Solar Enhanced Electric Powered Self Stabilized Remote Controlled Unmanned Aerial Vehicle

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Abstract— In today’s era, RC planes are getting more importance due to their multi-functional and reliable performance. This project is solar powered autopilot self-stabilized radio controlled unmanned aerial vehicle. We have designed a system, reducing the percentage of plane crashes. Autopilot acts as the brain of the aircraft along with the eyes and ears (i.e. Sensors). The aircraft is to be maneuvered with the help of different servo motors, steering / regulating the control surfaces of the aircraft. The flight time is considerably enhanced using 13V mono-crystalline flexible light weight solar plates fixed on the wings. This allows on-board charging of batteries during the flight increasing the time of flight.

key words— Self Stabilized, Solar powered, Unmanned, mono crystalline.

I- INTRODUCTION

In today’s era, RC planes are getting more importance due to their multi-functional and reliable performance. This project is solar powered autopilot self-stabilized radio controlled unmanned aerial vehicle. We have designed a system, reducing the percentage of plane crashes. Autopilot acts as the brain of the aircraft along with the eyes and ears (i.e. Sensors). The aircraft is to be maneuvered with the help of different servo motors, steering / regulating the control surfaces of the aircraft. The flight time is considerably enhanced using 13V mono-crystalline flexible light weight solar plates fixed on the wings. This allows on-board charging of batteries during the flight increasing the time of flight.

II- PROBLEM STATEMENT

The ultimate goal of this research is to provide our companies with a well-documented and fully capable UAV research platform, including an autonomous UAV, a control design simulation, and a hardware in the loop simulation. The research platform will support a multitude of advanced guidance, navigation, and control research objectives. The problem statement has four parts. Part one, deliver a well documented, integrated and fully capable unmanned aerial vehicle system. Part two, accurately model the UAV’s physical, inertial, and aerodynamic characteristics for simulation. Part three, develop a three-degree of freedom simulation in Matlab/SIMULINK incorporating the developed UAV model. In addition, in part three, set up a commercial autopilot Hardware in the Loop simulation for testing and training. Finally, part four, demonstrate both the open loop and autonomous flight-testing capability of the UAV system. Part four also includes developing flight-test procedures and maneuvers to fully characterize the airframe and autopilot. Furthermore, the flight test results obtained in part four should be used to validate the simulation results in part three. Solar powered based fueled aircraft is fit for persistent flight these days. The examination exercises completed till now have been fundamentally centered around flying wings or ordinary flying machine designs, with an awesome accentuation on the innovative perspectives.

III- LITERATURE REVIEW

There is a cruciform wing structure for sun based fueled airplane having 28 solar cells mounted on even wing surfaces. This sun oriented plane is made of traditional outline for fuselage, tail and propeller. Sunlight based fueled aircraft is equipped for constant flight these days.

A self-sufficient model plane “Sky-Sailor” created by The Autonomous Systems Lab of EPFL3 very light weight sunlight based. The principle objective of this venture is to explore on route, control of the plane. The plane will be fit for a nonstop flight over days and evenings, which makes it suitable for an extensive variety of uses. Energy optimal way arranging and interminable perseverance for unmanned elevated vehicles furnished with sun oriented cells on the wings, which gather vitality used to drive a propeller. The force proportion is utilized to foresee the subjective components of the ideal ways. In the event that the force proportion surpasses a sure limit, ceaseless continuance is conceivable. There are the sun based planes which have an office to manage the vitality for flight amid day-night cycles. Near the Earth's surface, they are valuable for transportation and at higher heights; they are helpful for checking and estimation applications, along these lines they are focused by a few exploration gatherings and establishments [2].

There is the investigation's idea of neighbor planets around the earth [4-6]. The ground robots are utilized yet they have restrictions. Along these lines, a flying machine which uses sun's vitality for flying consistently is the methodology of hobbies thusly. The progression in this bearing was an undertaking of sky-mariner began in 2004. The point was to
concentrate on the likelihood of sun oriented controlled aircrafts in the air of those planets. There is the aftereffect of two years of chip away at this venture.

Mr. Hannes Ross has demonstrated an outline of the notable sunlight based fueled aircraft is given and the essential difficulties which must be illuminated for a sun based controlled aircraft. The objective of this is to "Fly with Solar Energy" to common or military observation and surveillance missions. In any case, none of those aircraft had the capacity to show a persistent day and night operation until 2005.

There is an examination and advancement of the model to the point of sending a flying machine to Mars (which forces size impediments) has been finished by Andr'eNoth, Stefan Leutenegger, Walter Engel, and Roland Siegart. They demonstrated the genuine ideas for planning sun based planes for diverse scales and mission. In view of this thought the configuration of Sky-Sailor, a little model unmanned aircraft that utilized for persistent flight at low height.

The configuration elements of fuel-less air vehicles and their affect ability to a few key execution measurements for this class of aircraft are talked about by Adam M. Wickenheiser and EphrahimGarcia in their paper. They contemplated flying machine with wingspans in the scope of 3 to 5 m and Reynolds no in scope of 5*105 to 5*106 is considered. New measurements demonstrate that are exceptional to a microwave fueled aircraft and are likewise valuable in the advancement of its missions. These measurements are identified with the aircraft's configuration, the vitality transmitted to the span and scope of the vehicle's missions.

Mr. Derek L. Lisoski and Mr. Mark B. Tischler has demonstrated a review of Pathfinder-sun powered airplane and its flight test system, with an investigation's percentage method utilized, and their outcomes. Upon the arrival of seventh July, 1997, the NASA Pathfinder sun based control aircraft travelled to an elevation of 71,500 feet, which is the new world height record for aircraft fueled by electric vitality and driven by the propeller. The Pathfinder stage, which is produced by AeroVironment for NASA's Environmental Research Aircraft and Sensor Technology (ERAST) system is an unmanned solar powered plane, which was the first of a progression of innovation demonstrators which are slated to incorporate the 100,000 ft elevation Centurion and Helios sun oriented aircraft.

As indicated by the examination diary Abbasi, An., Al-Saggaf, U. M., & Munawar, K. (2014). Unmanned Arial Vehicle (UAV) is commonly a minimal effort aircraft intended to execute missions that are costly or unsafe to be executed utilizing its opposite i.e. Kept an eye on a flying machine. Autopilot goes about as the cerebrum of the UAV alongside the eyes and ears (sensors). Autopilot has two noteworthy parts, framework programming and equipment. Freescale's MPC5644A is chosen as the primary implanted controller. A Ground Control Station (GCS) is likewise created utilizing National Instrument's Lab Windows CVI (Integrated Development Environment) for steady observing of UAV wellbeing and mission arrangement transfer.

As indicated by More and Kulkarni (2014), the sun following framework is created taking into account microcontroller. The microcontroller based circuit is utilized as a part of this framework with a base number of segments and the utilization of DC servo engines empowers exact following of the sun. In the wake of inspecting the data acquired in the information table area and in plotting chart, It has been demonstrated that the sun following frameworks can gather most extreme vitality than a settled board framework and high proficiency is accomplished through this tracker, it can be said that the proposed sun following framework is an achievement system for expanding the light vitality got from the sun. Consequently, usage of this method in building galaxies will incredibly enhance utility fulfillment.

Taking into account the above surveys, we might want to make a flying machine which is worked on sun oriented force. In this writing we have examined outlines of diverse sun oriented planes developed. Presently we will outline changed airplane which will take the short runway for departure. Furthermore, this aircraft will be absolutely self settling.

IV- IMPLEMENTED ALGORITHM AND METHODOLOGY

Step by step procedure designed to perform an operation, which leads to the desired results if followed correctly. Like other systems, our self-stabilizing system also required an algorithm upon which the design implementations of the aircraft were based. Following is the algorithm, implemented [1,3] and designed on our own for our aircraft project [7,9-10].
A. Components Required

The components required are:
1. RC Plane
2. Servos
3. Propulsion Motor
4. ESC
5. Battery
6. APM 2 .6
7. Arduino Kit
8. GSM
9. Gyroscope
10. Accelerometer
11. Barometer
12. Magnetometer

B. Type of Data Required

The data required is:
1. Coordinates
2. Altitude
3. PWMs
4. Roll
5. Pitch
6. Yaw
7. Errors

All the above data will be accumulated through appropriate sensors/components.

Main features of this are:
A) Self stabilization
B) Solar powered
C) Gsm interfacing

C. Self stabilization

For self stabilizing we basically need following

D. Design Model:

The project design is straightforward. The control surfaces of UAV are to be handled as per requirement. If we want to give roll, pitch or yaw to our UAV we have to control one of the control surfaces from aileron, rudder, elevator or throttle. The figure shows the project design:

In the aircraft, the high pitch results in low RPM of the propeller but greater torque required.

E. Basic Control Surfaces

There are usually three separate control systems and three sets of the control surfaces of an aircraft which control all the flights from takeoff to landing, namely [12-13];

a) The basic function of the rudder is to control in yaw motion.

b) The basic function of the elevator is to control in pitch motion.

c) Ailerons are used for control in roll motion.

These yaw, pitch and roll are very important for stable flight of the aircrafts.

For the movement of control surfaces in an aircraft, servo motors are used. But for the flying purpose of the aircraft, servo motors with propeller’s electric motor are required [11].
F. Sensor IMPU

The inertial handling, measuring unit (IMPU) is a solitary unit which gets precise speed and straight quickening information from the whirligig and the accelerometer. This information is sent to the fundamental processor for further estimations. Accelerometer generates three analog signals each defining the accelerations along its three axis which are acting on the body it is mounted. This sensor senses the gravitational accelerations acting on it.

G. Global System for Mobile communication (GSM)

Our solution provides communication over the GSM data network. This allows for true remote control beyond visual range. To fully accomplish communication between APM2.5 board drone and mobile phone we suppose to connect and integrate GPRS shield on APM2.5 board. We did Arduino UNO communication channel with GPS shield and mobile phone, but it was challenging to move everything on APM2.5 board. Firstly, GPRS shield requires 5V to work with. It was difficult to find the 5V pin also on APM board. Then we transferred Arduino UNO based implementation code to APM2.5 board, and all our physical values of rotation of motors and their angles on XY an YZ axis were obtained in the form of sms on mobile phone.

H. Solar panels.

Solar cells The solar cells should provide enough power during flight to extend flying range drastically or even power the aircraft entirely. Just as with all materials used on our plane, mass is a crucial element, so the solar cells can’t be too heavy. Cells are often being integrated in glass, something that would contribute far too much weight. Three solar cell types are in current use. They include amorphous solar cells, monocrystalline solar cells, and multicrystalline solar cells. We purchased 2 of the HX-3.5 W 150*150*3mm strips, which offer a decent power output at an extremely light weight, in a convenient & flexible package.

<table>
<thead>
<tr>
<th>Model</th>
<th>HX-3.5 W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum voltage (Vmp)</td>
<td>6.6V</td>
</tr>
<tr>
<td>Maximum current (Imp)</td>
<td>0.53A</td>
</tr>
<tr>
<td>Dimensions</td>
<td>150<em>150</em>3mm</td>
</tr>
<tr>
<td>Max power (Pmax)</td>
<td>3.5W</td>
</tr>
<tr>
<td>Open circuit voltage (Voc)</td>
<td>7.78V</td>
</tr>
<tr>
<td>Short circuit current (Is)</td>
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<tr>
<td>Maximum system voltage</td>
<td>1000 v</td>
</tr>
<tr>
<td>Test conditions</td>
<td>AM1.5 1000/m^2 25deg. C</td>
</tr>
</tbody>
</table>

I- MISSION PLANNER

Mission planner software was used to show the physical demonstration of the plane stability [8]. It is a type of GUI in which the rotation of the planes clearly visible.

Fig.8 Prototype Plane

VI- CONCLUSION

During the initial stages of the project, we were self-motivated. It seemed as if this project is impossible to do at the time of angle calculations in coding because slight changes in the angles sometimes caused great loss for us in the form of plane crashes in the first two three flights of our aircraft. We faced great problems, and some of them are listed:

1. Angles acquisition error
2. Yaw confusion
3. Loop timing
4. PWM Correction

But later on with the blessing of Almighty Allah, great and encouraging support from our families and friends and selfless help of our supervisors, we were able to design a solar powered self-stabilizing RC plane.

VI- BENEFITS

The aircraft designed in our project gets stabilized in seconds due to the effective coding, keeping in mind even the point differences.

Our designed aircraft is environment friendly because instead of using any petrol or gas engine for power supply which causes air pollution, electric batteries and solar panels are used.

Implantation of cameras on the aircraft can be useful for:

1. Surveillance purposes
2. Media coverage purposes
3. Video making
4. Online transmission of the areas destroyed due to natural disasters where cars and other vehicles could not reach in time.
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