DESIGN AND FABRICATION OF A SOLAR POWER UNMANNED AERIAL VEHICLE

1SUVANJAN BHATTACHARYYA, 2SUMAN CHANDRA, 3SUMANTA LAHA, 4SUBHAM SAHA, 5DEBDEEP CHATTERJEE

1,2,3,5Mechanical Engineering Department, MCKV Institute of Engineering, Howrah. West Bengal., India.
4Computer Science Engineering Department, MCKV Institute of Engineering, Howrah. West Bengal. India.
E-mail: suvanjanr@gmail.com

Abstract- Fundamentals of unmanned aerial vehicle has been designed and runs for quite a while. An approach that involving in designing aircraft to meet emission constraints while minimizing cost. These include the definition of the mission of the aircraft and various requirements, such as performance, handling, manufacturing, certifiability, upgradability, maintainability, and many others. Experiments have been carried out to assess the performance of the unmanned aerial vehicle which runs on solar power. The main objective of this paper is releasing mechanism where we can attach a load in the unmanned aerial vehicle and by the help of a remote controlled device we can drop the load anywhere. In addition to developing concepts, another objective is used in this aircraft as a surveying purpose. A high power lens (live steaming camera) is attached to capture images and videos of the survey field. This can help to detect the enemy in the defence purpose. A wireless remote control is used to fly the aircraft and a feedback battery indicator mechanics is also developed. A lithium 3 cell battery is incorporated with the system.

Keywords- Aircraft, Explosive Releasing, Sensor, Remote Control, Surveying Mechanism.

I. INTRODUCTION

The achievement of a solar powered aircraft capable of continuous flight was still a dream some years ago, but this great challenge has become feasible today. In fact, significant progresses have been realized recently in the domains of flexible solar cells, high energy density batteries, miniaturized MEMS and CMOS sensors, and powerful processors. The concept is quite simple; equipped with solar cells covering its wing, it retrieves energy from the sun in order to supply power to the propulsion system and the control electronics, and charge the battery with the surplus of energy. During the night, the only energy available comes from the battery, which discharges slowly until the next morning when a new cycle starts. Nevertheless, major interdisciplinary effort is necessary to optimize and integrate concepts and technologies to a fully functional system. As a matter of fact, the major issue is the combination and sizing of the different parts in order to maximize a certain criterion, for example the endurance, one parameter being the embedded payload. North et.al tells the history of solar aircraft, premises of solar aviation with model airplanes, on the 4th of November 1974, the first flight of a solar powered aircraft took place on the dry lake at Camp Irwin, California.

In artificial intelligence and related areas, it has become popular in recent years to use the term agent, possibly with adjectives to yield an intelligent agent or software agent. This paper pertains to a suspension and release device and more particularly to a device for carrying a store such as a bomb or the like on a vehicle such as an aircraft, and provided with means for positively ejecting the store from the suspension device. The need for a workable suspension and release device which will positively eject a store carried by an aircraft has become increasingly critical. When a bomb is released from a modern high performance aircraft the aerodynamic loads on this store may cause it to violently strike the aircraft structure before dropping away from the aircraft.

With the normal design of this type the suspension mechanism holds the store at the location of its mounting lugs and an ejector member engages the store at a position intermediate of the lugs. The ejector member may be driven by a suitable source of power such as a cartridge. Upon detonation of the cartridge it is intended that the ejector member will forcibly remove the store from the aircraft. Such a design has certain short. The conventional way of suspending and releasing stores such as bombs, mines, torpedoes, cargo pods, etc. from aircraft is to use a bomb rack alone or with a bomb ejector. When the bomb rack is used alone the bomb is adapted to be released, that is, it is allowed to drop from the aircraft by its own weight. When the bomb ejector is used in conjunction with the bomb rack, the bomb is forcibly ejected from the aircraft by the ejector after it is released by the bomb rack. The bomb rack is essentially a mechanism which contains one or more hooks which are latched to lugs which are fixed to the store. When a simple release of the store is desired, the hooks are remotely actuated by electro-mechanical means by a bombardier or pilot. These hooks are thereby caused to become unlatched from the lugs on the store and the
store is thereby released. On the other hand, when it is desired to forcibly eject the store from the aircraft, ejection is obtained by the use of a separate linkage which operates in sequence with the hooks of the bomb rack and serves to push the store away from the aircraft after the hooks are unlatched from the store.

II. BRIEF DESCRIPTION OF THE PRINCIPLE

Solar panels, composed by solar cells connected in a certain configuration, cover a certain surface of wing or other part of the airplane (tail, fuselage, …). During the day, depending on the sun irradiance and the inclination of the rays, the convert light into electrical energy. A converter, called Maximum Power Point Tracker, ensures that the maximum amount of power is obtained from the solar panels. This power is used firstly to power the propulsion group and the onboard electronics, and secondly to charge the battery with surplus of energy. During the night, as no more power comes from the solar panels, only the battery supplies the various elements. This is schematically represented on the figure below.

![Solar Panels Diagram](image)

**Fig. 1 Schematic representation of power transfer**

III. CONCEPTUAL DESIGN METHODOLOGY

Aircraft design is the name given to the activities that span the creation on paper of a new flight vehicle. The design process is usually divided into three phases or levels of design [Leland]: Conceptual Design Preliminary → Design → Detail Design. This methodology will only focus on conceptual design where the general configuration and size is determined. Parametric trade studies are conducted using preliminary estimates of aerodynamics and weight to converge on the best final configuration. The feasibility of the design to accomplish a given mission is established but the details of the configuration are not defined. One will also consider only level flight. Whether it is intended to achieve surveillance at low altitude or serve as a high altitude communication platform, a solar aircraft capable of continuous flight needs to fly at constant altitude. In fact, the first one would be useless for ground surveillance at high altitude and the second one wouldn’t cover a sufficient area at low altitude. In this case, the energy and mass balances are the starting point of the design. In fact, the energy collected during the day by the solar panels has to be sufficient to power the motor, the onboard electronics and also charge the battery that provides enough power to fly from dusk to the next morning when a new cycle starts. Likewise, the lift force has to balance exactly the airplane weight so that the altitude is maintained.

IV. THE RATIO OF LIFT AND DRAG

The ratio of Lift and Drag, have been describe in the fig. 2 that the glide performance of the craft at a given time. The more the value of L/D ratio the better would be the aircraft performance. For a non-powered aircraft, L/D ratio of 10-12 is preferred; whereas in case of a powered aircraft, L/D ratio of 6-8 is preferred. Lift is directed perpendicular to the flight path and drag is directed along the flight path and this is because lift and drag are both aerodynamic forces, the ratio of lift to drag is an indication of the aerodynamic efficiency of the aircraft. Under cruise conditions lift is equal to weight. A high lift aircraft can carry a large payload. Under cruise conditions thrust is equal to drag. A low drag aircraft requires low thrust. Thus the L/D ratio is also equal to the ratio of the lift and drag coefficients. The lift equation indicates that the lift L is equal to one half the air density ρ times the square of the velocity V times the wing area A times the lift coefficient C_l.

![Lift to Drag Ratio Diagram](image)

**Fig. 2. Lift to drag ratio (L/D Ratio)**

V. AIRCRAFT SYSTEM AND DESIGN ASSOCIATE

In the design task the key design variables have already been identified. This mission is for a prototype transport, so a key requirement is the releasing weight capacity. The mission has three key phases: a short, low-speed, ground level phase to test takeoff capability. For conceptual design, an aircraft just by a set of values for major aircraft design variables such as wing area, aspect ratio, motor size, etc. In the current implementation, the design goal is to minimize the takeoff mass of the aircraft. Takeoff mass is the sum of weight releasing mass, solar collector, etc which provides a rough approximation of the operating cost of the aircraft, and “motor” mass, which provides a rough approximation of the cost of building the
aircraft. Takeoff mass of a particular aircraft design for a particular mission is computed as follows:

1. Compute “dry” mass using historical data to estimate the weight of the aircraft as a function of the design variables and weight capacity required for the mission.
2. Compute the landing mass which is the sum of the motor reserve plus the “dry” mass.
3. Compute the takeoff mass by numerically solving the ordinary differential equation which indicates that the rate at which the mass of the aircraft changes is equal to the rate of energy consumption, which in turn is a function of the current mass of the aircraft and the current time in the mission.

VI. DESIGN AND SPECIFICATION OF THE BODY

To design of the aircraft first of all collect balsa wood and then cut into a shape proper dimension with tolerance. Then fine all of this edge into round shape properly by seer’s paper. Then join two side parts by rectangular types of balsa wood under this side part. Join them up to the tail portion. In the front portion of the body set a carom ply with some thickness and also give two balsa pieces into at the support of the front carom ply. Then add carom ply no. 2 in the middle portion and add carom ply no. 3 after some distance of carom ply no 2. after that keep they free to dry the join.

Then at wing assembly has taken four long piece of balsa wood with minimum 0.5 cm. thickness and approx 30 cm. long. Upward part create V shape by smooth paper and lower part create flat of the long piece of balsa wood, then set 19 spur at the same distance by the help of two rib. Join them properly. Make another part of wing at the same procedure. Then join them into V shape.

After that cover them by thick plastic material and iron it to crunch them properly, then the motor in the front ply and screwed them with the ply. After that two servo at the middle of the body and connect them at fin and elevator. Both the servo easily connects by thick copper wire. Set one servo at the top of the wing for connects the aileron. At last setting of the battery is very important. It can be set at the C.G. of the plane which is locate 1/3 of the plane body. Set the battery in proper place.

VII. IRRADIANCE MODEL

A good model of irradiance depending on variables such as geographic position, time and solar panels orientation.

The maximum irradiance Imax and the duration of the day Tday, which are depending on the location and the date, allows to compute the daily energy per square meter as depicted in Eq. In order to take into account cloudy days, a constant is added with a value between
1 (clear sky) and 0 (dark). This constitutes a margin for the calculation.

\[ E_{\text{day density}} = \frac{I_{\text{max}} T_{\text{day}} k_{\text{sol margin}}}{\pi / 2} \]

VIII. POWER BALANCE FOR LEVEL FLIGHT

The forces acting on the airplane during level flight are the lift L and the drag D defined as:

\[ L = C_L \frac{\rho}{2} S V^2 \]
\[ D = C_D \frac{\rho}{2} S V^2 \]

where \( C_L \) and \( C_D \) are respectively the lift and drag coefficients, \( \rho \) the air density, \( S \) the wing area and \( V \) the airplane relative speed which is similar to the ground speed if one assume no wind. \( C_L \) and \( C_D \) heavily depend on the airfoil, the angle of attack \( \alpha \), the Re number and Mach number. The drag coefficient is the sum of the airfoil drag \( C_{Da} \), the parasitic drag of non-lifting parts that will be neglected here and the induced drag \( C_{Di} \) than can be estimated by:

\[ C_{Di} = \frac{C_L^2}{e \pi AR} \]

where \( e \) is the Oswald’s efficiency factor and \( AR \) the aspect ratio of the wing, the ratio between the wingspan and the chord. From above Eq. one can find the power for level flight

\[ P_{\text{level}} = \frac{C_D}{C_L^{\frac{3}{2}}} \sqrt{\frac{m g^2}{S^3}} \]

Using the relation between \( S, b \) and \( AR \), one can rewrite:

\[ P_{\text{level}} = \frac{C_D}{C_L^{\frac{3}{2}}} \sqrt{\frac{2 AR g^3}{\rho}} \frac{m^3}{b} \]

Then, to obtain the total power consumption, efficiencies of the motor, its electronic controller, the gearbox and the propeller have to be taken into account, as well as the power consumption of the control and navigation system and the payload instruments.

IX. OPERATION AND CONTROL

All functions of a remote control are controlled by radio controller. A high focus lens camera is attached with 4GB memory card and it continuously records the video of the surveying ground. It has a radio frequency which is send to the receiver and the receiver distributes it to all electronics device. Receiver has three parts which is connected to the servo motor. The function of servo motor is to control the plane’s upward control, downward control, right and left direction control. The other part of the receiver is connected to speed controller. The function of speed controller is to control the speed of the main motor. Main motor is a brushless motor is a brushless motor and its speed is 1500-2000 rpm. A radio antenna wire is attached with the receiver which can collect the signal from radio transmitter. Speed controller has three parts, one port is connected to receiver and the second port or front port is connected to the main motor to control the speed and the back port is connected to battery. It has a 3-cell lithium battery. Battery is the power supply of the main motor and servo motors. The main thing is that the receiver collects the signal from radio transmitter and distributes it to all devices. Radio transmitter has four channels. First is connected to the motor devices. Radio transmitter has four channels. First channel is connected to the motor, by up-down the channel that can regulate the motor speed. Next fourth channel is connected to third servo motor. Second channel of radio transmitter is connected to the first servo motor, which can control the rudder. Third channel of the transmitter is connected to the third elevator and it can control the second servo’s mechanism. If the servo position changes from that commanded, whether this is because the command changes, or because the servo is mechanically pushed from its set position, the error signal will re-appear and cause the motor to restore the servo output shaft to the position needed. Almost all modern servos are proportional servos, where this commanded position can be anywhere within the range of movement. Early servos, and a precursor device called an escapement, could only move to a limited number of set positions.

CONCLUSION

The studies carried out in the past use different methods to determine future trends in aircraft performance and emission control. In this paper the prototype aircraft is designed and experiment has carried out in the to assess the performance of the aircraft. A high quality video was captured for surveying purpose. The major findings of this experimental investigation are that access of the aircraft on solar and there is no emission. It is better for environment and emission control and also another important finding is the releasing explosive mechanism from the aircraft.

REFERENCES


★★★