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Design and Development of Flood Relief Hexacopter

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Abstract— During the time of natural disaters like Flood, people are left stranded with little or no resources for their and their family's survival. Especially in a country like india which is very densely populated, it becomes difficult for rescue personell to cater to evert nook and corner of the affected area. Our hexacopter can help the ground rescue personell to judge the extent of damage and also to supply the stranded people with essential resources until proper rescue and resources from the government can reach them.

Index Terms— Disaster management, Drone, Essential resources, Floods, GPS, Hexacopter, Rescue, Unmanned ariel vehicle.

1 INTRODUCTION

As it is a very well-known fact that India has been facing lot of trouble due the Floods. Almost 13 states in India have been greatly affected by it. Some states to name are Mumbai, Kerala, Bihar, Chennai, Assam and Karnataka. The death toll being lakhs, all the states put together. We humans will never be able to stand against the wrath of mother nature. But we can definitely do something to help people to overcome the drastic after-effects of the disaster. So, as engineering students of India, we have come up with an innovative way to make use of drones to help people during these hard-times [1].

Our main objective is to supply resources to people stranded in their building or houses with a Hexacopter, where it would be difficult or close to impossible for rescue personnel to go.

It will also be used to assess the damage done using aerial footage of the entire affected zone, which would help us to dispatch the rescue personnel to the exact location with the necessary equipment's for the rescue, rather than reaching the location with no or wrong equipment's. It is a matter of life and death [2].

Our concept is to help disaster affected people by supplying them with resources, as the availability of resource during these times are extremely low. As we have seen during the Chennai floods, people usually gather up on the roof of their house or the apartment building they reside in, to stay away from the rising water level. So, our idea is to supply these people with the Essential goods to help them survive the calamity, or until help from the government arrives. They type of goods we would be able to supply are couple of bottles of water, biscuit packets, glucose powder, sanitary napkins for women, bandages and if necessary 2 life jackets [3].

The above-mentioned items will be attached to the Hexacopter using a bag or a nylon net and will be dropped on the roof buildings using a specially designed servo motor. The servo will be operated using the remote controller. We are expecting a flight time of approximately 15 minutes with zero payload and approximately 8 minutes on full load. Multiple batteries will be available to swap for continuous supply [4].

The Hexacopter will be controlled using a flight radio controller and a,

FPV [First Person View] Goggle.

The FPV goggles not only helps the pilot to navigate and drop the payload at the precise drop point, it will also help us understand the amount of damage occurred due to the floods, and to find people in danger and what kind of equipment's will be needed for the rescue.

And this information will be transferred to the search and rescue team, and further action can be initiated.

2 METHODOLOGY AND WORKING

2.1 TECHNICAL DETAILS

Since we are designing a "HEXACOPTER", the drone will be flown with 4 BLDC [Brushless Direct Current] motors. There is a specific formula that is used to calculate the thrust of the motors used in the drone. The present weight of the drone without the payload is approximately 2000 grams.

The payload planned to achieve is approximately 2500 to 3000 grams. Thus, using the formula, we get a thrust requirement 900 to 1000 grams of thrust per motor. The motors will be powered by 6000 mah 3S lipo battery. The motors are connected to the flight control module using 6 electronic speed control modules. The drone will also be equipped with a GPS system.

Which will help the the drone to return to the take-off location if the battery is low or the payload is dropped. The frame of the hexacopter will be specially designed frame which will have 6 points for the motors to be mounted and will have an integrated power distributor board.3 out of the 6 motors will be clock-wise motors, while the other 3 motors will be counter clockwise motors. The propellers will be fixed according to the direction of the motor. The Electronic speed control module will be of 30 Amp each [5].

The receiver that will be used to control the drone would be a 2.4G 6CH PPM RC Transmitter. It will be used along with the FS-iA6B Receiver. The propeller used on the drone will be a 10x4.5 propellers. A total of 6 will be used, out of which 3 will be clockwise and 3 will be counter-clockwise. The drone will also be controlled by an FPV Goggle [6].

The pilot can wear the Goggles and can control the drone using first person view. The FPV Goggle will be connected to the drone using a dedicated radio transmitter which will be placed on the drone. The payload will be dropped using a specially designed servo motor with an opening claw type mechanism, which will be operated using the radio transmitter mentioned above [7].

The drone will also be equipped with a FPV High Definition camera which will be connected to the FPV goggles using the dedicated radio transmitter through any one of the channels, providing live footage to the pilot.

2.2 METHODOLOGY

1) Selecting Hexacopter Frame: The Hexacopter frame chosen by us was based on the motors being used and weight the drone will be built to carry.

2) Selection of Motors: The motors selected for this drone was selected based on the thrust calculations done. Keeping in mind the weight of the payload and the drone itself, motors capable of generating 1500 grams of thrust will be used.

3) Market Survey: Our Entire team had visited most of the major mechatronic establishments in the city to check for the availability of parts.

4) Purchasing of Required Parts: The Parts according to the decided and finalized specification are purchased.

5) Assembly: The parts of the drone were finalized and purchased with the complete satisfaction of all the team members and was assembled by us.

6) Tweaking: After the assembly of the parts, there were many minor and major adjustments done in order for the drone to perform according to the specifications it was designed and built for.

7) Demonstration: the final Output is showed to the coordinators and the Working of the same is demonstrated.

2.3 COMPONENTS

FIG 1 HEXACOPTER FRAME

FIG 2 TRANSMITTER

FIG 3 FPV CAMERA
CONTROLLER

FIG 4 FLIGHT

FIG 5 PROPELLER

FIG 6 BATTERY

FIG 7 RADIO RECEIVER

FIG 8 GPS

FIG 9 BLDC MOTOR

FIG 10 ELECTRONIC SPEED CONTROLLER

FIG 11 FPV GOGGLES

FIG.1 IMPORTANT COMPONENTS OF HEXACOPTER.

2.4 FUNCTION

1) HEXACOPTER FRAME:
This F550 Hexa-Copter Frame is made from Glass Fiber which makes it tough and durable. They have the arms of ultra-durable Polyamide-Nylon which are the stronger molded arms having a very good thickness so no arm breakage at the motor mounts on a hard landing. The arms have support ridges on them, which improves stability and provides faster forward flight (Fig.1).

2) TRANSMITTER:
ADrone Radio Transmitter is an electronic device that uses radio signals to transmit commands wirelessly via a set radio frequency over to the Radio Receiver, which is connected to an aircraft or multirotor being remotely controlled. In other words, it's the device that translates pilot's commands into movement of the multirotor. A Drone Radio Transmitter transmits commands via channels. Each channel is an individual action being sent to the aircraft. Throttle, Yaw, Pitch and Roll are the four main inputs required to control the quad. Each of them uses one channel, so there is minimum of four channels required. Every switch, slider or knob on the transmitter uses one channel to send the information through to the receiver (Fig.1).

3) FPV CAMERA:
The FPV camera is mounted onto a drone to send real time video down to the ground using a video transmitter. The FPV camera allows you to see where the drone is flying and what it is seeing as if it had its own eyes.Depending on the drone, the FPV transmitter will send the live video signal to your Remote-Control screen, monitor, smartphone device, tablet or FPV goggles.FPV cameras allow you to fly higher and further with some of latest drones being able to fly up to 5 miles away using FPV technology. Military drones or large high-end drones can fly thousands of miles using FPV technology (Fig.1).

4) FLIGHT CONTROLLER:
The flight controller interprets input from receiver, GPS module, battery monitor, IMU and other onboard sensors. It regulates motor speeds, via ESCs, to provide steering, as well as triggering cameras or other payloads. It controls autopilot, waypoints, follow me, failsafe and many other autonomous functions. The flight controller is central to the whole functioning of the UAV (Fig.1).

5) PROPPELER:
There are two types of propeller used in the building of a drone. They are as follows (Fig.1):

A. Standard Prop
The "tractor" propeller are the props at the front of the quadcopter. These props pull the quadcopter through the air like a tractor. While some drones like the DJI Phantom look more or less the same from any angle, there is a front and back.
Most drone propellers are made of plastic and the better quality made of carbon fiber. For safety, you can also add drone prop guards which you need especially if you are flying indoors or near people.
Propeller design is an area where there is plenty of new innovation. Better prop design will assist in a smoother flying experience and longer flight times. There is also some big innovation towards low noise uav props.

B. Pusher Prop
The Pusher props are at the back and push the UAV forward hence the name "Pusher props". These contra-rotating props exactly cancel out motor torques during stationary level flight. Opposite pitch gives downdraft. These can be made of plastic with the better pusher props made from carbon fiber. You can also purchase guards for the pusher props.

6) BATTERY: The battery used for any drone is usually a Lithium Polymer battery. A lithium polymer battery, or more correctly lithium-ion polymer battery (abbreviated as LiPo, LIP, Li-poly, lithium-poly and others), is a rechargeable battery of lithium-ion technology using a polymer electrolyte instead of a liquid electrolyte. The density of energy in a lipo battery is higher than normal batteries. More energy can be given out by a smaller battery compared to a bigger normal battery (Fig.6).

7) RADIO RECEIVER:
A Radio Receiver (Fig.7) is the device capable of receiving commands from the Radio Transmitter, interpreting the signal via the flight controller where those commands are converted into specific actions controlling the aircraft. Radio Receivers can have the following features:
• Telemetry (sending data back to transmitter)

• Redundancy function (two receivers connected together, if one loses connection, second one takes over)

• Easily removable antennas (more convenient with connectors if antenna is to be replaced).

8) GPS MODULE:

The GPS module (Fig.8) often combines GPS receiver and magnetometer to provide latitude, longitude, elevation, and compass heading from a single device. GPS is an important requirement for waypoint navigation and many other autonomous flight modes. Without GPS, drones would have very limited uses.

GPS stands for Global Positioning System. It is an American standard which provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.

9) MOTOR:

Practically all the latest drones use a brushless electric DC type motor, which is more efficient, more reliable, and quieter than a brushed motor. Motor design is important. More efficient motors save battery life and give the owner more flying time, which is what every drone pilot wants (Fig.1).

10) ELECTRONIC SPEED CONTROL MODULE:

An electronic speed controller or ESC is an electronic circuit with the purpose to vary an electric motor's speed, its direction and possibly also to act as a dynamic brake. It converts DC battery power into 3-phase AC for driving brushless motors. Electronic Speed Controllers are an essential component of modern quadcopters (all multirotors), which offer high power, high frequency, high resolution 3-phase AC power to the motors in an extremely compact miniature package (Fig.1).

11) FPV GOGGLES:

Drone FPV Goggles or Screens are the devices used by pilots to observe the live video feeds being transmitted from their quadcopters. FPV viewing devices come in a variety of sizes, feature sets, and price points. It is crucial to choose an FPV viewing device fit for application very essential (Fig.1).

2.5 Payload Dropping Mechanism

Fig. 2 a) Servo drop Mechanism b) Iso view with jumper cable

A servo-based Payload dropping mechanism will be used to drop the payload from the drone. A servo-based mechanism was chosen because of the ease of use. The servo will be connected to the radio receiver in the drone and it will be connected to the flight controller with the correct channel with respect to the transmitter (remote controller). When the appropriate channel is triggered using the transmitter, the payload will release. In this case a metal rod will move back with the help of the servo Arm, which cause the Hook like structure to have no constraint under it, thus causing the package

attached to it to fall to the ground. But this mechanism only allows one package to fall at a time, thus requiring us to reload the payload every drop. But using several servos require several channels to function, thus requiring an advanced transmitter which will cost much more. So, we decided to use a single servo drop mechanism.

Using multiple servo mechanism will also increase the weight of the drone will reduce the payload carrying capacity of the drone. And also, multiple servos will use up more battery life for the working hence also reducing the overall flight time of the Hexacopter.

As the payload of the drone has been greatly limited to 1500 grams. The contents of the payload must be carefully selected in order to be productive and also have a safe flight. If the payload is increased beyond the drone's capability, then the drone will be unstable in flight which would cause a crash wasting the essential resources.

The payload contents are selected in a way where people will get food, water to drink, hygiene equipment and also to protect them from the elements. These products are limited to just the essential commodities. No luxury items. And also, these items will not take up much weight when put together which will make it easier for the drone to carry and drop it to people.

The payloads will be dropped with a net or a plastic bag. It will be dropped from a height of no higher than 20 feet. If dropped from a higher altitude than that, then the possibility of damage to the resources are high.

3 CALULATION

4.1 TO CALCULATE THRUST PER MOTOR:

• WEIGHT OF THE DRONE WITHOUT THE PAYLOAD
= **1500 grams/ 1.5 KILOGRAMS**
(Includes the Esc, Flightcontrol, Motors, Battery)

• WEIGHT OF THE DRONE WITH PAYLOAD:
= **4000 grams/ 4 KILOGRAMS.**

• REQUIRED THRUST TO PROPELL THE DRONE
= 2 [WEIGHT OF THE DRONE + PAYLOAD]
= 2 [1500 + 2500]
= 2 [4000]
= **8000 GRAMS OF OVERALL THRUST REQUIRED**

• THRUST REQUIRED FROM EACH MOTOR

= [Overall thrust required / Number of motors]
= [8000 / 6]
= **1333 GRAMS OF THRUST PER MOTOR**

4.2 TO CALCULATE FLIGHT TIME

• Battery Capacity = 5200 mAh 4s LiPo
• Battery Discharge = 80%
• Avaerage Amp Draw = 40 AMP
[we know each motor draws 1 amp to produce 100g thrust.]

• Our hexacopter is required to take 4000g to flight, each motor will have to produce 666g (666g = 4000g / 6 motors) of thrust in order to hover.

Then our hexacopter average amp draw is 40AMPS
(40AMPS =6MOTORS * 666G/100G)]

Thus, The hexacopter Overall flight time =
[(Battery capacity * Battery discharge /Average amp draw) *60]

= [((5200*80)/ 40) *60]

=**7.2 Minutes (with full payload)**

= **16 Minutes (without payload)**

With larger capacity battery, the flight time can be increased even further according to the requirement. But as we increase the battery capacity, the overall weight of the drone increases too.

4. PROGRAMMING AND CALIBRATION OF DRONE

Programming of a drone is very different for different types of flight controllers used. Some of the flight controllers need manual programming. Manual programming can be done through JAVA, Arduino, C++ and Raspberry Pi for Low level applications and programming. And python coding for high level and intricate applications.

The flight controller used by us in this project is an ardupilot flight controller. This is a modified Arduino mega based board. The ardupilot flight controller can be easily programmed with the help of easily available and easy to use software such as “mission planner software”.

The calibration of a drone controlled by such a flight controller is calibrated while it is being programmed. We should hold the drone and feed in information such as specifying the front of the drone and the back of the drone. And also help the computer understand the different positions of the drone by rotating and tilting the drone at different angles and save the data using the software. Battery can also be calibrated using this software.

Programming is done with all the propellers removed to keep the drone from taking off during the testing of the electronic speed control module.

Many other Flight controller such as the KK2.1.5 use manual programming which makes them a little harder to use for beginner drone pilots like ourselves. professional and long-time drone users can find this kind of flight control module more user friendly as manual programming makes a drone even more customized and can be programmed to do exactly what it is built to do.

5. Conclusions

By the end of this project, we expect to be of great help to the society. We think it is a great initiative to be using drone technology for the wellbeing of the people. Since what we are expecting to achieve is very much just a prototype.

We are looking forward to developing this project to increase the payload capacity and the range of the drone with full payload to at least 1 hour, with a payload capacity of 30kgs. This goal is highly achievable using powerful motors and with an octocopter design with 8 motors in place of 6. Motors with thrust capacity of 3000 to 4000 grams approximately.

In the future we look for adding a sophisticated GPS system. Using a GPS system, we can give the drones several missions to complete. We can give the drones certain commands for it to fulfil, so it becomes easier and quicker to assist people. This is done using the location information given to flight control module in the drone from the GPS module.Using GPS also helps the pilot to fly the drone, and if the battery of the drone fails or has drained out mid-flight, the GPS helps the drone fly itself back to the take-off location.Since we are looking to increase the payload and the range of the drone, we have to give equal attention to the batteries as well. We are looking forward to increasing the battery capacity to double or triple battery to increase the range.

The frame also will be modified from a plastic moulded modular frame to a fully CARBON FIBRE FRAME. Which will reduce the weight of the frame and increase the rigidity and stiffness.

We eagerly look forward to seeing our drones flying around the flood affected areas, helping people in distress in the future. On the flipside, we also highly wish there should never be a flood ever again which will put people in distress and trouble ever again.

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