

Quadcopter with Bifacial Cells and Aerodynamic Design

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ABSTRACT: Generally, drones are used in respective configurations such as Hexacopters and Octocopters that have better stability and yaw where as flying time is limited. It's an area of conflict. Here an experiment on quadcopter type drone is conducted. In this experiment, bifacial solar cells are used and design of quadcopter is changed. Considering this design as the basis, improvement in flying time of quadcopter is calculated. Solar cells and its accessories have some weight but generated energy will sufficient to carry its own weight as well as provides surplus energy. This energy will enhance flying time and overall efficiency.

KEYWORDS: Quadcopter, Flying time, Aerodynamic design, Bifacial solar cell.

I. INTRODUCTION

In this type of drone or aquad rotor helicopter is a multi-rotor copter that is lifted and propelled by four rotors. All the four arms have a motor and a propeller at their end each. The lift is generated by a set of rotors and vertically oriented propellers. Such an arrangement is employed where reliability and flying time plays crucial role.

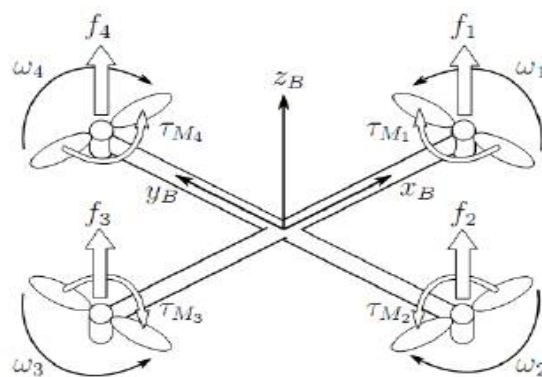


Fig. Structure of quadcopter

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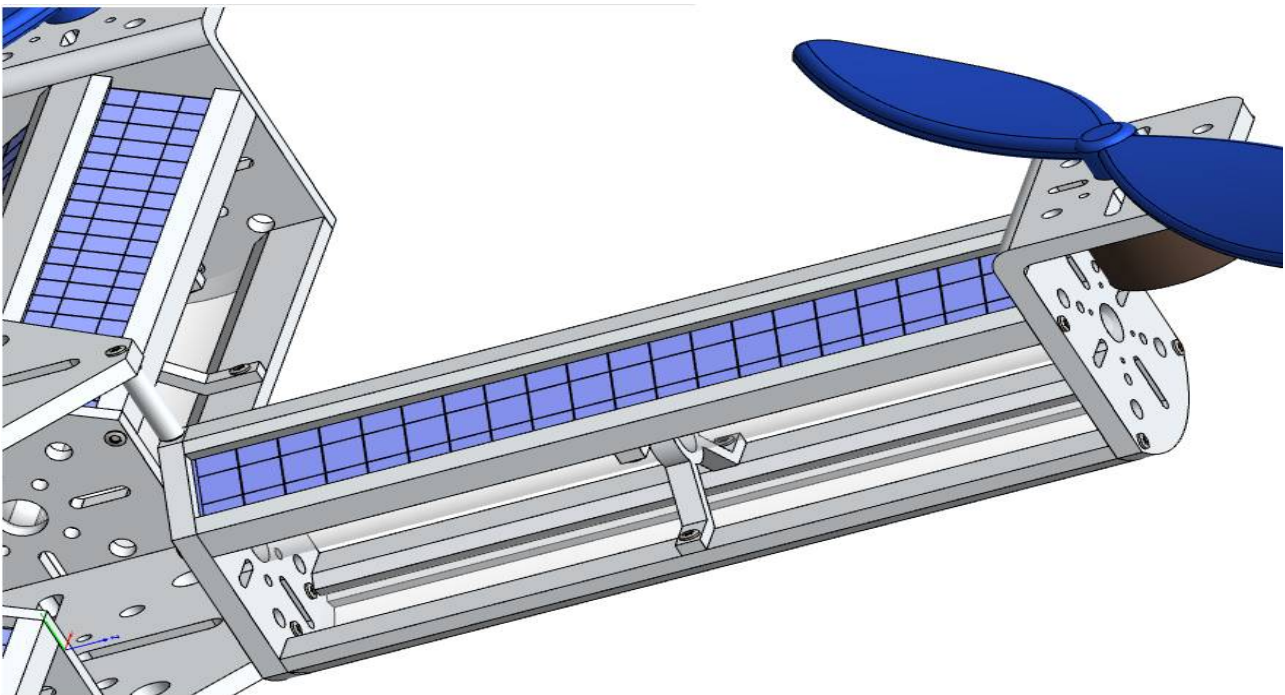
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II. CONSTRUCTION AND WORKING OF QUADCOPTER AS PER DESIGN

As per dimensions, A model of quadcopter was designed and calculated surplus power generation. The design of quadcopter with bifacial cell is shown in the below figure.



Serial No.	Parameter	Dimension
1	Frame	350 mm
2	Motor mounting	30 mm
3	Solar cell (L*W*H)	190*25*3 mm
4	Propeller	175 mm
5	Type of cell	Bifacial
6	Number of cells	8

Table: Dimension of quadcopter

III.CONSTRUCTION OF QUADCOPTER AS PER DESIGN

Quadcopter with bifacial cells are placed at 120° which collect higher amount of sun lights throughout the day as well as it diverts the flow of air while moving in upward direction. In addition, Curved glass at bottom of the arm provides 25-30% reflection which helps to hit rays on the back side of the cells. Construction are made from lightweight aluminium to reduce the weight as well as quadcopter have more thrust available than needed. However, higher thrust gives faster acceleration but it draws higher current and plummet efficiency. So, 2208 sized motor with 7" propeller is used to produce required thrust. Furthermore, solar cells generate direct current and connected in series to build up necessary voltage. Automatic voltage regulator circuit plays vital part to avoid fluctuations in voltage.

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Top and front view of new designed quadcopter is shown in below figure.

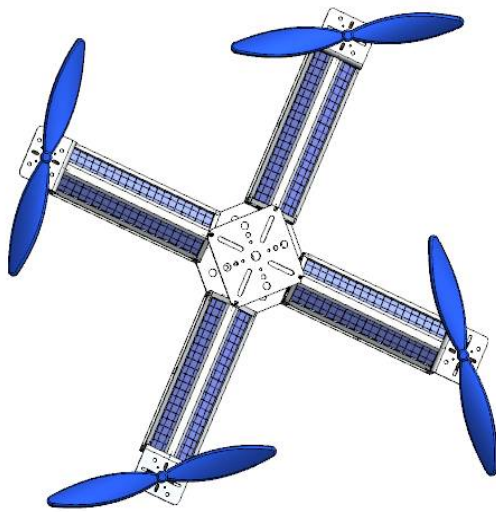


Fig 1. Top view of quadcopter

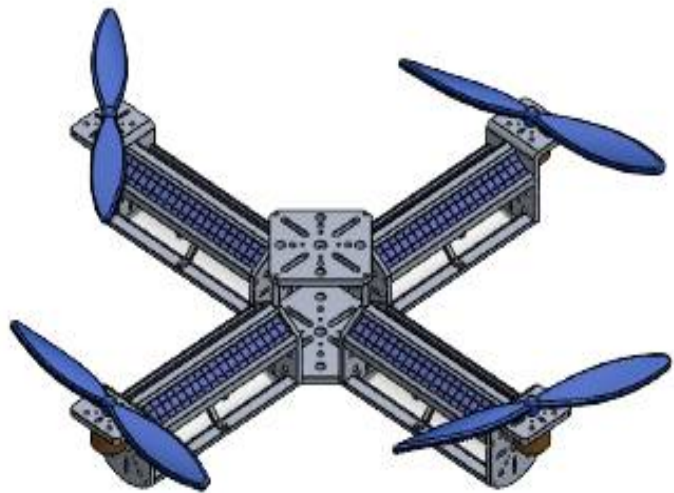


Fig 2. Top-Front view of quadcopter

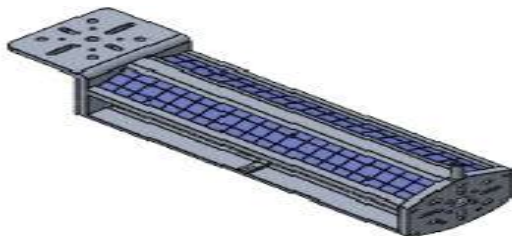


Fig 3. Top-Front view of single arm



Fig 4. Top-Bottom view of single arm

IV. WORKING OF QUADCOPTER AS PER DESIGN

First and foremost, Brushless DC motor works pretty much same as fan which push air down whereas all forces come in pairs and leads to air pushes up on the rotor. Size of the motor depends on various parameter like thrust, weight, efficiency and current drawing. BLDC motor generate required thrust but it draws high current from battery. Controller is circuit board with sensors which detects orientation on drone. It also uses to receive commands and control the motor.

In my design, laminated bifacial solar cells without frame is mounted on the top of quadcopter where solar rays' hits on both side of cells and produce 17-18.5% power on every side. Generated energy is in direct current form and regulated by automatic voltage regulator circuit to maintain constant power output to the sink.

Total weight carried by ordinary quadcopter is W_1 , requirement of thrust is N_1 and total power consumed is P_1 . However, in this type of quadcopter, total weight is increased to W_2 because of weight of solar cells. Its also uplift the need of thrust and power to N_2 and P_2 respectively.

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V. METHODOLOGY

At first, total area of solar cells and power generated by it will be calculated. Simultaneously, increased weight and demand of thrust is calculated and compared with ordinary one.

Total area of Solar cell (A, mm²):

$$\begin{aligned} A &= (\text{Length}) * (\text{width}) * (\text{Number of plates}) \\ &= 190 * 40 * 8 \\ &= 60800 \text{ mm}^2 \\ &= 0.060 \text{ m}^2 \text{ (single side)} \end{aligned}$$

According to manufacturers,

Power Generation of bifacial cell from front and back side is 245 W/m² and 200 W/m² respectively

Power generation by comparing with area:

Power generation from front side = 245*0.060

$$P_f = 14.7 \text{ W/h}$$

Power generation from back side = 200*0.060

$$P_r = 12.0 \text{ W/h}$$

Total power generation:

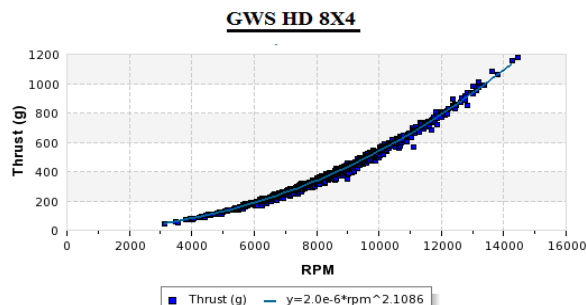
$$\begin{aligned} P_t &= P_f + P_r \\ &= 14.7 + 12 \\ &= 26.7 \text{ W/h} \end{aligned}$$

Total weight and Weight addition:

- 80-100 gm weight will be added in to ordinary drone
- 1.6-1.8 gm total weight approximately

Selection of propeller:

GWS HD 8X4 is best option to sustain that thrust with appropriate acceleration.



Individually, it requires 56 W to generate 420gm thrust.

It means 7.5 g/W

Power requirement:

$$\begin{aligned} P_{req} &= \frac{\text{Total weight}}{\text{Power requirement per gram}} \\ &= 100/7.5 \end{aligned}$$

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= 13.33 W

VI. CONCLUSION

After making this design and calculating power generation, it is concluded that, frameless bifacial solar cell has very less weight and it can produce energy. Generated energy can overcome its own thrust and feed surplus power to motor which can increase flying time.

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