GALGOTIAS UNIVERSITY

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4G CONTROL QUADCOPTER

A Project Report of Final Project – 2

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GALGOTIAS UNIVERSITY

SCHOOL OF COMPUTING AND SCIENCE AND ENGINEERING

BONAFIDE CERTIFICATE

Certified that this project report "……..….4G CONTRAL QUADCOPTER………."

is the bonafide work of "………AVINASH KUMAR, ASHUTOSH RANJAN………"

who carried out the project work under my supervision.

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ABSTRACT

Quadcopter is an unmanned aerial vehicle, which can be implemented in different applications. In product it will be represented a development of a quadcopter system and potential application in which it can be implemented. Quadcopter structure model, basic components with block diagram, hovering stability, dimensions, and description of basic movements will be represented and discussed. Control algorithms with steps in empirical methodology will also be presented. Current civil and military application will be examined, and future applications will be suggested. The quadcopter will be controlled from a laptop or a RC (Remote controller) from a certain distance wirelessly. This small and highly manageable system would acquire data such as video/images from a camera installed in the quadcopter and send them to the base station. The project would have an impact on carrying out future rescue missions and would provide visual and audio aid to the people in distress. It will have the ability to help assist, locate and save victims, faster with more efficiency than any other option. It could also be used as a measure for survey or surveillance.

1. INTRODUCTION

In the last few years we have witnessed significant climate change in both the region and all over the world. Climate change is a lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years. It may be a change in average weather conditions or in the distribution of weather around the average conditions (i.e., more or fewer extreme weather events).Many factors have been identified as significant for Climate changes such as: plate tectonics, variations insolar radiation received by Earth and human activities, which has caused global warming increasing greenhouse gas levels. Analysing climate change occurring around the world, it Was determined that these changes, have more negative impact on both the people and the economy. Some of the disasters that have happened in the last few months on the territory of Serbia and region, which are caused by climate change, are: floods in Serbia (June 2013, April/May/Jun/July 2014) and region, the team snow drifts in Vojvodina (February 2014), fires caused by thunderstorms and wildfires (Serbia, Croatia, Greece, Russia, etc.).

These data clearly indicate that it is necessary to develop a system for defining evacuation / safe way in case of natural disasters and accidents. The system described in this paper consists of quadcopter equipped with cameras to capture different terrain (land or water), and a processing unit for processing the recorded state, which is placed on the vehicle / vessel or used as a handheld device. This system can be used in different kind of applications for example in: advertisements when taking pictures of sightseeing (tourism), buildings, etc., scenes in movies, performances and air shows with lights, fireworks, aerobatics, etc., industrial applications for lifting tools and materials, diagnostics (observation of inaccessible places), finding missing persons, etc.

A Quadcopter consists of the following essential parts:

- Frame
- Motors
- ESC (electronic speed controller)
- Propeller
- Battery
- Flight Controller

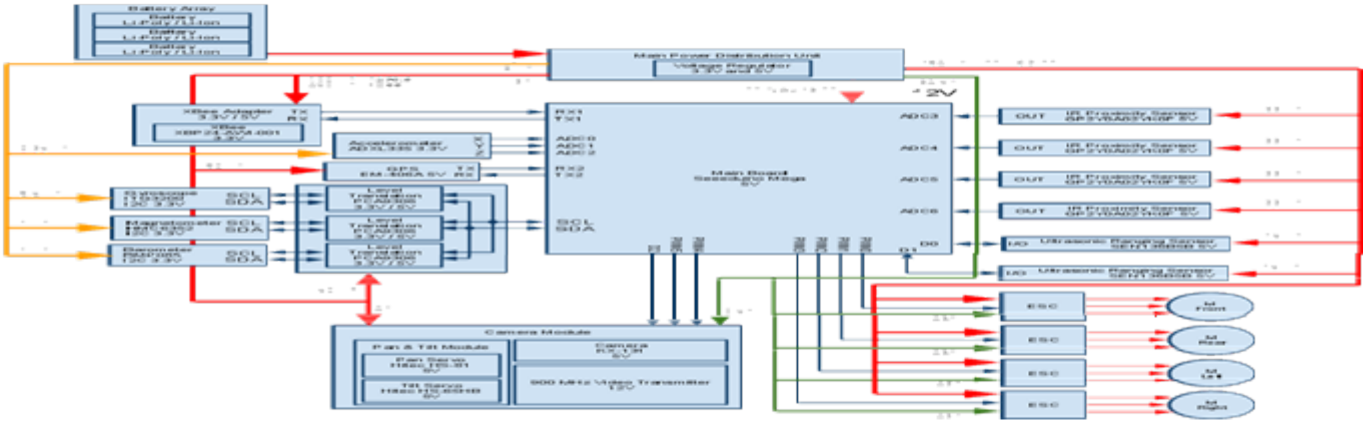
- RC Receiver

To Fly FPV (first person view), you will also need the following parts:

- FPV Camera
- Video Transmitter / VTX
- 5.8gHz antenna

There are other non-essential but useful hardware for example buzzer, LED’s, HD Camera, GPS etc.

I.PURPOSED MODEL

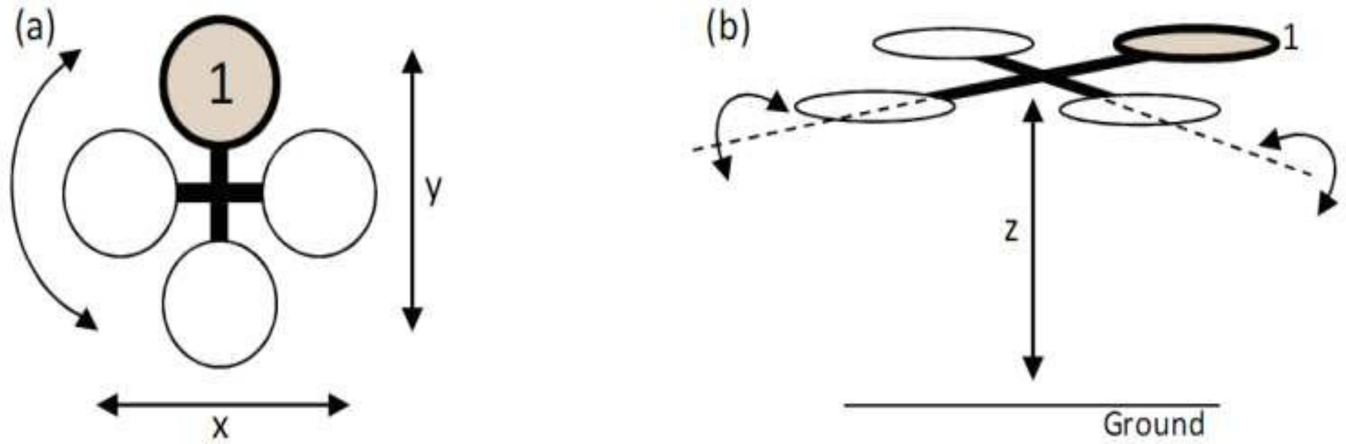


Quadcopter is a kind of unmanned aerial vehicle (UAV). UAV can generally be defined as a device used or intended to be used for flight in the air that has no on-board pilot .These devices are sometimes referred to as drones, which are programmed for autonomous flight, and remotely piloted vehicles (RPVs), which areflown remotely by a ground control operator .This fact in many cases can result in high maintenance and deployment costs particularly speaking in the industrial domain applications.Some applications implement an autonomous flight mode, however the autonomy here is

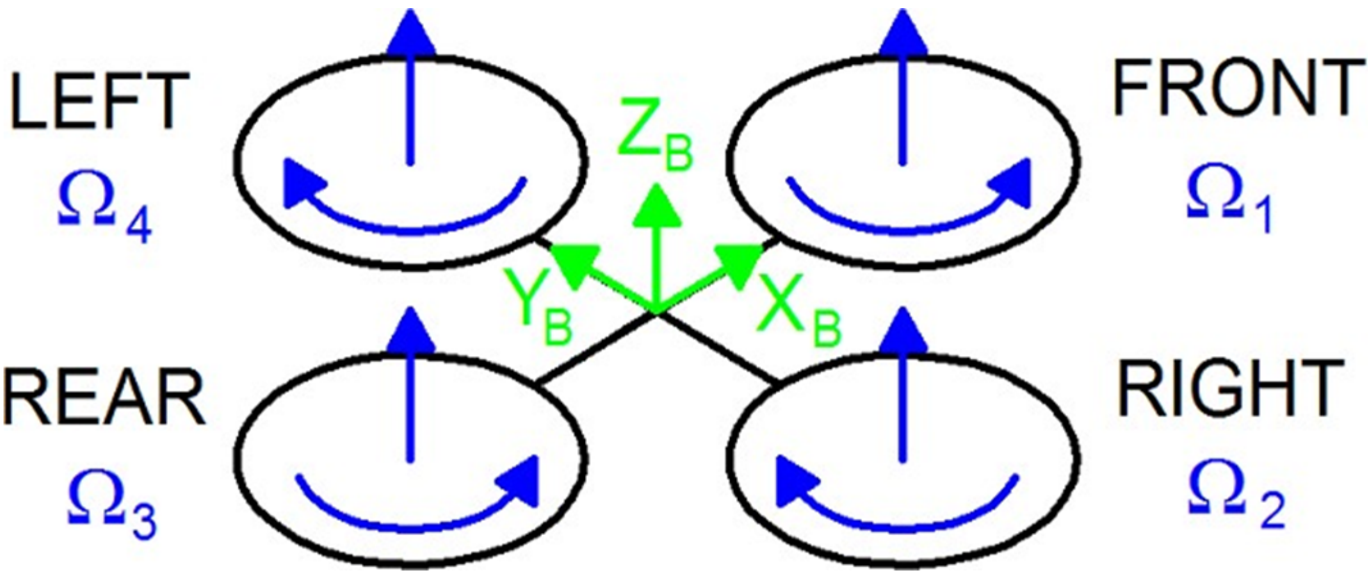
intended as a simple path planning through several given points. Quadcopter can be used in applications such as aerial

recognition, search-and-rescue, industrial monitoring missions among others. For instance, the Predator and Reaper, two drone built by General Atomics, which were used by the United States Air Force to recognition and combat over several countries. A more pacific application of UAVs is monitoring agriculture as done by the company AGX Tecnologias that developed several configuration of aerial vehicle to map different varieties of plantations. Dimensions of quadcopters can vary from the size of an insect to a size of a professional aerial vehicle. Dimensions differ according to the type of application in which this UAV are going to be implemented and the equipment they are taking. For example in application where there is a need for detecting toxic substances in the air, quadcopter needs to be equipped with sensors (in most cases they are light) so the quadcopter can be small. In military applications, where the quadcopter needs to be equipped with camera, sensors, and sometimes weapons, quadcopter needs to be much larger. Camera and adequate software can be used to provide imaging-based automatic inspection and analysis for such applications as automatic inspection, process control, and robot guidance in industry. A quadcopter is a multirotor UAV that is lifted and propelled by four rotors. Quadcopters are classified as rotorcraft, as opposed to fixed-wing aircraft, because their lift is generated by a set of rotors (vertically oriented propellers). One of applications is in Amazon.com Inc., the world's largest online retailer. They announced their Prime Air service which is a new shipment system where a multi-rotor delivers packages to customers. A quadcopter uses four propellers for trust and has them configured in either a cross or plus format. The quadcopter robot can take off and land vertically which is a big advantage as it lowers the requirements for alanding platform. Also, it allows the quadcopter to hover in place with considerable stability. Hover stability prevents the quadcopter from crashing in the event of strong wind or due to its weight. shows the six degrees of freedom of the quadcopter. In (a) (birds eye view), x and y represents the translational motion along the x- and y-axes respectively and ψ represents yaw, the rotational motion about the z-axis, while in (b) (frontal view), θ represents roll, the rotational motion about the x-axis,φ represents pitch, the rotational motion aout the y-axis and z represents the translational motion in the direction per pendicular to ground. The label '1' signifies the front propeller. With a hover control unit, the quadcopter can hover at a constant height z, with its roll and pitch angles stabilised by the gyroscope. The person at the command base will only need to control the quadcopter's motion along the x- and y-axes and also its rotation about the z-axis (to turn corners), reducing the degree of complexity from six to only three.

II. System Architecture



Quadcopters use 2 sets of identical fixed pitched propellers; 2 clockwise (CW) and 2 counter-clockwise (CCW). These use variation of RPM to control lift and torque. Control of vehicle motion is achieved by altering the rotation rate of one or more rotor discs, thereby changing its torque load and thrust/lift characteristics. The front and the rear propellers rotate counter-clockwise, while the left and the right ones turn clockwise. This configuration of opposite pairs directions re-moves the need for a tail rotor (needed instead in the standard helicopter structure).shows the structure model in hovering condition, where all the propellers have the same speedThe quadcopter structure model in hovering condition Also the angular speed of the propellers is represented. In addition to the name of the velocity variable, for each propeller, two arrows are drawn: the curved one represents the direction of rotation, the other one represents the velocity. This last vector always points upwards hence it doesn't follow the right hand rule (for clockwise rotation) because it also models a vertical thrust and it would be confusing to have two speed vectors pointing upwards and the other two pointing downwards. All four propellers rotate at the same speed



which is represented as Ω [rad s-1] to counterbalance the acceleration due to gravity.Even though the quadcopter has 6 DOF, it is equipped just with four propellers. Thanks to its structure, four best controllable variables can be chosen related to the four basic movements which allow the quadcoper to reach a certain height and attitude. It follows the description of these basic movements: Throttle (U1 [N]) - increasing (or decreasing) all the propeller speeds by the same amount. It leads to a vertical force which raises or lowers the quadcopter. If the quadcopter is in horizontal position, the vertical direction of the inertial frame coincide. Otherwise the provided thrust generates both vertical and horizontalaccelerations in the inertial frame. Roll (U2 [N m]) - increasing (or decreasing) the left propeller speed and by decreasing (or increasing) the right one. It leads to a torque with respect to the XBaxis which makes the quadcopter turn. The overall vertical thrust is the same as in hovering, hence this leads only to a roll angle acceleration (in first approximation). Pitch (U 3[N m]) - similar to the roll and is provided by increasing (or decreasing) the rear propeller speed and by decreasing (or increasing) the front one. It leads to a torque with respect to the YBaxis which makes the quadcopter turn. The overall vertical thrust is the same as in hovering, hence this leads only to a pitch angle acceleration (in firstapproximation).Yaw (U4[N m]) - increasing (or decreasing) the front-rear propellers' speed and by decreasing (or increasing) that of the left-right couple. It leads to a torque with respect to the ZBaxis which makes the quadcopter turn. The yaw movement is generated thanks to the fact that the left-right propellers rotate clockwise while the front-rear ones rotate counter clockwise. When the overall torque is unbalanced, the quadcopter turns on itself around ZBThe total vertical thrust is the same as in hovering, hence this leads only to a yaw angle acceleration (in first approximation).

III. MODULE SPLIT-UP

Each quadcopter can have a very different hardware component which mostly depends on application in which it will be implemented. Standard components are: microcontroller, sensors, motors, Global Positioning System (GPS) power supply and telemetry devices. is representing a primer of block- diagram of quadcopter. Basic component of each quadcopter is frame. The arms and centre plate of the quadcopter frame is in most cases are made of carbon fiber. Connections between the centre plates and arms, as well as the motor mounts can be made of aluminium. The modular integration of the frame allows components to be replaced easily if necessary. The frame, illustrated in is 485 cm long from motor to motor and weighs approximately 450 g. The propulsion system is mounted directly onto this frame.Another important part of quadcopter is propulsion unit. The propulsion unit for the quadrotor consists of four brushless DC motors and four electronic speed controllers. The power source for the system can be cell lithium polymer battery. Propellers mounted on the motors must be several cm lengths and have a fixed pitch angle. This propulsion configuration allows safe operations of the frame and ensures excellent lift and thrust performance for all of the flight. Beside microprocessor and inertial measurement unit with accelerometers, magnetometer and gyroscopes

There is a need for external sensors. In most cases, as external sensor, infra-red sensors and ultrasonic sensor can be used. They can be used for the collision avoidance schemes and for altitude control. GPS modul is another type of equipment which is mandatory for navigation purposes. A primer of the quadcopter with all necessary components is represented.

Frame

The frame of a quadcopter is the main structure, or the skeleton upon which the rest of components will be attached. Once you have decided on what you want your craft to do (Aerial Photography, Racing, Micro Freestyle etc.), you need to decide what size best suits your requirements. The size of the frame will determine what size props you will use (or vice versa), in turn the size of the props will determine the size of the motors, which will specify the current rating of your ESC's. Builders tip: When choosing a frame it is important to check that the mounting for the FC (Flight Controller) and the motors match your choice for these components. Full featured flight controllers are most common with 30.5 x 30.5mm mounting pattern. Motors for 5" props often have a 19 x 12mm mounting pattern.

Note: 1st time builders should choose a well documented frame that is easy to work with. This is a great looking frame that is robust and spacious with great access to the components, but a little limiting on the choice of parts. Check out the review of the Diatone 2018 GT M200. This frame also offers great protection to the components which is important because you will crash it!!

PDB

PDB stands for Power Distribution Board and it is often where the battery power lead (ie. XT60) is connected. As its namesuggests, the PDB distributes power to the components at the voltages they require. These days the necessity of using a PDB is being negated by FC's, ESC's and other (dubbed AIO or All-In-One) components providing the same function. These components have a wide input voltage range and can be connected to battery voltage (aka VBAT), they can then output a stable voltage ie. 5v to power an FPV camera or other components.Builders tip: Make sure that your PDB is actually necessary, nowadays it is likely that you will be able to distribute power to your components by other means. Ie. some VTX have a wide input range and can output a regulated 5v to power your FPV camera.

Note : AIO is a common term used for components that can fulfill more than 1 function, ie. an AIO FPV camera will be a camera and VTX (video transmitter) integrated into one unit.

Flight Controller

The Flight Controller (aka "FC") is the brain of a quadcopter, it has sensors on the board so it can understand how the craft is moving. Using the data provided by these sensors, the FC uses algorithms to calculate how fast each motor should be spinning for the craft to behave as the pilot is instructing via stick inputs on the TX (Radio Transmitter). Most of the wiring on your quad will be focussed around the FC. It needs to have the RX (receiver) connected, so it can be told what the pilot wants the craft to do. Each of the ESC signal and ground wires need to be connected for the FC commands to be carried out by the motors. With the introduction ofBetaFlight OSD (On Screen Display), even the video feed from the FPV camera goes via the FC to the VTX (Video Transmitter).Builders tip: More functions often means more wires. For beginners an "all singing, all dancing" FC might sound fantastic, but the wiring might become very tightly spaced making it difficult to solder. Remember to test fit your components to your frame before you start trimming wires. measure twice, cut once!

Note : Some AIO FC's will have a selection of various different components integrated onto the board from receivers to VTX, now even ESC's are being integrated with FC's though this is quite controversial.

RX (Radio Receiver)

Transmitters (TX) and receivers (RX) are not universal and you need to buy an RX that is compatible with your TX, an FrSky Taranis transmitter cannot work with a FlySky receiver. These days it is most likely that you will be using either PPM or a digital Serial protocol, which will only require 1 signal wire for all of the channels, plus power (3.3v or 5v) and GND.The signal wire will be connected to one of the UART terminals on your FC (Flight Controller). Some FC's actually have integrated receivers, if you are taking this route make sure that it is using a compatible protocol.Builders tip : Make a note of which UART you have connected your RX to, so you can easily configure the FC to communicate with the RX in BetaFlight Configurator.

Note : Spektrum based receivers usually require 3.3v while FrSky and FlySky RX require 5v. Never supply 5v to an RX that only requires 3.3v!

ESC – Electronic Speed Controller

An ESC is a device that interprets signals from the flight controller, and translates those signals into phased electrical pulses to determine the speed of a brushless motor. Make sure that both your FC and ESC's are capable of running the same ESC protocol ie. DShot 600. When selecting an ESC, remember that the current rating must be higher than the amperage drawn by your combination of motors and props.These days an ESC has 4 input terminals, 2 are for signals coming from the FC. Signal and signal ground are wired to the FC, the 2 heavier wires are for Positive and Negative, they carry the high current to the ESC to supply the motor. These Positive and negative are wired to the PDB. An ESC has 3 output terminals, one for each of the wires of a brushless motor. Some ESC's now offer telemetry Builders tip : If you are using an FC with an integrated PDB then all 4 wires going to the ESC input will come from the FC. 4-in-1 ESC's are becoming popular as they can shave a few grams off your AUW (All Up Weight or takeoff weight *inc. Battery and other peripherals). A 4-in-1 ESC can connect to the FC in different ways, and they are not universal – Unless you know exactly what you are getting, I advise you purchase a 4-in-1 ESC as a stack combined with the FC such as the HolybroKakute FC and tekkoS 4-in-1 ESC.

Note : The specs provided on the data sheets of motors are under static thrust test conditions. Props spin easier in free air and therefore motors use between 20% and 30% less current in flight conditions than that shown in static tests. If the maximum amperage draw of a motor is the same or just under the maximum current rating of your ESC it should be fine.

Motors

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. Remember to check the specs of your motors for their maximum amp draw, and ensure that your ESC's are rated to withstand this amperage.Builders tip: The brushless motors that are most commonly used on a miniquad have 3 wires, it doesn't really matter which of the 3 output terminals these are connected to on the ESC, swapping any of the 3 will change the direction of rotation. Motor rotation can be set in BL_Heli configurator.

Note : Remember to ensure that the motor mounting screws are not too long and that they do not touch the stator windings of the motor. This contact can cause a short in the windings, spelling the end for your motor, also make sure that any grub screws are fitted and tightened.

Propellers

There are possibly thousands of different types of propeller for quadcopters, with multiple options in almost every size. A heavier propeller will require more torque from the motor than a lighter prop, also blades with a higher AOA (Angle Of Attack – aka "aggressive props") encounter more resistance from the air and require more torque. When a motor has to work hard to turn, it draws more Amps. Finding a balance between the thrust produced and the amperage used by the prop and motor combination is a balancing act that every quad pilot goes through, there is no "right answer".

Builders tip : Remember that your props have to be really tight, it helps to have a tool to grip the motors while tightening the prop nuts. If the props slip this will cause erratic behaviour in flight.

Note : Props these days are generally well made, but they may still be unbalanced. If you are getting vibration or 'jello' in your camera, check your props are undamaged, unbent and balanced, before your start disassembling!

Battery

LiPo batteries are the power sources of the quadcopters. LiPo is used because of the high energy density and high discharge rate. LiPo batteries are rated by their nominal voltage (3.7v per cell), cell count in series, (shown as a number followed by 'S') ie 4S = 14.8v, capacity in mAh (ie.1300mAh) and discharge rate or 'C' rating (ie. 75C). If you want to know more here is an article on LiPo battery C ratings.Builders tip: The battery is the single heaviest component of your quad, just because you put a bigger battery on it, it doesn't mean it will fly longer.

Note : buying cheap "no name" batteries is not recommended you will find inconsistencies in cell voltage, inflated claims of capacity, and they will suffer from "voltage sag".

FPV Camera

An FPV camera allows the pilot to see the view from onboard the craft. On an FPV mini quad, there are normally 2 cameras, one for real time video streaming, and the other for recording HD footage.FPV cameras don't have great video quality – they are designed for WDR (Wide Dynamic Range) and low latency, which is extremely important to FPV. WDR refers to a camera's ability to display changes in lighting conditions, and areas of shadow and light in the same image. Latency is the amount of time between your FPV camera capturing the image, and display that image on your screen or in your goggles.The FPV camera will connect to the VTX (Video Transmitter), often via the FC which then overlay's OSD (On-Screen Display) information on the image. A camera usually requires 5v to operate but some are capable of wide input voltage and can be connected to VBAT.Builders tip: If you are getting interference in your FPV image when applying power to your motors you should fit a capacitor to filter the noise. Here is an article to tell you more about capacitors for noise filtering.

Note: Cameras transmit images in different size ratios (ie. 16:9 & 4:3), check and make sure that your FPV display (goggles or screen) is compatible. Different signal formats are used in image transmission too, (ie PAL & NTSC) your FPV display must also be capable of decoding the relevant signal type. These days cameras are often able to switch between these signal formats, and some are now even able to switch between image display ratios as well.

Video Transmitter

Video transmitter, or VTX, connects to the FPV camera to transmit video to the FPV goggles or monitor. Most quadcopters these days use the 5.8GHz for video transmission. You may find that your VTX can offer other functions such as a regulated 5v output that can be used to power your FPV camera. Remember that if you power your VTX without an antenna connected, it may burn out!The VTX will receive a signal from the FPV camera (often via the FC) which it then broadcasts on one of a number of channels incorperated by the 5.8gHz frequency bracket. Some VTX run on 5v some require more. Be aware that if your VTX does run on 5v that it will be active when you connect your FC to USB, so you should have an antenna connected when configuring BetaFlight. Remember that if your VTX requires more than 5v it will not function with USB power and you will need to connect a battery to set up your channel, band and output power.Builders tip: Your VTX gets hot, it is a good idea to place it somewhere on the frame where it has some space for airflow to cool it down.

Note: If you are flying with others be aware of your VTX power, make sure that you are aware of the frequencies being used by others, so you can maintain good signal spacing.

FPV Antenna

Every VTX requires an Antenna to transmit signal. This guide explains the basics of FPV antennas. Antennas come in various shapes and sizes, directional, linear and polarized.Builders tip : Carbon Fiber will block the 5.8gHz signal that is used by the VTX, make sure that the antenna is far enough away from the frame to be able to transmit without the signal being blocked.

Note : If you are using polarized antennas, make sure that both the antenna on your VTX and the one on your goggles are using the same direction of polarization. LHCP works only with LHCP, and RHCP only works with RHCP.

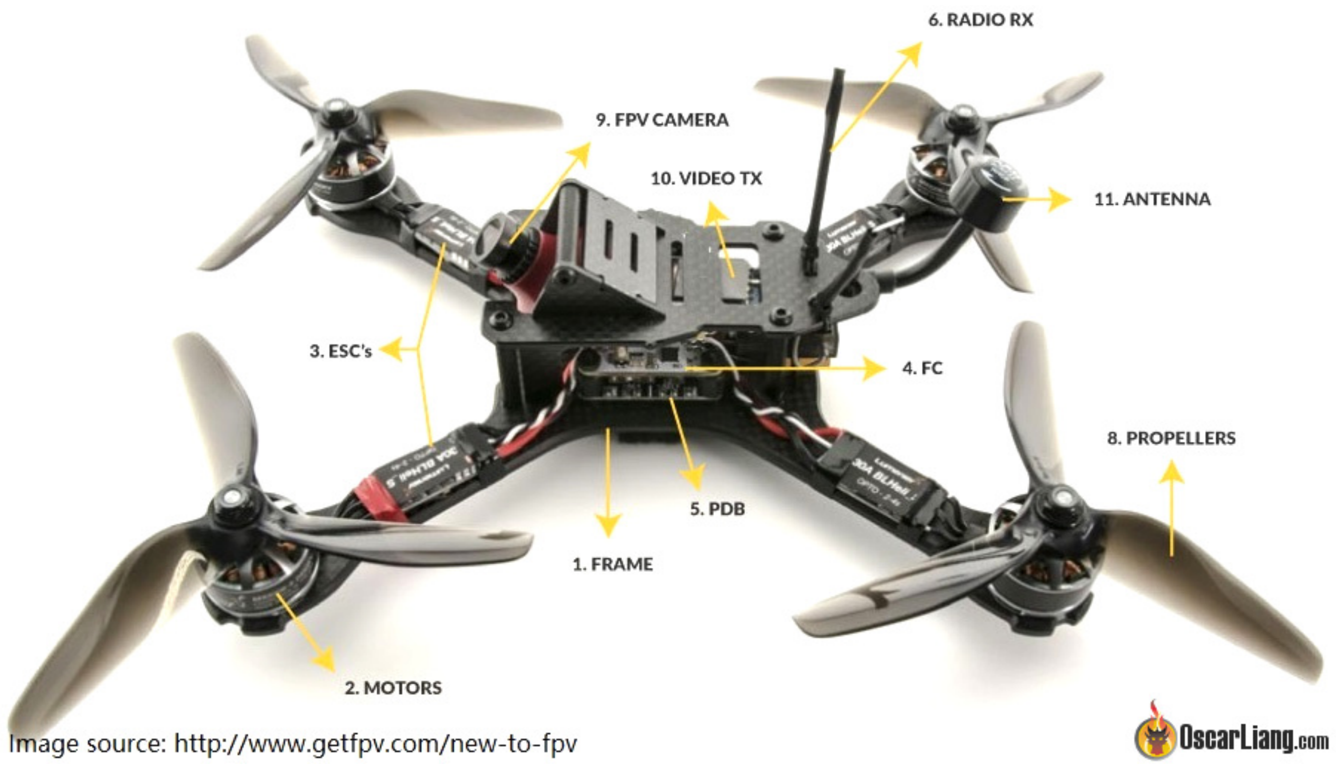
Optional Components

The most common additional components added to a mini quad are LED’s and a lost model buzzer. These are really important for a beginner, especially if you don’t have a nice flat area of mown grass, your quad can go really quickly which means it can be far away quite fast.

Especially if you are a beginner and are disoriented flying FPV, without something to draw your attention, your quad could be gone forever! Of course the Go-Pro or similar action camera is is a common feature. so we can show off all our successes and failures to our like mindedyoutube subscribers! Builders tip: Smaller quads are better at hiding in long grass!

2. WORKFLOW DIAGRAM

Quadcopters have been used, are being used or are actively being considered for different applications all over the world. They have range of potential environmental or commercial applications (emergency response, pollution detection, crop spraying, etc.). Also, they can be deployed in surveillance applications against civilians, such as applications in policing and border surveillance. Some police departments in Europe and North America have been using quadcopters since 2006. At least five police forces in the UK (Essex, Merseyside, Staffordshire, Derbyshire and the British Transport police) have purchased or used micro-quadcopters. The range of potential applications is clear to police forces, where, for example, the South Coast Partnership between Kent Police and five other police forces in the UK is seeking to introduce drones (quadcopters) 'into the routine work of the police, border authorities and other government agencies' across the UK. Police forces use quadcopters to monitor large crowds, prevent or detect crime and assist in incident responses. UK police have used quadcopters to monitor festivals, to monitor protests and to monitor the Olympic ceremony. In 2007, quadcopters were reported over political rallies in New York and Washington, DC. The CannaChopper has been deployed in the Netherlands and Switzerland against cannabis smokers, football fans at the European football championship in 2008 and "troublemakers" at the NATO summit in 2009. India has also recently begun using quadcopters to help secure sensitive sites and events.A North Carolina county is using quadcopters with infrared cameras to monitor gatherings of motorcycle riders and to detect marijuana fields. In this deployment, the quadcopters flies a few hundred feet in the air, which is close enough to identify faces. Six police departments in Canada are using quadcopters in populated areas to record crime scenes and Canadian police are responsible for the first photographs taken by a quadcopters being admitted as evidence in court after the local police force used a quadcopters to photograph a homicide scene in 2007. Quadcopters may also be used to assist police in incident response. Merseyside police are credited with the first UK arrest using a quadcopter, where a car thief was tracked through undergrowth by the quadcopter's thermal imaging camera. Once the teenage suspect's location was detected by the AirRobot flying at 150 feet (45.7 m), the information was relayed to ground forces who arrested the youth. In Los Angeles, a sheriff's department deployed their SkySeer drone to seek missing persons in rural areas, monitor accident or crime scenes and assist police in pursuits. Quadcopters have been used in border surveillance operations in the USA since 2002. The US is one of the most well documented users of UASs in this capacity along the US/Mexico border and the US/Canada border. In 2002, a US Marine operated Pioneer quadcopter intercepted people who were attempting to smuggle 45 kg of marijuana from Canada into the US. In 2005, Predator quadcopter along Arizona's border with Mexico were integrated into a surveillance system that included seismic sensors, infrared cameras and laser illuminators. If the seismic sensor is triggered by drug smugglers, the Predator can investigate and, upon finding drug smugglers, tag them with its laser illuminator. With the GPS coordinates and the infrared illuminator, agents have no difficulty intercepting the smugglers.

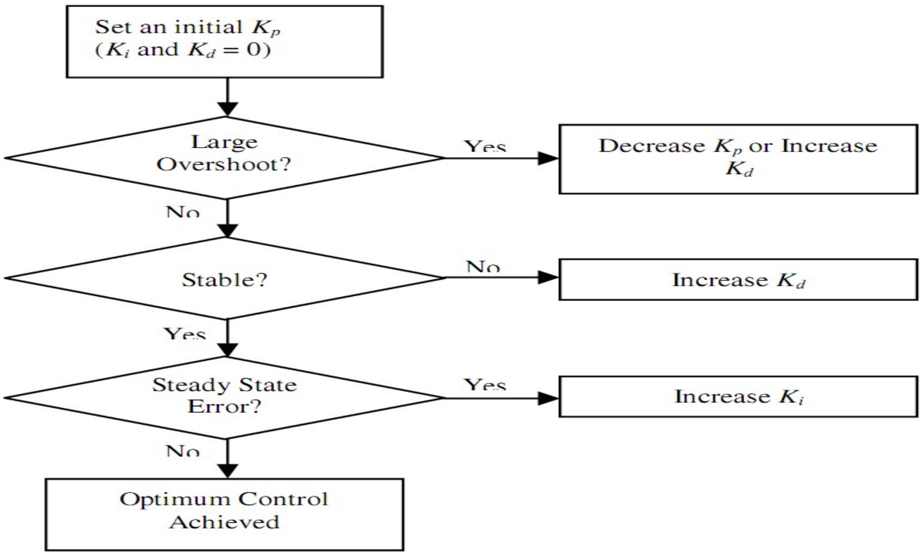


Control algorithms

The PID (Proportional-Integral-Derivative) control algorithm has been considered and implemented in literature to control the hover altitude of the quadcopter. PID control is a type of linear control that is widely used in the robotics and automation industry. The PID algorithm is popularly used mainly because

- It has a simple structure
- It provides good performance

- It can be tuned even if the specific model of the controlled plant or system is not availableA PID controller functions by calculating the error, or difference between a measured output and a desired set point and adjusts the system control inputs such that the calculated error is minimised. The PID algorithm consists mainly of three control parameters, P – Proportional, I – Integral and D – Derivative. The mathematical expression of the discrete-time PID algorithm is given in. P determines the reaction to the current error, I determines the reaction based on a sum of recent errors while D responds to the rate at which the error has been changing. Calculation of the control input by control algorithms such as PID control may return a control input gain which may be too high for the quadcopter system. This results in a large control input magnitude which may be out of the limits recognisable by the system. To solve this problem, the linear quadratic regulation (LQR) method can be employed. LQR is a form of linear optimal control regulation which aims to reduce the magnitude of the control input without affecting the performance of the control algorithm. The LQR algorithm is used to obtain the parameter settings that will minimise the undesired deviations (in this research, altitude) while at the same time limiting the energy expended by the control action by using a mathematical algorithm that minimises a cost function or performance index with weighting factors. The cost function or performance index refers to the sum of deviations of measured values from its desired values. For a discrete-time LQR, the performance index is defined as By adjusting the weight parameters Q and R, the optimal control sequence that minimises the performance index is given by Different approaches have been developed for formation of flight control. Linear formation flight controller has been discussed in. The advantage of the linear control is that it is intuitive and easy to synthesize, but it cannot handle the constraints directly and may not be valid for large operation range since it is designed around a fixed operating point. Some researchers addressed the nonlinear formation flight control problem by using feedback linearization and adaptive control. Although these nonlinear control methods can deal with the unmodeled dynamics, they cannot handle the constraints directly and the implementation of such controller may result in ill-defined control inputs.



Set an initial K_p (K_i and $K_d = 0$)
Large Overshoot?
Yes
Decrease K_p or Increase K_d
No
Stable?
No
Increase K_d
Yes
Steady State Error?
Yes
Increase K_i
No
Optimum Control Achieved

I. GANTT CHART

	10-01-2020	20-01-2020	30-01-2020	10-02-2020	20-02-2020	03-03-2020	10-03-2020
researching on the project		completed					
project requirement analysis			completed				
IFTTT applet programming							PENDING
NODE MCU							PENDING
working on creating the architecture							completed

3. RESULT &CONCLUSION

Quadcopter is a special kind of vehicle, which can be implemented in different applications. In this paper basic principles of quadcopter design as well as current applications are represented. In the future applications, quadcopter could be used for a variety of new policing functions. Quadcopter could be used for safety inspections, perimeter patrols around prisons and thermal imaging to check for cannabis being grown in roof lofts and other not easy to access locations. The police could use them to capture number plates of speeding drivers, for detecting theft from cash
machines, railway monitoring, combat fly-posting, fly-tipping, abandoned vehicles, waste management.

Future research will be in field of search and rescue. In future an effort will be directed to development of a system for defining evacuation/safe path in case of natural disasters and accidents. The system will consists of quadcopter which is equipped with a camera to capture different terrain (land or water) and a processing unit for processing the recorded condition which is placed on the vehicle/vessel or in form of handheld device. In addition to the situations of natural disasters and accidents it is possible to use this system in cases of climatic changes that affect the safety and health of the population, or in cases where it is endangering the functionality of different economic systems.

4. REFERENCES

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