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Upcoming Trends in Solar Powered Multipurpose Drone

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Abstract: *This paper presents the upcoming technology in solar powered multipurpose drone which can over-come the short duration flight problems in on going technology due to use of continuous rechargeable batteries through solar energy. The light weight thin film flexible solar cell will be mounted on the top of the drone body. So, that the PV cell can directly absorb the solar radiation incident on the drone body and can use that solar power to continuously recharge the drone battery which can give the long-lasting flight to the drone.*

Keywords: Solar Cell, Agriculture, Forestry, Disaster Management, Carbon Free Delivery

I. INTRODUCTION

Any remote-controlled aircraft that flies without a pilot is considered to be a drone, otherwise known as an unmanned aerial vehicle (UAV). Under this definition, aircrafts that're considered drones include anything from small toy helicopters to larger surveillance planes used for military purposes.solar drones are defined as drones that use solar cells powered directly from the sun.The solar powered UAV would be able to collect and store solar energy by the sun to be used for the flight, and thus does not require returning to recharge (R/R) requirements [7]. Manufacturers looking to build solar drone products that will run as long as possible will typically look for the most lightweight solar solution (such as thin-film products), as the heavier the solar cells are, the more power it will take to keep the drone in the air. Ideally, these solar cells will also have as high efficiency as possible, given that drones will typically have limited surface space available to place solar cells[1] "Energysage",last modified January 7, 2019, accessed April 26, 2022, https://news.energysage.com/solar-drones-what-you-need-to-know/.

The Solar powered drone is the Nobel conceptwhich can be used in performing a broad range of civilian activities (e.g.,Deliveries, Disaster Management, Forestry, agriculture and others) and their usage is expected to keep increasing in the near future.The use of special types of solar cell(thin film solar cell) for reducing the weight and providing long duration flights, as thin-films solar cell has an external property of flexibility which makes easy to mount on the drone and has no complexity on construction of solar powered drone.The idea behind the solar powered flight is that the aircraft or airship has not to land for a very long-time span in order to get refuelled, because it generates the necessary energy with solar cells. Such an aircraft will be capable of a "permanent" or "eternal" flight, it will not produce any emission and will have less maintenance cost than conventional aircraft [10].

Technical parameters are implemented into the mathematical model reported in [11]. This model was used for the development of this research work. The Eq. 1, represents the power required for the UAV flight(P) where ρ represents the air density (kg/m3) considering the altitude of the flight, V is the cruising speed (m/s) which is considered quasi-stationary, i.e. the forces are neglected of inertia when establishing the balance forces, S is the reference area of the UAV (m^2), the drag coefficient with zero elevation CDo quantifies the resistance of the UAV in mid-air (dimensionless), W is the weight of the UAV (kg) [8].

$P = 0, 5.\rho.V^3.S. [CDo+ k.(2.W/ \rho.V^2.S)^2]$ … (1)

1.1 Types of Solar Drones

There are several types of UAV models, some of them use fossil fuels to convert the thermal energy in mechanical energy, other models use batteries. During the last decade, the development of photovoltaic technology has allowed solar cells to be included in the UAVs fuselage in order to receive clean energy from the sun [8].

There are several solar drone products that have been developed in recent years, or are currently in development. Here are some examples of solar drones.

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A. Sunbirds

B. The SB4 Phoenix

Sunbirds, a French company established in 2015, designs and sells solar drones that can travel for up to 10+ hours under ideal conditions. Their solar drones fly autonomously, but can also be controlled by remote control if needed. Sunbirds solar drones are equipped with cameras to use for mapping and aerial photography and come with a 1-year warranty for buyers[1] "Energysage", last modified January 7, 2019, accessed April 26, 2022, https://news.energysage.com/solar-drones-what-you-need-to-know/.

C. AeroVironment

D. The Helios Prototype

AeroVironment, a California-based company, is a leader in UAVs for defence and commercial purposes. In January 2018, the company announced a joint venture with Japanese multinational Softbank to build high-altitude long-endurance (HALE) solar drones for commercial purposes.

This is not the company's first entrance into the solar drone space; AeroVironment created a solar drone in collaboration with NASA known as the Helios Prototype, which reached an altitude of 96,863 ft in 2001. Though not AeroVironment's first time producing the technology, this new venture will the company's first attempt at building solar drones for commercial sales[1] "Energysage",last modified January 7, 2019, accessed April 26, 2022, https://news.energysage.com/ solar-drones-what-you-need-to-know/.

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Thin-film flexible solar cell for solar powered drones

Thin-film photovoltaic cells can use cheap glass, plastic, ceramic, graphite and metal sheets as the substrate to be manufactured by surface engineering methods. The thickness of the thin film that can generate voltage is only a few microns, which can save a lot of photoelectric conversion materials. It has the characteristics of flexibility and easy combination with structural materials, and has a wide range of uses. It is called the second-generation photovoltaic cell[2]"Analysis and Application of Solar Energy Characteristics" last modifiedNovember 17, 2021, accessed April 26, 2022,https://www.walnutsolarcar.com/characteristics-types-and-applications-of-thin-film-solar-cells.html.

1.2 Types of Thin-Film Solar Cells

The classification of thin-film solar cells is shown in Figure 1. The main types are: silicon-based thin-film solar cells, compound semiconductor thin-film solar cells and nanocrystalline thin-film solar cells.

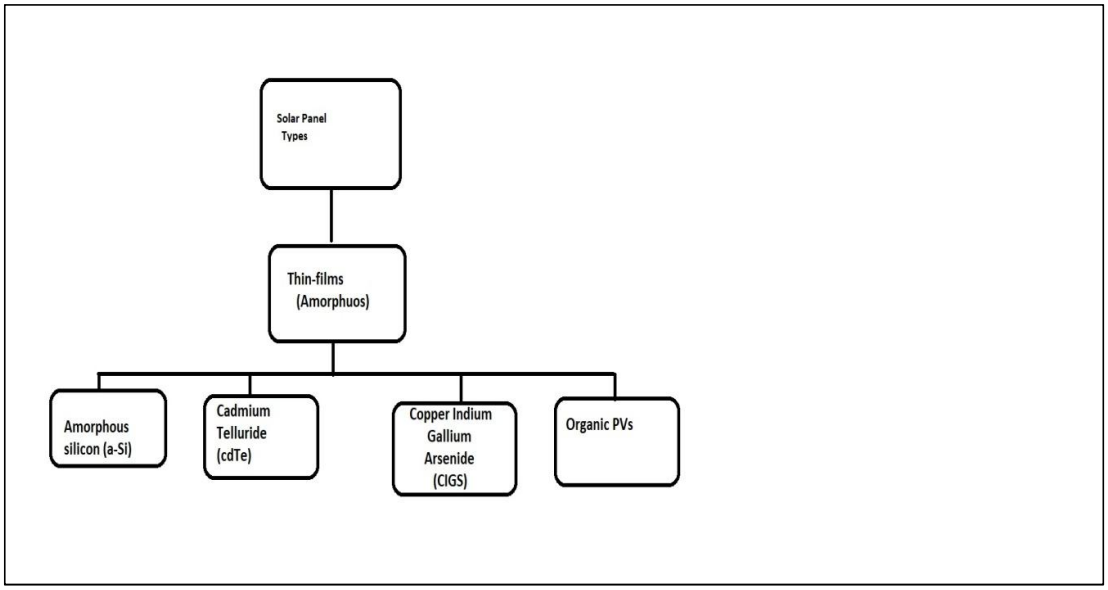

Figure 1: Classification of thin-film solar cells

II. Multiple uses of Solar Powered Drone in Upcoming Future

1. Solar Drones for Deliveries
2. Solar Drones for Supporting Disaster Management
3. Use of Solar Drones in Forestry
4. Use of Solar drones in Agriculture

2.1 Drones for Deliveries

With advancing drone technologies and increasing commercial usage, we believe the last mile shipping industry is ripe for disruption by delivery drones. Drones can significantly accelerate delivery times and reduce the human cost associated with the delivery. As internet evolution continues. Whether it is online shopping, ordering food, buying gifts, grocery runs, shipping official or personal packages the consumer space is increasingly relying on fast and reliable door step delivery [3].Mobisol is currently producing a fleet of solar-powered drones that can be used to overcome infrastructural deficits in rural regions. While drones are useful for performing tasks such as the delivery of goods to rural areas, the issue of charging these devices is somewhat complicated. These new drones are powered by the energy of the sun, making them a more viable option for places that have limited access to electricity. In order to makes drones more accessible to rural communities, Mobisol is combining its micro-solar arrays with a series of charging stations for delivery drones. By integrating existing customers into the drone-charging network, the company is able to work around a lack of existing infrastructure. This means that communities in countries such as Rwanda and Tanzania will have access to sustainable,

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carbon-free deliveries[3] Trend hunter,"These Solar-powered Drones Can Deliver Goods to Rural Areas"last modified February 10, 2016, accessed April 26, 2022,https://www.trendhunter.com/trends/solarpowered-drones.

Companies Working On Solar Drones

A. Airbus (QinetiQ)

Airbus, with its subsidiary Astrium, has been working on High Altitude Pseudo Satellites (HAPS) since 2008. In 2013 Astrium acquired the Zephyr solar powered UAV assets from British defence technology company QinetiQ, integrating the QinetiQ Zephyr staff into Airbus' organization. Video link: -[4]Bloomberg ,"The Drone That Is Years Ahead of Google and Facebook 2014", YouTube video, 4:12, November 12, 2014, https://youtu.be/cwfbEMe5a4I.

B. Google (Titan Aerospace)

Google got into the business of solar-powered drones with the acquisition of **Titan Aerospace,** a high-altitude, long endurance (HALE) solar-powered UAV manufacturer in April 2014.

Titan Aerospace developed drones called **Solara 50** and **Solara 60** capable of flying at a reported altitude of 20km for impressive periods of over 5 years. That period is an estimate, however at these altitudes there's few that can disturb a plane to continue its steady path in the air [4] "SINOVOLTAICS", last modified April 26,2022,accessed April 26, 2022, https://sinovoltaics.com/technology/top8-leading-companies-developing-solar-powered-drone-uav-technology/.

2.2 Solar Drones for Supporting Disaster Management

A disaster is a natural or man-made (or technological) hazard resulting in an event of substantial extent causing significant physical damage or destruction, loss of life, or drastic change to the environment. A disaster can be defined as any tragic event stemming from events such as earthquakes, floods, accidents, fires, or explosions. It is a phenomenon that can cause damage to life and property and destroy the economic, social or cultural life of people [4].Before the eruption as a pre-disaster activity Solar drone application can support the prevention or be able to supply theearly detection as it can fly high for very long time and can monitor every think from far away. In case of any man-made disasters like a chemical accident during illegal transport the drone road observation belongs to prevention, following a toxic smoke spreading belongs to early detection, while avoiding the escalated forest fire by drone flight patrol can belong to both prevention and early detection [4].

2.3 Use of Solar Drones in Forestry

Remotesensing using drones has a range of benefits such as reduced costs, flexibility in time and space, high accuracy data and the advantage of no human risks. It is important to mention that even through forest fires monitoring and management was one of the first field in forestry that showed the importance of drone in forestry.

An application in order to map forest areas was made by Koh and Wich, where a drone was used in mapping tropical forests in Indonesia. The experiment involved a small UAV type aircraft (under 1 kg) with a flight time range of

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approximately 25 min per flight and a maximum distance travelled per flight of about 15 km [5]. For the fast-growing forest plantations can have similar approaches to precision agriculture from the drone remote sensing perspective and increasing their productivity is a major concern, especially nowadays when the demand for timber is highly increasing. Regarding this field, Felderhof and Gillieson acquired NIR (Near-Infrared) images using drone remote sensing to map the vitality of tree canopy in a macadamia plantation, where they found significant correlations between spectral radiation of trees and the levels of nitrogen in leaves measured in-situ [5].But there are a number of issues associated with flying drones for long periods – such as the risk of the drone losing connectivity with its controller – utilizing solar energy to power a drone can help reduce the need for drones to return to their base for chargingwith the use of Solar powered drone we can do all of these work every cost efficiently and carbon-free.

2.4 Use of drones in agriculture

The world population has increases day by day and projected to reach 9 billion people by 2050, so the expert expect that the agricultural consumption will also increase in the same time period. In order to feed this larger, more urban and richer population, food production (net of food used for biofuels) must increase by 70 percent [6]. The Use of advanced technologies such as drone in agriculture offer potential for facing several major or minor challenges. The major applications of drone in agriculture are irrigation, crop monitoring, soil and field analysis and bird control.

Farmers and agriculturists are always looking for cheap and effective methods to regularly monitor their crops. The infrared sensors in drones can be tuned to detect crop health, enabling farmers to react and improve crop conditions locally, with inputs of fertilizer or insecticides. It also improves management and effectuates better yield of the crops. In the next few years, nearly 80% of the agricultural market will comprise of drones [6].

But if you have a drone, you know the average duration of its fly. Statistically, an agriculture drone flies between 10 and 20 minutes. In case of an advanced drone, its flight may have a duration of up to 30 minutes in the air. In any event, for big fields, this is not enough. However, longer flights are an attribute for more expensive drones. In other words, this means that mass-market lightweight quadcopters don't have extremely good batteries. As a result, an agriculture drone equipped with a special camera or a sprayer, means extra load to carry during the flight. Hence, you must expect to decrease the time of the flight as well as the covered area of the field[5] "PETIOLE PRO", last modified April 26, 2022, accessed April 26, 2022,https://petioleapp.com/disadvantages-of-agriculture-drones/.

To overcome this types of problem we can highly recommend solar drones which have a very long flying time in comparison of ordinary drones (Airbus has set a world record for the longest continuously-flying solar powered drone for6 days in the air without taking a single break for refuelling)which gives it a verity od advantages in agriculture sector as it can cover the whole land monitoring without any break, no need of recharging time and again, can easily carry camera and spray for a very long period of time etc.

III. CONCLUSION

There are many other alternative energy sources that are present including bio-fuel and hydrogen fuel cells, but nothing is as limitless as compared to solar technology. Some applications of high-altitude long endurance UAV that can potentially be very large, whether it is in goods delivery, studying natural disasters, or agriculture sector etc. With the right combination of solar technology and storage, a solar powered drone has the potential to run for longer distances. This means less time on the ground, regardless of the purpose it's serving. The solar energy used to fuel the drone is renewable as well, which means spending less money on drawing electricity from the grid to power the drones.

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