International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 4 Issue 02, February-2015

Autonomous Onboard Power Generation System in Uavs for Long Range

Nijandan S,
Gokulakrishnan G,
Nagendra Prasad R,
M.Tech., Avionics Engineering,
School of Aeronautical Sciences,
Hindustan University,
Chennai, India.

Mr. Mahendran S. M.Tech.,
Mr .P. S. B.Kirubakaran. M.Tech.,
Assistant Professor,
School of Aeronautical Sciences,
Hindustan University,
Chennai, India.

***Abstract*— Endurance happens to be the primary challenge for manufacturers of unmanned aerial vehicles (UAVs), which play a key role in a wide range of commercial and noncommercial operations. Although there are onboard power generation systems existing for fixed wing UAVs. This project paper particularly concentrated about designing a mini power generation system to charge up the battery or to power up the avionics system of multi rotor unmanned aerial vehicles or remotely piloted vehicles' which is operated manually or autonomously. Basically the mini power generation system comprises of Brushless DC (BLDC) motor or Brushed DC motors coupled with each rotors of UAV which in turn acts as a generator to produce a sufficient amount of electrical energy fed into charge controller circuit with switch relays connected between main battery and backup battery which in turn required amount of supply is being used to charge the backup battery connected to the system.**

***Keywords*— Autonomous onboard generator, Drone onboard recharging, Long endurance, Onboard avionics power support, Power generation for multi rotor, Power generation, UAV power.**

I. INTRODUCTION

The area of Unmanned Aerial Vehicles (UAV) has been dominated by the aerospace industries. The reason for this can be attributed to the complexity and cost of designing, constructing and operating of these vehicles. In recent year's advancement in manufacturing techniques have placed the design and construction of UAVs in the domain of the commercial civilian user. UAVs are extremely well suited for the dull, dirty and dangerous tasks encountered in performing various applications. For these tasks the primary design considerations in the design of the UAV would be the propulsion system.

Unmanned Aerial Vehicles are ideally suited for long endurance applications, but to be able to make full use of this feature, effective power sources need to be developed to ensure the long endurance functionality of the propulsion system and onboard equipment. For a UAV the flight endurance is in direct relationship to the total weight of the aircraft. In order to maximize flight endurance the need for high density energy sources are created.

Autonomous Electric Aircraft using no Fuel (Unmanned Aerial Vehicle – UAV Propeller powered electric UAV takes off on batteries and actively searches for updrafts. After encountering an updraft the UAV switches of the propulsion electric motor and soars. Air passing through the propeller during soaring revolves it and the movement is transmitted to the electric motor. Electro motor works as a generator in this mode. The produced energy recharges batteries and powers the elect=ric equipment of the UAV. Energy gain is improved using solar power. The proposed UAV can stay aloft for long periods of time and can be used in reconnaissance and other applications. The control system of the UAV is responsible for autonomous behavior and for implementation of the human issued commands. Recent developments in battery and motor technology have seen an upsurge in the utility and performance of electric powered aircraft. Thus, the opportunity to explore hybrid-electric aircraft power plant configurations is compelling. This thesis considers the design of such a configuration from an overall propulsive, and energy efficiency perspective.

II. METHODLOGY

The problem is that a drone wears down the charge on a battery much faster than you can charge it from a charger. This has been the frustrating, but these problem has been overcome by now a hybrid power plant that hybrid engines are a popular and well-known product and have long been proven to be environmentally superior by auto makers, and most major auto manufacturers have some variation of a hybrid-engine vehicle on the road. Now we can say that your drone operation is no longer limited to the charge of its battery but by added generator system its battery will be recharged in flight. It is an easy to install, self-contained unit that mounts to your drone's frame and plugs easily into your drone's existing battery. It's that simple. But unlike a hybrid automobile, it can be adapted to any kind of multi rotor UAV the UAV will operate the same way it always has, except when the battery's output starts to drop to a low level, the system will start and makes the battery to charge. When the battery has recharged back up to strength, the system charges the other battery. Now the system allows you to go many times farther than with the on board battery alone.

III. PROPOSED SYSTEM

This proposed system consists of same procedure like what is being carried out in fixed wing UAV. But instead of using ICE and fuel tank, in multi rotor number of BLDC which is used in propulsion system the equivalent number of BLDC motor are used to design an Autonomous onboard power generation system. The motors and propeller are being placed in same arm opposite to each other.

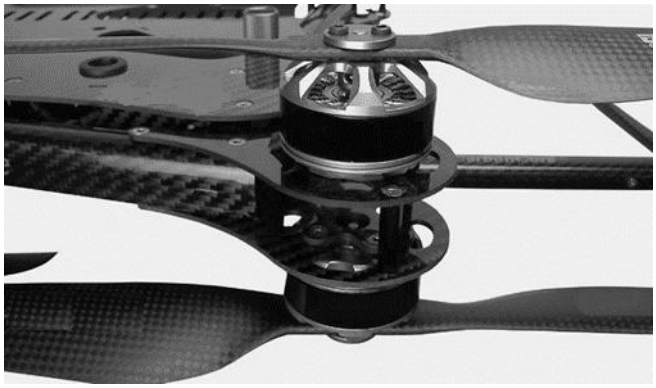

Figure 1. Motor Placement

Now the bottom motors is connected to the charging circuit, the charging system comprises of small charging unit of required specification which is also integrated with switch relay connected to the Arduino board which senses the battery voltage using voltage sensor integrated with the board and switch the circuit relay to the low voltage battery so that the system gets charged. Thus the cycle continues for each and every time when the battery gets discharged.

IV. DESIGN AND IMPLEMENTATION

This module includes the assembling of airframe and BLDC motors for the multi rotor. Motors have to be fixed and wired with ESC according to the clockwise and counter clockwise direction as shown in diagram.

Autopilot or stability board has to be placed in the center part of the frame to operate the motors at desired rotation. Once the designing of multi rotor frame is being done. Then the BLDC motors of required specification and the propellers attached to the main motor and the generator system motor facing opposite to each other of the main propulsion system.

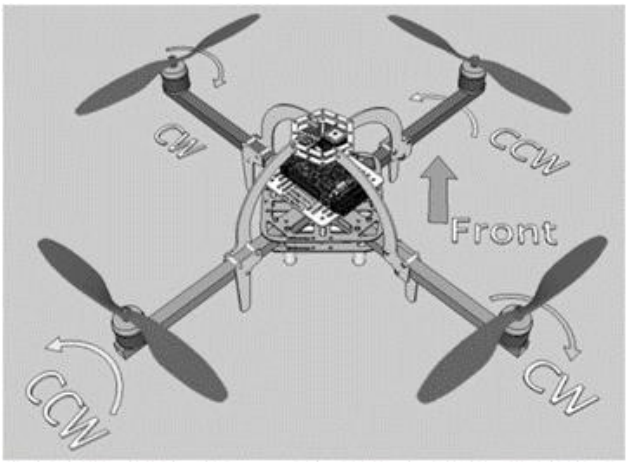

Figure 2. Airframe and Motor assembly

So that the subsystem to be designed has to be placed underneath the main motor propulsion system so that the way the thrust created by the propulsion system hits the subsystem motors and makes them to rotate. There the system is made compact as well as aerodynamic so that lift produced by the thrust makes the multi rotor to lift without any oscillation in the UAV.

Figure 3. Airframe and Motor assembly

V. CHARGING CIRCUIT

The charging circuit of the generator system consists of the connections from the output terminals of the motors of the generator system which has three terminals they are Power, Ground, and Neutral.

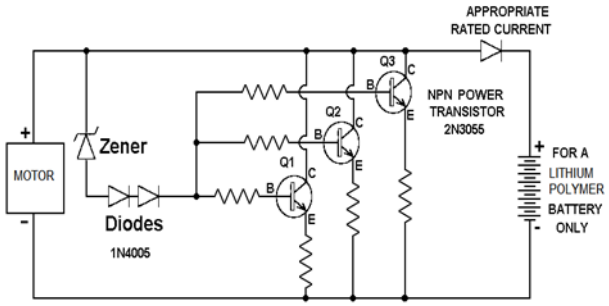

Figure 4. Charging circuit for the battery

In which the power and neutral from the motor is connected to the input leads of the circuit, but before that the connections from 4 motors are connected in parallel to sum up the current and series to sum up the voltage as like we required for our convenience so that after this process the charging circuit terminal is connected to the switch relay circuit were the Arduino is integrated with both the circuits to switch the supplying charge as per the connection are required. This happens to be the electronic part of the system.

VI. MODEL

Hybrid-electric aircraft power plant configurations is considered as the design of such a configuration from an overall propulsive, and energy efficiency perspective. A prototype system was constructed using a representative small brushless Direct current (BLDC) motor.

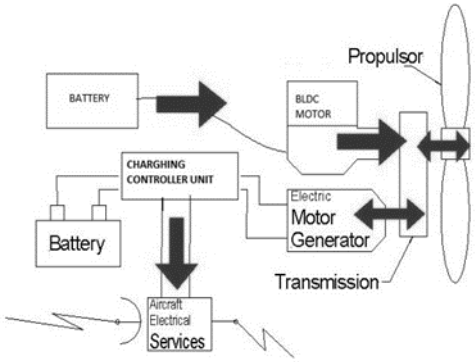

Figure 5. Model System

These components were chosen to be representative of those that would be found on typical small UAS. The system was tested on a dynamometer in a wind-tunnel and the results show an improvement in overall propulsive efficiency of 17% when compared to a non-hybrid power plant. In this case, the improvement results from the utilization of a larger propeller that the hybrid solution allows, which shows that general efficiency improvements are possible using hybrid configurations for aircraft propulsion.

VII. CALCULATION

This model calculation is done based on the charging and discharging time of the batteries according to the power consumed by the motor when they are in flight, first the discharging time is being calculated based on the

A. Specification

- 2 * 1500 KV Motors
- 2 * Motor suits to the main propulsion system
- Batteries 6000mah Backup Battery 3000mah
- 30 Amps Electronic Speed Controller
- Arduino mega 2560
- Wattmeter

6000 Mah battery ---- 15 minute flight time

Mah	=	milliamps per second per hour
Amps	=	milliamps / 1000
Amps	=	6000 / 1000
Amps	=	6.0 per second per hour

Reduction of time from 1 hour to 15 minutes will increase the amps by

4 = 60 / 4

6.0 * 4 = 24.0

Based on the battery mah and 15 minutes till battery dead we can assume that the drone is drawing a constant 24.0 amps load over that 15 minutes A compatible circuit for this size drone could generate 4 to 6 amps while running without Hybrid management.

For this calculation we will split the high and low amp output and use 5 amp charge rate total

Drone amp draw - circuit amp Output= Reduced draw with generator

To Calculate the increased flight time

Total draw minutes / circuit reduced draw reduced draw for a 15 minute period

Reduced draw for a 15 minute period * 15 minutes =New Flight time

This flight time may increase or decrease according to the mission or pay load which is being fixed in the multi rotor all this conditions are calculated only when there is no pay load condition for the system which is being flew in the air. And these calculations are made based on the theoretical values of the motors and batteries which are going to be used in the generator system. According to the system to be designed the main propulsion motor or the generator motor can be replaced for our convenience according to which the calculation has to be done.

B. Charging calculation:

Battery used for charging which is considered to be the backup battery is 3000 mah and discharge rate is 10c then the time required for the charging can be calculated as follows using the charging time formula.

Therefore the approximate time taken for the battery to charge is 0.5*60 secs = 30 mins

This charging time of 30 minutes is also calculated approximately and this time can be increased by increasing the current rate of the charging with safety measure to ensure that the system does not behave badly due to high current rating.

VIII. CONLUSION

The above paper have discussed about the building the most efficient propulsion and autonomous power generation system for the multirotor UAV using the BLDC motor and how the power is being generated according to the tie calculated which is being used in the system to check how reliable and applicable the system to the existing system. And my future works which has to be extended in such way that would provide a clear and vast knowledge about the system how it can be used or utilized such way to increase the endurance of the system in such efficient to make it applicable for all the multirotor unmanned aerial vehicles.

ACKNOWLEDGMENT

I wish to express my heartfelt gratitude to my parents, friends and well-wishers who have been the greatest support while I worked day and night for the project to make it a success.

REFERENCES

[1] Erturka.S. R. Antonb , D. J. Inmanb. (2009), Piezoelectric energy harvesting from multifunctional wing spars for UAVs, Active and Passive Smart, Structures and Integrated Systems, Vol. 7288.

[2] Guarino.P. L. Cascella, S. Stasi, M. Dassisti and M.Chimienti. (2014), Solar-Powered Ultra- Light Aircrafts: An Overview on Power System technology, International Journal Of Energy, Volume 8.

[3] Héctor Manuel González Vidales (2013), Design, Construction and Test of the Propulsion System of a Solar UAV, IJREAT International Journal of Research in Engineering & Advanced Technology, Volume 1, ISSN: 2320 – 8791.

[4] Jean Koster Cody Humbargar, Eric Serani, Alec Velazco Derek Hillery, Daniel Larrabee, Thomas Wormer, Joshua Marshman, Eric Petersen, Daniel Gaide. (2011), Hybrid Electric Integrated Optimized System (HELIOS) Design of a Hybrid Propulsion System for Aircraft, 49th AIAA Aerospace Sciences Meeting including the New Horizons Forum and Aerospace Exposition,Volume 12.

[5] Olivier Montagnier Laurent Bovet. (2010) Optimization of a solar powered high altitude long endurance uav, 27th International congress of aeronautical sciences.

[6] Recoskie.S (2009), Fahim. A, Gueaieb.W, Lanteigne. Hybrid Power Plant Design for a Long range Dirigible UAV, IEEE, Volume 19 issue 2, ISSN- 1083-4435, Page number- 606-614.

NIJANDAN S

I'm Nijandan S, studying Master Degree in Avionics engineering from Hindustan University. I did my Under Graduate in Electrical so I have special interest in dealing with avionic system of drones.

GOKULAKRISHNAN G

I'm Gokulakrishnan G, pursuing M.Tech - in Hindustan University with the specialization of Avionics Engineering. This paper shows that how much I'm crazy about drones. Also I have designed and fabricated many of fixed wing aircrafts as a hobbyist.

NAGENDRA PRASAD R

I' m Nagendra Prasad R, pursuing M.Tech - Avionics Engineering in Hindustan University. I know that in future UAVs are one of those who will rule the world. So, I decided to work in to this.