Solar Unmanned Airplane for Continuous Flight

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Goals and Objectives

The goal of Solar Airplane is to develop an autonomous airplane that maintains continuous flight throughout day and night, powered by the sun. This will be achieved with advanced thin-film solar panels to power Solar Airplane during the day while charging a light-weight, high-density power battery bank for overnight flight. Solar Airplane is a proof of concept to demonstrate how solar renewables can revolutionize unmanned aircraft vehicles (UAVs). Potential uses for continuous unmanned flight include communication relays, surveillance, and unmanned search and rescue. To demonstrate this proof of concept, a Solar Airplane prototype of will be designed and fabricated at UC Irvine, and will circle over a set area and altitude for a 24 hour period. The coupling of solar panels and battery bank system will be tested both on ground and in air. Other tests will also be performed to find top speed and maximum attainable altitude. The final delivery will be the solar airplane prototype that successfully sustains a one-day flight.

Figure 1: Helios Aircraft Designed by NASA[2]

Introduction to Solar-Powered Flight

The Solar Airplane Project consists of two Aerospace Engineers, and one Mechanical Engineering Major with a Minor in Materials Science and specialization in Sustainable Energy Systems. Together, we will each direct one of three major aspects of the Solar Airplane: flight structure and aerodynamics, flight dynamics and controls, and power generation and storage. This project encompasses each of our respective talents and career aspirations.

Common Unmanned Aircraft Vehicles (UAVs) involve flying for extended periods, but are limited by gas tank capacity, or battery capacity. Solar Airplane proposes a solution to this: integrate the means of power generation *within* the autonomously flying aircraft. This project as a whole will demonstrate the applicability of solar energy UAVs in addition to the adaptability of thin film technology in a diverse array of systems.

Some key challenges of this system are maintaining a lightweight structure, programming autonomous in-flight control dynamics, ensuring overnight battery supply, and the solar panel-wing integration. As each of these systems affect the others, e.g. a heavier plane needs a larger battery which needs a larger wingspan, it will be critical to create a full system model to simulate both flight dynamics and efficiencies, and power performance. The below images are taken from *Design of Solar Powered Airplanes for Continuous Flight* by André Noth[1], who's Ph.D. thesis centered around autonomous solar-powered flight and design. This project was successful in flying across the Atlantic Ocean, continuously and autonomously.

Approach and Methods

Design Parameters:

Solar Airplane project goal is to develop cost-effective, infrastructure-independent continuous flight. The benefits of unlimited flight time extend to a wide range of applications, such as providing an effective and low-cost assistance to search and rescue, surveillance, and/or establishing communication relay. According to our calculations and estimates, these missions will require certain flight conditions: relatively low flight speed, altitude ranges from 5000 ft. to 30000 ft., one kilogram of payload mass and steady flight patterns. We will use these parameters as the starting point to develop the first draft of our design.

Since Solar Airplane will be operating at low velocity, the aircraft will take on the form of a glider. It will have a long rectangular wing with an airfoil shape optimized for high lift at lower speed. Rather than creating our own airfoil design and spend even more time testing its capabilities, we will select one from the NACA database with the appropriate lift to drag ratio. The wing span will be many times longer than the chord length of the airfoil, resulting in a high aspect ratio, ideal for increasing total lift generated at any particular speed. Furthermore, the rectangular wing design allows for ease of production, in terms of time and manufacturability.

A Combination of Three Systems:

The three major systems required for Solar Plane are: aircraft flight, control system dynamics, and power management. Each of these systems will be overseen by one of three engineers, Tri Luong, Sage Thayer, and Callum Lamb, respectively, and independently tested before ultimate integration into the final system. André Noth's Design of Solar Powered Airplanes for Continuous Flight provides a key reference for Solar Airplane. Throughout the design review, Noth provides a detailed guide to theoretical calculations and model-creation, in addition to manufacturing processes and outcome requirements. Solar Airplane will use Noth's work, in addition to other academic resources, to design, build, test, and ultimately fly a continuously, autonomously flying solar-powered airplane, adaptable to a wide variety of applications. See Figure 3 & 4.

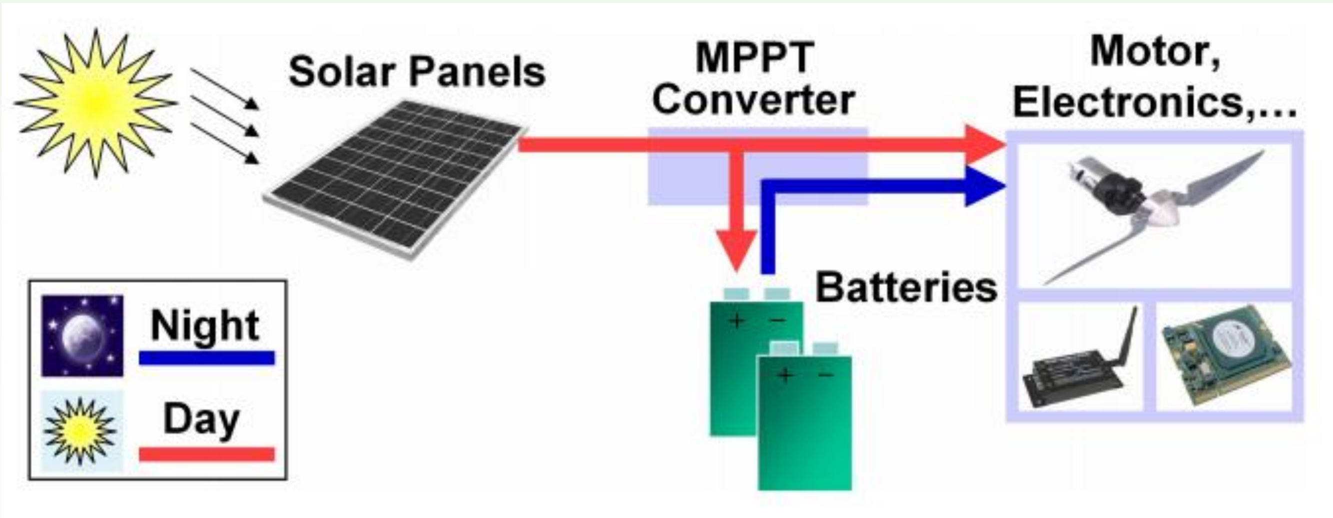

Figure 2: Integration of Power Management and Electronic Systems[1]

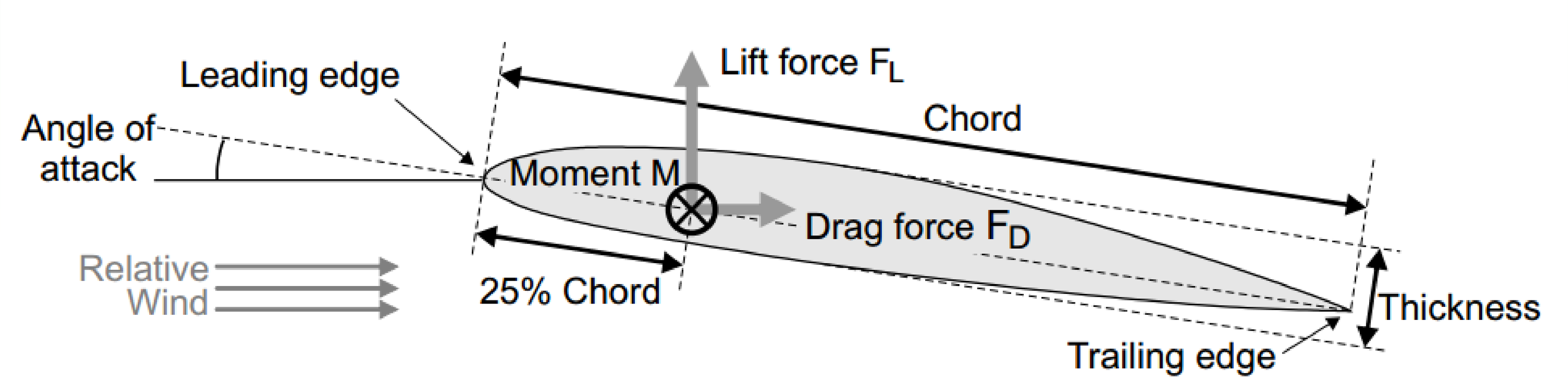

Figure 3: Air Foil Dynamics and Geometry[1]

Executive Summary

Solar Airplane will design and develop an autonomous airplane that maintains continuous flight throughout day and night, powered by the sun. Current Unmanned Aircraft Vehicles (UAVs) are restricted by flight length, making their uses, by definition, temporary. This critical component renders technological advancements such as providing internet access to a remote city via UAV virtually impossible. Solar Airplane will be designed to not only maintain continuous flight, but also carry a 1 kilogram payload, which will be used to mount technologies such as internet connectivity, thermal cameras for search and rescue, and high-definition cameras. The applications are effectively endless. Furthermore, Solar Airplane seeks to demonstrate the integration of thin-film solar technologies into diverse applications. One major barrier to solar technology is the medium by which it is provided. The vast majority of solar has served as an integration into an already-existing power grid. While this development is crucial to societal advancement and fossil fuel independence, Solar Airplane will demonstrate the diverse functionality that thin-film photovoltaic technology can offer to motile devices and systems.

Figure 4: Sky Sailor final construction[1]

References

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Company Support & Contact

The Solar Airplane Senior Design Project team at University of California, Irvine, is seeking donations from companies that would benefit from the research and design of this technology.

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