FABRICATION OF A PROTOTYPE FOR CARGO DELIVERY HEXACOPTER

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Abstract : In advancing drone technologies and increasing commercial usage, This project represents to design the hexacopter which is used for product delivery purpose and also it can greatly reduce the labor in commercial purpose. The hexacopter is capable of sustained without a human operator onboard which can be controlled by autonomously. In this active world, the product does not reach the consumer in time due to some bad infrastructure (such as, traffic). In order to rectify the drawback here the hexacopter is used for delivery purpose. The product is delivered to the consumer based on barcode (every barcode has its own address based on latitude & longitude). The scanner in the hexacopter scan the barcode and fix the destination with the help of GPS. It can also track its current position and to control it with the help of Android Apps (or) computer through satellite control. Drones can significantly accelerate delivery times and reduce the human cost associated with the delivery. This report examines the value chain and opportunities in the delivery drones market.

IndexTerms **– Drone, UAV, Hexacopter.**

INTRODUCTION

Unmanned Ariel vehicle (UAV) has been massively used in the military world over the last few years and in order to get the successive result of the military application is increasingly put an effort to establish unmanned aircraft in non-military roles. A delivery drone it is also called as parcel copter, is an unmanned aerial vehicle (UAV), used to transport packages, food or other goods. The UAV can transport medicine, vaccines and retrieve medical samples even in the inaccessible region. In July 2015, the FAA approved the first use of drone within the United States to deliver medicine to a rural virginal medicine clinic in a program called "Let's fly wisely". Drug Cartels have used UAV's to transport contraband, sometimes using GPS-guided UAV.

HEXA-COPTER:

The term Hexa-copter is a VTOL (Vertical Take-Off and Landing) aerial vehicle belonging to the class of multi rotor helicopters. They differ from the standard helicopters in using rotors with fixed pitch, thus as the blades rotate their rotor pitch does not vary. Hexacopter consists of six rotors.

Fig. 1 Hexa-copter

The hexa-copter has six motors which are mounted on 6 symmetrical frames making 120 degree of angle from each other. They have three sets of CW (clockwise) and CCW(counter clockwise) propellers. It's very similar to the quadcopter, but due to larger number of motors it provides more lifting power. The main advantage behind hexa-copter is that if one of its motor fails then also it can still fly in air. Hexa-copters has more lifting power than quadcopter in spite of having similar flight mechanics. Due to extra motor they have more lifting power. This makes it easy to carry camera equipment more simplex than an average action camera, like high-end DSLRs (digital single-lens reflex).

This is a type of remote controlled flying device that has six propellers. They are arranged in a circular shape above the main body of the hexacopter. This body often carries a camera and features two legs shaped like skis. These skis allow the device to be stable when it lands. The six propellers give this craft more maneuverability and flying power than a quadcopter. The craft can fly very steadily and reach higher altitudes than a quadcopter too. This is because it has more lifting power. If you are using an expensive camera to capture footage with this craft, you can be sure that it is can fly the camera without any problems of stability.

The main advantage of this craft is that it can keep flying even if one propeller blade fails. The motors powering the propellers are placed 120 degrees apart. If one fails, the other 5 can easily keep the craft airborne. The drone will land safely with no issues thus protecting the camera that is attached to it. In addition to that, this craft can easily be landed even if it loses two propellers. 4 of them are equal to those on a quadcopter.

Objective of our work:

The main concept of our project is to implementation of UAV- unmanned aerial vehicle for product delivery purpose. We go for this concept because, in this busy world every people required their needs very urgently, but due to some bad infrastructure (such as, traffics) the product does not reach the consumer in time. To overcome this draw back we use hexacopter for delivery purpose. The product is delivered to the consumer based on barcode (every barcode has its own address). The barcode is scanned with the help of scanner which is placed in the hexacopter. The hexacopter tracks the destination with the help of GPS. After delivery it returns back to its original position.

Configuration:

There are mainly 3 different types of configuration of hexacopter:

X-Configuration/+ Configuration

Like quadcopters, hexacopters can be configured either in **X** or **+** mode. In both of these designs, the rotors are arranged with equal spacing around the body. The only difference between X mode and + mode is that, in X mode two of the motors face front while in + mode one of the motor faces front. Like quadcopters, **+** mode is most commonly used for acrobatic flying and **X** mode is most commonly used for aerial videography or photographic purpose.

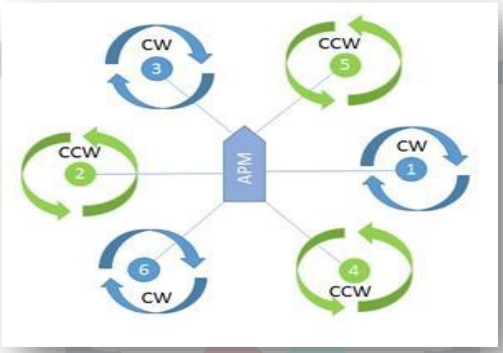

Fig.2 X-configuration of hexacopter

Y6 configuration

Y6 copters are as similar as tri-copters, the only difference is thathexacopter contains two motors on each arm which is mounted on top of other. The pairs of motors stroll in opposite directions and just balance the forces and prevent an unintended yaw. Y6 copters are more compact than other hexa-copters but are slightly less efficient.

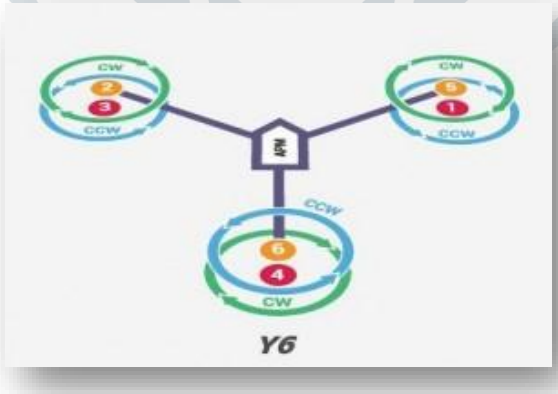

Fig. 3 Y6 configuration of hexa-copter

COORDINATE SYSTEM

Modeling coordination To keep track of the hexa copter, two different coordinate frames are used to represent the position and orientation in three dimensions—the earth frame (Oxyz) and the body frame, as seen in Figure 4. The earth frame is a fixed frame used as an unmoving reference. For example, if the user wants to define a path that the hexacopter should follow, then that path would be represented in the earth frame. The body frame axes are aligned with the sensors, which is convenient when reading sensor data and controlling the angular orientation (attitude).

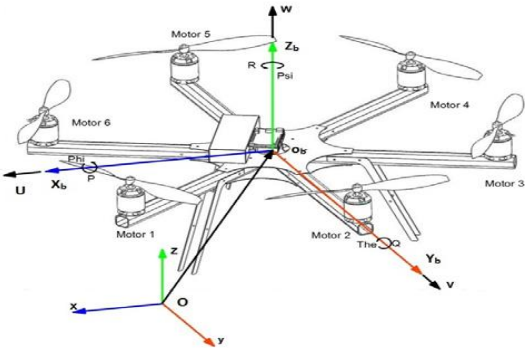

Fig.4 System coordination

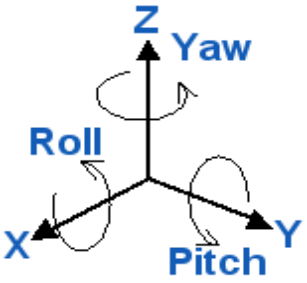

Fig.5 Axis labels and conversion

Thrust calculation:

To test the motor thrust and determine its relationship to ESC command signal, one of the motors was mounted to a load cell. The load cell had a 7kg maximum load, more than adequate for the less than or equal to1kg maximum that we expected from the motor. For each BLDC motor and the propellers of 10X4.5 we were able to generate a thrust of 1200kg when supplied with 12 volts. So, by using the six blade dc motors we can generate the maximum weight lifting capacity of 6X1200=7.2kg for the hexacopter provided the battery must be fully charged.

Fig.6 Thrust measurement set-up

COMPONENTS OF HEXACOPTER:

Flight controller

Only the sonar will be used for measuring altitude since the barometer is not accurate enough for indoor use and since it depends on air pressure it can react to if someone opens a door to the room etc. The magnetometer is also ignored because flights are made indoors and metal objects and beams as well as other electronics seem to cause major disturbances. Not using the magnetometer will cause some drift in heading but it tends to be rather small. A GPS signal is unavailable indoors and thus the GPS receiver is ignored. The autopilot is supplied with its own source code.

Fig.7 ArduPilot Mega 2.6 (flight controller)

Electronic Speed Controller:

An Electronic speed controller is an electronic device used to control the speed of rotation and direction of electric motors. A Brushless Electronic Speed Controller is a type of Electronic speed controller which produces trim phase Limited voltage AC from a DC power source to drive a brushless DC motors. six 30A ESCs (electronic speed controllers) are used in proposed hexacopter. It convert the PWM signal received from flight controller or radio receiver and then drives the brush less motor by providing required electrical power. Thus ESC is an electric circuit that control the speed and direction of electric motor by varying the magnetic forces created by the windings and magnets within the motor.

Fig.8 Electronic speed controller

Brushless DC Motor:

Brushless DC motor is a type of synchronous motor that is powered by a DC source and aninverter/switching circuitry which converts DC to limited voltage AC.Also known as electronically commuted motors (i.e. ECMs motors). BLDC motor are synchronous motor powered by DC electricity. Rated in KV, where it rotates 1300rpm per 1 volt supplied to it (if its rating is 1 KV). It offers several advantages over brushed DC motors like more reliability, low noise, reduction in EM Interference (EMI), high torque per watt etc.

Fig.9 Race star 2830 1300kv BLDC motor

Printed Circuit Board Frame:

The F-550 hexacopter frame is used as it is best suited for the propellers and payloads which has to be lifted along hexacopter. hexacopter requires a light as well as rigid frame to host a LIPO battery, 6 BLDC motors, 6 ESCs & a controller.Arms are made up of 5/8 hollow square aluminum bars and uses common nuts and bolts to hold the frame together.

Fig.10 components of frame

Fig.11 hexa-copter frame

Propellers:

Used 10 x 4.5 CW and CCW 6 pieces of black propellers as per the requirements. Size of propellers varies with its applications like smaller propellers (under 8 inch) are used for racing. .While large sized propellers (over 8 inches) along with motors are used for carrying some weighted object like camera ,other components.

Fig.12 Propeller

Lithium Polymer Battery:

Li-Po (Lithium Polymer battery) is a rechargeable battery of lithium ion technology. They provide higher specific energy and are being used where weight is a critical factor. It also provide high voltage and long run time as they hold huge power in small package and have high discharge rates required to meet the need of powering hexa-copters.

Fig.13 Lithium Polymer Battery

Radio Control Transmitter:

Radio remote control devices canbe used to send flight instructions directly the UAV. Thesedevices generally send analogue yaw, pitch and roll signals directly to a receiver on the UAV, allowing it to respond in near real-time. Most modern remote control systems utilize a spread spectrum technique over the 2.4 GHz band. This technique spreads the bandwidth of the transmitted signal over the frequency domain, allowing for a more stable connection with increased immunity to interference and noise.

Fig.14 radio controller Transmitter

Radio Control Receiver:

Radio control receiver canbe used to receive flight instructions directly from the radio control transmitter. It receive the signals what the command is given by the user and send signals to flight controller. The flight controller can control the motors to get desired output**.**

Fig.15 Radio Control Receiver

Telemetry:

The telemetry kit is a hardware transmitter receiver system that allows an Android device to connect to the UAV and act as a Ground Control Station. Using 2-way communications live interactive display of flight data called Telemetry information makes and the ability send commands to the UAV to generate missions and tasking's. The Ground Control Station (GCS) uses the operators existing Android mobile phone or tablet via a local Bluetooth link monitor flights or planning and executing missions.

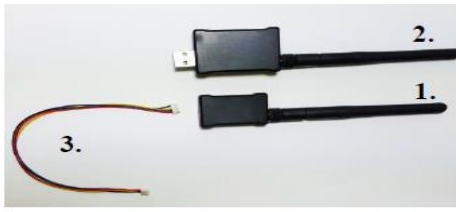

Fig.16 Telemetry

Cargo handling mechanism:

An impactive type of gripper used claws like fingers whose opening and closing is controlled by a servo motor. This servo motor is powered by the DC power. we can give the signals by radio controller for rotation either clock-wise direction or anti-clock wise direction.by using this mechanism we can hold and open the the product while delivering the product.

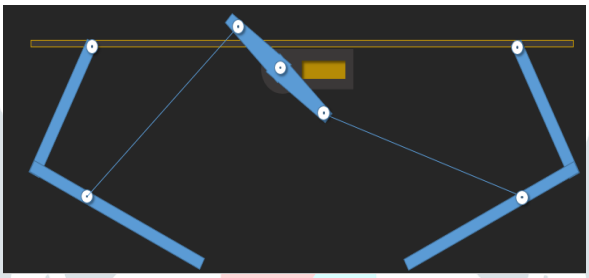

Fig.17 cargo mechanism

Fig.18 cargo handling system

GPS Device.:

A new generation Ublox GPS NEO-M8N, with low power consumption and high precision, the ultimate accuracy is 0.6 meters, actually almost 0.9 meters, greater than the previous generation NEO-7N 1.4-1.6 meters accuracy, support GPS/QZSS L1 C/A, GLONASS L10F, BeiDou B1 protocol, and mode or more.

Fig.19 GPS module

Camera

Since GPS cannot be used for position estimation indoors a simple web camera is used for position estimation. The camera is mounted underneath the hexacopter facing downwards towards the ground and the cameras used in photography are usually high end, costly and heavy. Also they have inbuilt storage media or a slot for external storage devices like memory cards. The FPV cameras on the other hand are light in weight, small, comparatively cheaper and don't have any sort of storage media. Their sole purpose to capture video to convey the visual data in front of them.

Fig.20 camera

Video Transmitter (Vtx)

Fig.21 FPV Audio Video Transmitter and Receiver

An FPV camera can capture the video of the objects in front of it but it cannot relay them to a receiver or ground station on its own. So a video transmitter is used to convey the data from the camera to a receiver. There are two standard protocols for FPV video transmission in the world. They are NSTC and PAL. Before setting up, it is essential to identify the correct local protocol. In India, PAL encoding is followed.

Real–time working:

Set up Calibration

Set up calibration illustrates the interconnections of various hardware components used in hexacopter. Firstly, program is uploaded on flight control board using mission planner Software and then some motor arming routine is followed as illustrated in flow diagram shown in following figures.

ESC's Calibration*:*

ESC calibration varies with the brand of ESCs used in hexacopter. The calibration of ESC is done on priority basis with the help of a radio system for each rotor and corresponding ESC. It includes the following steps as follows:

- First upload the program on controller board, then turn ON the transmitter and put the throttle stick to its maximum.
- Now connect the battery, The auto pilot's red, blue and yellow LED will light up in cyclic pattern that indicates ESCs are ready for calibration mode.
- By keeping transmitter throttle stick high, disconnect and then reconnect the battery.
- Regular no of beeps on transmitter indicates the battery cell count and additional two beeps specify that maximum throttle has been captured.
- Now set the transmitter throttle stick down to its minimum position.
- ESCs should now emit a long tone that indicates minimum throttle has been captured and calibration is complete.

There are basic steps to using a Telemetry kit to monitor the UAV, plan missions and activate missions.

- Power the hexacopter then connect the Ground station radio and connect using the tower app
- Configure waypoints
- Send mission to hexacopter
- Activate mission and monitor hexacopter

Select the Waypoint tool select a starting location on the map where you want to start the hexacopter. In figure The starting point for the mission is depicted as point 1 in the green circle Now tap to add waypoints passing over the 4 troughs taking note that the troughs are not all in a straight line. See waypoints 2,3,4,5. Now that the mission is set to fly over the area of interest you can even program it to land in a safe area. Place waypoint 6 in an open area free of obstacles then at the bottom of the screen select the green tab representing waypoint 6. A blue square will appear with information allowing you to configure the waypoint.

Fig.24 Placing the way points

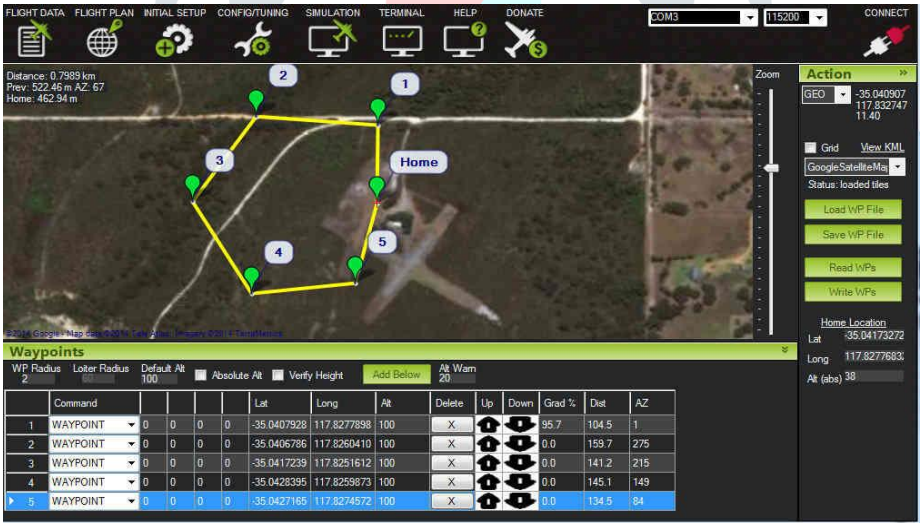

Fig.25 Selecting the way points on mission planner software

To receive flight data, you only need to have the telemetry kit connected. You will be able to see the location of the hexacopter and a line to indicate where it has gone. For detailed data a tab of current telemetry information can be seen by swiping from the right of the screen (as seen right and on page 8) and from this tab you can see the Artificial horizon, numerical compass bearing, tit and roll angle, speed and altitude

Fig.26 Passive flight data

Before we start the take of hexacopter we can hold the product by placing the cargo handling mechanism as shown in figure. The cargo mechanism is connected to servo motor when we can give signal to servo to open the the motor will rotate clock-wise direction to some angle and we can place the product in cargo and give signal to servo and it rotate anti-clockwise direction and hold the product.

Fig.27 Hexacopter hold the product

The product is delivered to the consumer based on barcode (every barcode has its own address based on latitude & longitude). The scanner in the UAV, scan the barcode and fix the destination with the help of GPS and also it can track its current position and to control it with the help of Android Apps through satellite control. Finally, the acknowledgement is send to both consumer as well as supplier through GSM. The final shape of the cargo delivery hexacopter as shown in figure.

Fig.28 Final product of hexacopter

CONCLUSION AND FUTURE SCOPE:

Conclusion:

In this Paper we have presented the Autonomous hexa-copter for the product delivery Purpose using mission planner Software. Nowadays Many New technology has implemented on the UAV and it mostly used for Military, Navigation and Civilian Purposes. By using the Autonomous UAV we can greatly reduce the need of labors in commercial purposes. The Autonomous UAV with the help of GPS to find its location and deliver the product. The Barcode may be generated using software and interfaced with the hexacopter with Scanner will deliver the product successfully. Android application also helps to find the Latitude Longitude and Distance of the UAV.

Future Scope:

Our team goals were to fabricate and cargo delivery of a hexacopter. With the increasing advantages of multi-rotors more improvement can be done in this field. Multi-copters with more battery life can be developed which will remain in air for longer time. Weight of the copters will be reduced to make it more efficient and reliable. Voice command can also be added to make it more sophisticated. They can work in the remote areas where man could not be able to reach and thus makes much hazardous work to be easy There are various possible up-gradation in future based on its application which includes:

- Adding a sonic sensor module to controller board for more accurate altitude determination.
- Implementing a GPS module on kit for tracking & spy based applications.
- This design can employ Motor Driver of high rating or Relay driver can be used for its commercial applications.
- Can be used for real estate photography by employing camera on it. Other applications includes inspection, surveillance and monitoring a wide area by camera equipped quadcopter.
- Pesticides sprinkling.
- Based on the weight lifting calculations we can use our single economical hexacopter to lift these different modules satisfying the weight lifting criteria.

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