copter is equipped with long range wireless FPV 8 MP high-resolution camera to transmit aerial footage to the ground station. Long range flight can be achieved by lightweight Li-PO battery 10000 mAH with BCM. Main function of drone is to extinguish fire and spray pesticide in the field of one kilometer square area.*

**Keywords:** Hexa-copter UAV, electronic speed controller, brush less DC motor, flight controller

## 1. Introduction

It is apparent to extinguish a fire in a large area by a fire-fighter is time consuming and life-threatening to the fire-fighters. Remotely control UAV (unmanned aerial vehicle) used as fire-extinguisher can mitigate the issues that the fire-fighters are being faced during the manual operation of fire-extinguisher methods to accomplish their task. One of the problems in the multi-copter (UAV) application is the ability to lift a heavy load that requires the excellent design plan and selection of the proper type of multi-copter for its ability in carrying out the missions involving heavy load lifting. Hexa-copter is a remotely controlled electronic vehicle used to achieve vertical flight with stability. It has many uses and with increasing technological advances the performance and reducing the cost of the professional flight microcontroller unit unlike Pixhawk which allows an open-source flight control software PX4 for drones and other unmanned vehicles therefore, an engineers and researchers can design their own drones for plenty of application from entertainment to professional tasks. Our project is a multi-objective UAV (unmanned aerial vehicle) to design a heavy lift hexa-copter which can be used to sterilize streets, public parks and other places, fire extinguisher, pesticide spray in agriculture, logistic services. Hexa-copter is equipped with long range wireless FPV 8 MP high-resolution camera to transmit aerial footage to the ground station. Hexa-copter consists of carbon fiber frame, a flight controller, electronic speed controllers, trans-receiver, Li-Po battery, one five-liter capacity container for liquid spray and GPS module used for return to launch capability.

To spray approximately 1 km<sup>2</sup> area, five liters of liquid is

required. Type of liquid depends upon mode of operation, our drone is multi-purpose drone therefore, water is used when it is used as fire extinguisher, pesticide is used when it is used as an agricultural drone. In order to carry this mass of liquid disinfectant/pesticide/water a heavy lift hexa-copter is needed. More no. of drone motors is viable for heavy lift therefore due to this reason our project chosen six motors to make the drone (hexa-copter). To minimize the air friction all supporting accessories like sanitizer tank should be aerodynamic. Brushless hexa-copter motor should have high value of 960 KV in order to lift heavy objects. We used a 10-channel radio controller that gives a range of 2.4 miles and operates at the transmission frequency of 2.4 GHz in ISM band DSSS&FHSS mode. We used excellent anti-interference R9DS RC receiver SBUS/PWM long range control for transmitter with DSSS&FHSS pseudo random algorithm to give R9DS with excellent anti-interference ability. Our designed hexa-copter has return-to-launch (RTL) capability.

## 2. Implementation Methodology

The strategy of the methodology depends upon various parameters to maneuver a successful prototype project, which includes cost of the project, designing, coding, fabrication, calibration, manipulation and testing of the machine and future improvements.

- i) Study of the country's environment where we want to fly the hexa-copter such as air speed, air humidity, air temperature, rain forecast, dust storm, tree population and high rise building etc.
- ii) Calculate the amount of water/liquid-chemical required for per square meter of the area to extinguish the fire.

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- iii) Calculate the time required to extinguish the fixed area.
- iv) On the basis of the time taken for extinguishing a particular area, calculate motor torque and propeller size.
- v) Selection of the flight controller, motors and its propellers for the hexa-copter depends upon the application and accuracy such as racing drones, long range drone, high altitude, small size, big size and heavy lift. Our project machine is for low altitude, medium range and heavy payload or lifting. The flight-controller consists of a microprocessor and plenty of sensors. The cost of a flight-controller depends upon the speed of microprocessor and the no. of sensors.
- vi) Determine the size, type and material of the hexa-copter frame. Again, this depends upon application and location where the drone (hexa-copter) has to operate.

The basic principle behind the Hexa-copter is, the three motors will rotate in the clockwise direction the other three will rotate in an anticlockwise direction allowing the aircraft to vertically ascend. While taking the flight with container for water we can extinguish fire place and with the help a camera we can capture images of the fire. We chose this hexa-copter because it is good for moving, turn is okay and average in cost. Hexa-copters use six separate arms, each with a rotating propeller in order to achieve stable flight. Recent technological developments in microprocessors have made possible the complex, dynamic control systems necessary for the stability of flight of a hexa-copter.

**Ground station and mission planning software**

Many UAV flight plans and control software are available, some are paid and some free. We have selected Q-Ground Control (QGC) flight mission software shown in figure-1. QGroundControl (QGC) is an intuitive and powerful ground control station (GCS) for UAVs. The primary goal of QGC is ease of use for both first time and professional users. It provides full flight control and mission planning for any MAVLink enabled drone, and vehicle setup for both PX4 and ArduPilot powered UAVs. Instructions for using QGroundControl are provided in the User Manual (you may not need them because the UI is very intuitive!). All the code is open source, so you can contribute and evolve it as you want. The Developer Guide explains how to build and extend QGC.



Figure 1: Ground station and Q Ground Controller (QGC)

**Flight Controller: System heart**

Pixhawk flight controller shown in figure 2 is used in our project which is an independent open-hardware project providing readily available, low-cost, and high-end, autopilot hardware designs to the academic, hobby and industrial communities. Pixhawk is the reference hardware platform for PX4 and runs PX4 on the NuttX OS.



Figure 2: Pixhawk PX4 Flight Controller Pixhawk 2.4.8 32 Bit ARM CortexM4 high-performance processors Flight Control Board, Safety Switch, Buzzer, I2C Splitter Expand Module.

UAV platform’s FC (flight co) must be designed to provide smooth and stable flight performance shown in figure 3. Mainly, FC is designed to automatic control of angular stabilization, angular position and trajectory during flight phases (operation modes) from take-off to landing. Internal communication among modules of FC is shown in figure 4.

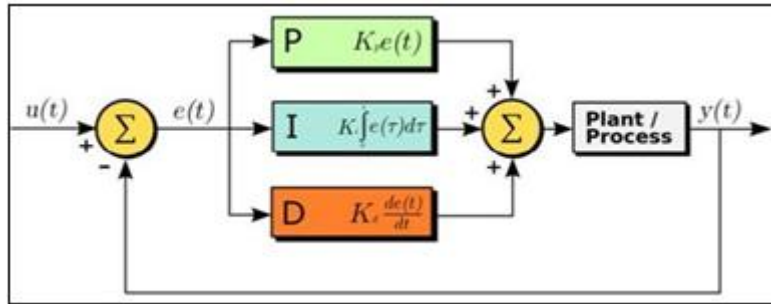


Figure 3: PID controller to hex-copter Flight Controller.

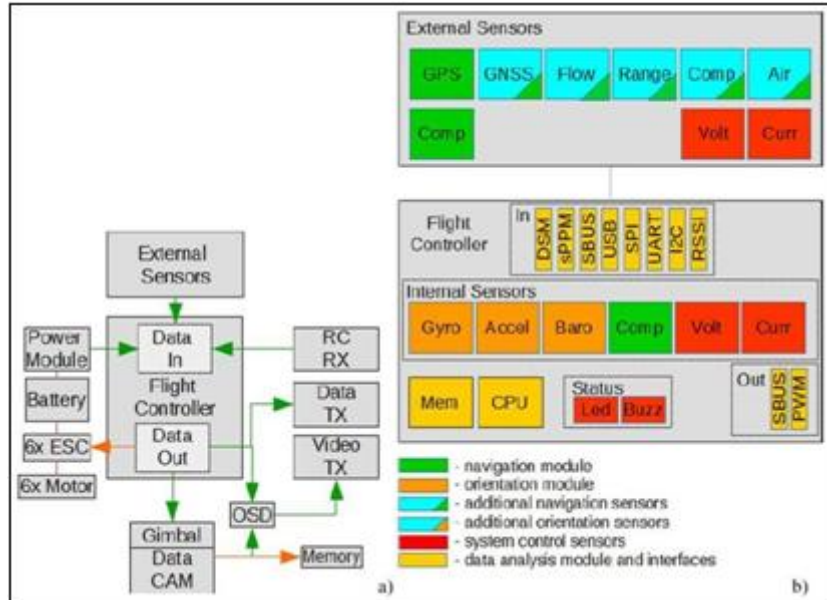


Figure 4: Hexa-copter platform’s hardware modules internal communication (a) and (b) flight controller modules and communication ports

### 3. Operational Principle

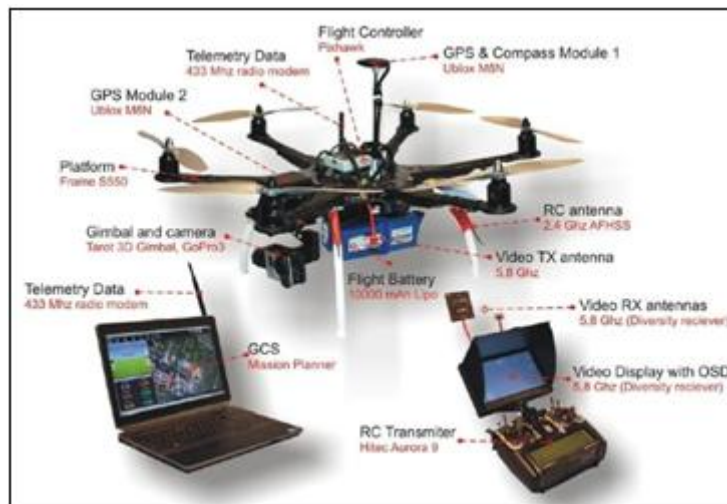


Figure 5: Hexa-copter platform hardware configuration and components assembly

In figure 6 hexa-copter is shown which has a liquid container of the five liters and equipped with FPV wireless camera to transmit aerial footages to ground.



**Figure 6:** Hex-copter equipped with water container 5-liter capacity and wireless FPV camera.

#### 4. Potential Impact

Our proposed UAV is a fire-fighting UAV equipped with six 9800 kV BLDC motor mounted on 10-inch carbon fiber propellers and 8000 mAH lithium polymer (LiPo) battery which gives it a 15-minute flight time. It is a long-range hexa-copter that can fly up to 3 km and is equipped with an 8 MP wireless FPV camera which is capable of sending good resolution images of fire area to the ground station unlike laptop or mobile phone.

##### Limitation of fire-fighting hex-copter

There are several limitations of our fire-fighting UAV project.

a) It can not fly in extreme hot weather since its operation

temperature is 45°C.

- b) It can't take flight in rainy season because it is not fully insulated.
- c) It can't reach tall buildings since its vertical height with full load is 100 m.
- d) It can't operate for more than 15-minutes due to the size of LiPo battery.
- e) It can't fly indoors and outdoors in congested areas.
- f) It can't fly extremely long range more than 2.5 km.
- g) It can't operate if fire flames are too high since it can operate for moderate fires.

In society drone fire-fighting facilities are very less due to its high price and lack of training for the operation of the firefighting drone. But slowly government and people are understanding technology and its advantages. Tradition method of Firefighters control a fire's spread by removing one of three ingredients fire needs to burn: heat, oxygen, or fuel. They remove heat by applying water or fire retardant on the ground with pumps or wildland fire engines, or by air using helicopters or airplanes. One of the most common methods of extinguishing a fire is by cooling with high pressure water shown in figure 7. This process depends on cooling the fuel to a point where it does not produce sufficient vapor to burn, with the reduction in temperature dependent on the application of an adequate flow of water to establish a negative heat balance.



**Figure 7:** Fire-fighter with high pressurized water canon gun.

Carbon dioxide is very cold as it comes outside the fire extinguisher and also it does not support combustion, hence it is suitable for filling in a fire extinguisher. Dry Powder extinguishers are filled with monoammonium phosphate, an extinguishing agent that spreads easily and melts over

flames. When the powder covers a fire, it blocks heat and oxygen, causing the fire to die down. There are several types of extinguishers which are widely used according to the type of the source of fire spread which is listed in the figure 8.

1st Class Fire Protection 01603 742781 enquiries@1stclassfireprotectionforuk.co.uk		Fire Extinguisher Type					
Fire Type		Powder	Foam	CO <sub>2</sub>	Water	Wet Chemical	
<b>CLASS A</b>	<b>Solids</b> (e.g. wood, plastic, paper)	✓	✓	✗	✓	✗	
<b>CLASS B</b>	<b>Flammable Liquids</b> (e.g. solvents, paint, fuels)	✓	✓	✓	✗	✗	
<b>CLASS C</b>	<b>Gases</b> (e.g. butane, propane, LPG)	✓	✗	✗	✗	✗	
<b>CLASS D</b>	<b>Metals</b> (e.g. lithium, magnesium)	✓	✗	✗	✗	✗	
<b>ELECTRICAL</b>	<b>Equipment</b> (e.g. computers, servers, TVs)	✓	✗	✓	✗	✗	
<b>CLASS F</b>	<b>Cooking Oils</b> (e.g. cooking fat, olive oil)	✗	✗	✗	✗	✓	
Some examples of businesses that may need this extinguisher		Outdoor locations, garages, wedding workshops, firecourts	Schools, offices, hotels, shops, hospitals, apartments	Offices, server rooms	Schools, hospitals, shops, apartment blocks	Kitchens, carehomes, restaurants	

Figure 8: Different Types of Fire Extinguisher.

But the vital issue is with the manual of all these kinds of fire extinguishers. However, manual operation is risky or life threatening for fire fighters. Therefore, the solution to this problem is to make machines which do not require human intervention. The meaning is, to make the machine

autonomous. Our proposed fire extinguisher hexa-copter is fulfilling the object. It is automatic, fast, accurate and human less operation. It can fly over the fire area and extinguish the fire automatically shown in figure 9.



Figure 9: Firefighting drone

### Area of Application

Our proposed project is highly beneficial for the governments, oil and gas companies, crude oil companies, arms and ammunition companies, match box making industry, cracker industry, paper and wood industry, highly inflammable chemical producing industry, textile industry. The list of companies are endless those are highly vulnerable to the fire. The list of companies mentioned above have a large area because these kinds of companies require large land for the operation some of them are spanned in few kilometers therefore, firefighting drone is extremely useful for extinguishing the fire remotely with video recording and picture of fire operation.

### 5. Conclusion

The development and implementation of a High Thrust Hexa-Copter for fire extinguisher applications present a promising solution for enhancing firefighting capabilities. The unique characteristics and capabilities of this unmanned aerial vehicle (UAV) offer several advantages in combating fires and ensuring the safety of both responders and the public. The agility and stability of the hexa-copter enable

precise and targeted deployment of fire extinguishing agents. This precision is vital in optimizing the use of resources and containing fires effectively, minimizing damage to property and reducing the risk to human lives. By leveraging the hexacopter for initial firefighting efforts, the safety of human responders can be enhanced. The UAV can be deployed in situations where sending firefighters could be perilous, such as in the presence of toxic fumes, structural instability, or intense heat.

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