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Design and development of Hybrid Drone

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***Abstract*:** *The authors have tried to put emphasis on the major design parameters of the hybrid drone system. Much effort has been spent on the materialselection of the system. Hardware design paramters, motor and electronic speed controllersystems, aerodynamics of the system, etc. are discussed in detail. The selection of components isdone on the basis of practical and theoreticalconsiderations. The availability of the components in the marketisalsokept in mind. If all the parameters are favourable and optimallyselectedthen the system canbeimprovised and customised as per the need of the situation in whichit has to beused.*
Keywords : *Aerodynamics, Controller Systems, Drone, Hybrid, Motor, HydrogenCell*

I. Introduction

The drone is an unmanned aerial vehicle which can be controlled from anywhere around the world. Drones can be classified into 2 types as rotary wing and fixed wing. The rotary wing denotes the drone which operates vertically just like helicopter while fixed wing denotes the drone which has propeller system just like airplanes. Typical drone consists of frame, motors, power source and communication system.Hybrid drone is nothing but a drone whose power source is fuel cell, which operated on hydrogen gas. Fuel cell is part which can produce electricity from chemical reaction of hydrogen and oxygen. The hydrogen is a future fuel as more research is going on the fuel.Drone can be used for various purpose like agricultural purpose, surveillance. The rotary wing drones generally have less operational radius while fixed wings have more operational radius. The rotary wings drones can be used specially for agricultural purpose and surveillance. They can achieve Vertical Take-Off and Landing(VTOL) in more stable condition unlike Helicopter[1]. The fixed wing drones are usedin military operations like surveillance and remote detonations.The material selection, electronic system as well as aerodynamics of the system is discussed in detail. The hybrid drone can be used for various purposes to ease the life of humans and to benefit the whole world.Our literature survey found that, B.O. Omijeh et.al. [1]The aim of this study was to create a drone capable of carrying out real-time inspection of pipeline facility and perform surveillance operation. This is achieved using special components and governing equations. Preflight and post flight tests are done which resulted that capabilities of the stated design were asymptotic in nature. B.O. Omijeh et.al. [2] Specified various materials preferred for drone frame. It stated the salient features of various material and their applicability to purpose. This study helped in deciding the best material for drone frame. G. Ononiwu et.al[3] described the design and implementation of aerial surveillance from a quadcopter for the purpose of search and rescue operation. This paper was aimed to design the compact, cost effective drone. The drone wasdesigned for total weight of 1.5 Kg. The URL addresses of the websites from which motor and ESCs are selected are mentioned.

II. Material Selection 1

The materials used for manufacturing of drone are as discussed below.

2.1 Wood(Balsa)

Wood is cheap and readily available material with good machinability. Balsa is type of wood used in aircraft construction are the making of fillets and low-density contourblocks in early ages. As it is porous in nature, it can get easily attacked by moisture if not handled properly.

2.2 Aluminium Alloys

Aluminium alloy is the lightweight material with one-third the density of steel. Aluminium has good corrosion resistance to common atmospheric conditions. Aluminium alloys retains its properties even in low temperature just like at high altitude makes it very important for aerospace industry. It has very poor vibration absorption capability hence vibration dampers should be placed to absorb the vibrations in case of drone motor.

2.3 Carbon fiber

Carbon fiber is synthetic, lightweight material with comparably high strength. When it is combined with resin forms a composite which produces parts that are extremely light and rigid. Thecarbon fiber parts are lighter and stronger than equivalent metal parts, hence used extensively in the aerospace industry. Although its cost is high it reduced weight of the drone considerably and hence reduce the required thrust. When carbon

fibers are cured with epoxy resins, they become highly resistant to water, fuel, anti-freeze, and solvents.

2.4 Carbon fiber reinforced plastic(CFRP)

Carbon fibers are separated in two parts matrix and fibers. Fibers gives the strength while matrix has work to hold the fibers together making it extremely strong and light weight. These are used in Micro air vehicles(MAVs) due to its high strength to weight ratio as the required weight is less and power also. Even the aerospace industry uses it in extensive percentage due to same property like Boeing Dreamliner has its wings set almost 50% made from it.

III. Design Specifications [1]

The parameters for the design are listed below in table 1 and appropriate components are chosen accordingly:

Table 1: Parameters of motor

Parameters	**Value**
Lifting thrust in N(total)	98.1 N
Weight(kg)	5kg
Power Source	Hydrogen fuel cell
Visibility	In clear weathers only

IV. Hardware Design Parameters [5]

4.1 Quadcopter frame

From the above material Carbon Fiber Reinforced Plastic provides high strength and it is light in weight. Although its cost is high it reduced weight if the drone considerably and hence reduce the required thrust.The body of quadcopter consist of three parts namely- frame, landing gear and gimbal. The frame is drilled with holes to reduce weight and maintain stability. The landing gears are used to lower center of gravity and hold stability while landing. The gimbal is used to hold the camera or other equipment. The overall dimensions of quadcopter are

4.2 Motor and Electronic Speed Controllers (ESCs)

The first step towards choosing the motor is to calculate approximate weight of the drone which is designed for approximate of 5 Kg.

Then the thrust produced will be considered. If this value is too little drone will not respond well or won't even lift up. On contrary if thrust is too much then drone will become too agile and hard to control. Hence optimum value of thrust to weight ratio has to be considered. For surveillance purpose it is taken as two and for acrobatic maneuveringhigher values of this ratio are considered.

Considering Thrust/Weight=2

Thrust= (Weight*2)…….(for 2:1 ratio),

Total Weight of drone=5kg,

Total Thrust produced by four motor = (5*2) = 10 kg = 98.1N,

Each motor will produce thrust =10/4 =2.5kg= 24.525N,

From the above estimate of thrust we can use EMAX GT 2826/06 TYPE 1090KV out-runner Brushless DC motor [6].

Table 2 Specifications of Motor[5]

COMPONENT	SPECIFICATIONS
Kv(rpm/v)	710
Weight	175g
Max Voltage	12.67V
Max Current	51A
Total length	28mm
RPM	7600

Therefore, mentioned motor when used with APC 14*7 propeller produces the thrust of 2500g which is equal to the theoretically calculated value for drone. Hence the selected motor is justified.

While selecting the Electronic speed controller (ESCs) , the current rating of the motor is considered.ESCs are chosen such that they can withstand the maximum current input of the motor. Hence, in above scenario we can consider using Hobbywingskywalker60 A UBEC Brushless ESC [7].

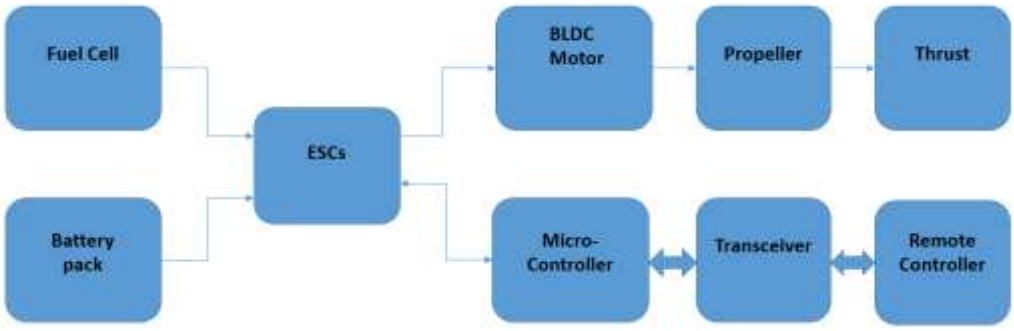

Fig 1: Block diagram of hybrid drone

4.3 Power extraction

Primarily, all the power requirements of the system will be provided by a fuel cell. It has to be selected or designed such that it satisfies almost all the power needed to drive the system.The weight: Power ratio should be brought down to the much possible extent for that we have to select the material which should have less density and stronger just like carbon fiber reinforced plastics. The shape of the fuel cell also needs to be designed carefully, keeping in mind the center of gravity and stability concepts which can affect the flight of the system to a great extent as buoyant force plays an important role in hybrid drone. Hybrid drone uses fuel cell to extract the power from the chemical reaction of hydrogen and oxygen. The variety of hydrogen cells are available in market ranging from 1kW to 2MW. The battery pack has less capacity.

V. Aerodynamics Of The System

Aerodynamics plays an important role for any self-propelled objects. It helps in reducing the resistances that are applied on the Body. The lift and Drag becomes very important parameters here. The lift can be generated by pushing upward Fluid (Air) downwards with the help of rotary moving Motors. While, The Drag can be generated with tilting of wings of Rotary Motor.This is not only the parameter that effects the aerodynamics, but Lift coefficient which is limited to 1, Coefficient of skin friction, density of air plays an important role in actual calculations. As we go higher and higher the air becomes thinner and makes speed of air also increases that can make Drone unstable. At such time Aerodynamic Resistance coefficient may rise up to 0.1 To avoid this we need to choose a low pitch propeller which makes less turbulence.To make it more stable the angle of attack of air on wings of rotary motor must be reduced making the air flow not to disrupt, if it happens so then this can create the back air to form an un-controllable draft creating a tilt.So to improve this we need to install an electronic sensor which can tilt rotors according to air speed and angle of attack

VI. Conclusions And Future Scope

From the literature survey, the CRPF is selected for the frame of drone which provides great strength and reduces the overall weight.Further the paper successfully calculated the thrust required for the propulsion of drone and suggested the motor which can provide that thrust. The fuel cell is suggested as an alternative power source to conventional lithium batteries. The camera can be fitted on the gimbal provided on the main frame making it suitable for surveillance purpose.The future is full of innovations in the hybrid technologies and Hydrogen has the potential to be the future fuel. These systems will always try to ease the life of humans and benefit the whole world with less environmental destruction. In future, the drones with high payload capacity can be used for the transportation purpose making it more efficient way of transportation.

Conflict of interest The authors declare that there is no conflict of interests regarding the publication of this paper.

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