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DEVELOPMENT AND PERFORMANCE STUDY OF SELF-CHARGING ECO-FRIENDLY DRONE - A SHORT REVIEW

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ABSTRACT

Presently, drones are now used in different industrial, agricultural, engineering and domestic applications due to their distinctive advantages, including effective inspection, crop monitoring, saving lives in emergencies, scientific investigation, quick shipment and delivery. As a result, the demand for drones is rising every day. The ability of a traditional drone to maintain a charge over long distances is one of its limitations. So, this paper explores about the self-charging of solar drones that could have a lot of benefits when compared with conventional drones. The prime discussion of this paper is about the recent developments and benefits of drones. Solar energy is a renewable energy source. Using this energy in drones leads to spend less money on getting electricity through grid to power the drones. The development of drones that use solar energy as their main source of charging is discussed in this study in a linear fashion.

Keywords: Unmanned Aerial Vehicle, Quadcopter, Fuel Cell, Energy Storage, Solar Power

1 Introduction

Drones theoretically solve the technical hurdle of continuous flying, solar drones with extraordinarily long endurance have become a prominent research focus in recent years. [1]. Unmanned Aerial Vehicles (UAVs), sometimes known as drones, are a disruptive technology trend with growing uses and social significance in both the present and future [2]. Typically, an air vehicle that flies like an airplane or pilot but with a different pilot is referred to as a “drone” [3]. However, there are a number of requirements for achieving a lightweight and reliable structural design due to the specific configuration and mission characteristics of solar drones [1]. Solar drones typically have wide aspect ratio wings to lessen the associated drag. Additionally, the total weight has a significant impact on how feasible the design plan is. Accordingly, the wing needs to exhibit maximal stiffness and particular strength. Solar drones often use flexible materials for their skin and rely on their wing beams for bearing capacity, which usually simplifies secondary elements like the fuselage and landing gear [1].

During the first World War, the concept of drones came into existence [4]. At the starting stage, drones were used only for military purpose. But because of significant developments in technology, usage of drone has increased [4]. To escape from cloud obstruction, mini drones operate at high altitudes and they regularly fly in day time which will get a good amount of sunlight energy. However, compared to traditional power sources, even the greatest solar cells only offer a little amount of power. The energy coming from sun is attractive for transportation because for the conversion of power, a solar panel is sufficient. In the field of science, the usage of drones has spread worldwide in Supervision, detection of organisms and usage of land [5].

It is interesting to note that during the COVID-19 crisis, the potential of drones was further realized [6]. In the recent years, drones have caused many damages. Drone producers are developing by reducing their production cost [7]. The cost of using satellite was relatively high. When compared with Satellite, the aircraft availability degree is moderate [8]. Developing a vehicle without the existence of pilot is a big task [9]. Using the technology's lack of human interaction, current service delivery methods were changed to increase capacity and safety. In making decisions regarding environment, maps and images are utilized by the drones which helps in giving views to persons who are making decision [10]. One may argue that Corona Pandemic created development in several fields in which drones are also seen a significant growth [11]. Drone has a capability of smart sensing and intelligent system [12]. Regardless of the applications, the main driver for using drones is their capacity to speed up and be more flexible in supply chain operations while also improving cost-efficiency and precision [13].

2 Objective

The objective of this paper is to view the trends in drones and solar panels within the last one decade and see how commentary on research article has transformed and is still transforming. This review study is especially interested in identifying the key research difficulties appearing in drone delivery systems, as well as some suggested solutions to address them. In terms of the paper's significance, it focusses on the credibility of drone delivery services near metropolitan areas and groups existing studies according to several categories of drone delivery issues. One of the drawbacks of conventional drone is its capability to bear the charge for lengthy journeys. So, this paper investigates about the self-charging of solar drones that could have a lot of benefits when compared with conventional drones.

3 Literature Review

3.1 Applications of drone

Ahirwar et al. [14] introduced the most promising sector now is agriculture, which is faced with several issues, one of the main problems is the lack of labour for farming. Drones are primarily used in the field of farming sector. They provided these guidelines for using drones, to avoid the some of the difficulties in agriculture. They concluded that there is a need of drones in agriculture instead of labor. Mishra et al. [15] suggested usage of drone in exploration and saving has received the least attention, and academics need to focus on providing knowledge for drone monitoring. They concluded that the models now in use are insufficient for important applications like SAR, which led us to develop a model for human detection and action identification that was modelled

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after the pyramidal feature extraction of SSD. Shahmoradi et al. [16] provided detailed examination of drone technology's position now and how it is used in the mining industry. They considered these applications as they thought of includes controlling ores, discontinuity in rocks, measurement of post-blast rock fragmentation, and tailing stability monitoring.

3.2 Working principle of drone

Hassanalian and Abdelkef [17] showed that various drones have been classified as unmanned air vehicles and smart dust, with newly defined applications at both ends of this spectrum. They concluded that drones can be classified into various categories, including unmanned air vehicles, micro air vehicles, nano air vehicles, Pico air vehicles, and smart dust. Additionally, manufacturing methods and challenges, propulsion systems and actuators, power supply and endurance, and control and navigation of drones were examined to come up with new ideas to eliminate current limitations. Fauci and Robert [18], by exploring the batteries, propulsion, avionics, and payload components, discovered maximum power point tracking, battery management, energy storage, and flux tracking. He concluded that the power management system is capable of continually supplying a 10-watt load in its current configuration. They came to a conclusion that the system of power management is capable of continually supplying a 10-watt load.

Further, Elatab et al. [19] suggested addressing the design issues with the embedded electrical systems in flying drones. The methods utilized to extend flight endurance using various types of solar cells are then covered in detail, including the materials employed, the mechanical flexibility of the cells, and various navigation and control techniques. A viable way to increase drones' flying time is to equip them with solar energy-gathering capabilities. Hassanalian et al. [20] proposed a whole cycle that included every aspect of micro air vehicle design, including aerodynamics, stability, structure, and navigation. The cycle's primary goal is to shorten the time required for finding an ideal solution. By studying the effects of defined parameters during the cycle, decreasing the statistical methods, and utilizing this cycle to design, they came to the following conclusions: increased efficiency and lowered design time, optimization, and reduction of the cost of creating such MAV.

Alsharoa et al. [21] investigated cellular Heterogeneous Networks (HetNets) supplemented with mobile solar drones, they offer an energy management system. They concluded that preserving network connectivity and coverage while reducing the overall energy usage of the networks was the best course of action. Figure 1 depicts an example of a HetNet assisted by DBSs.

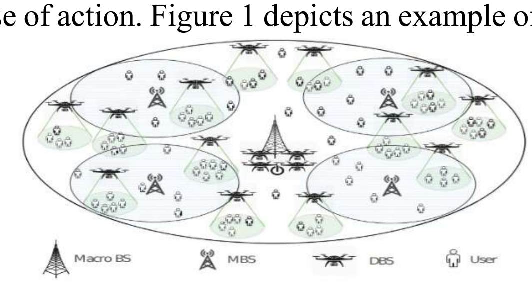

Figure 1: Example of a HetNet assisted by DBSs [21]

3.3 Power storage systems and charging system in drone

Boukoberine et al. [22] stated that both the civic and military sectors have recently begun to pay more attention to drones. Battery-powered drones have some beneficial qualities, like a wide range of applications and low cost, but their endurance is still constrained. They held a review-based debate of the remedies for this problem, which included switching out tethering and laser-beam inflight charging. They came to the conclusion that a hybrid power supply system is another viable option. Battery Combination that to additional energy, like fuel and solar cells, and supercapacitors, enables to take advantage of each source's strengths and address its weaknesses.

Kidd et al. [23] suggested idea of a drone using some of the natural surroundings it will come into contact with along its flight path as power was examined. They used three types of power generating: flexible solar panels, thermoelectric generators, and motors for vibration-induced power generation, which are either installed in power pods or inside the wings and are activated by atmospheric gusts or wing flutter. The UAV energy storage systems will be able to use this hybrid type of AC and DC current. They came to the conclusion that the power management system integrates all of these sources converted into unit output power. It depends on a hybrid power design, where the sources of input are merged into a unit Output. Wang et al. [24] unveiled the magnetic resonance technology in 2007, wireless power transmission (WPT) methods have gained increased attention. They discovered the benefits; wireless magnetic resonant transmission of power is a new technology that has several benefits compared with previous forms of transfer of energy via wireless since it is secure and versatile while still providing electric devices with the energy they require. They came to the conclusion that a wireless magnetic resonant power transfer system, which helps drone to supply power to address endurance issue. A flow chart explaining the process of Solar energy system is shown in Figure 2.

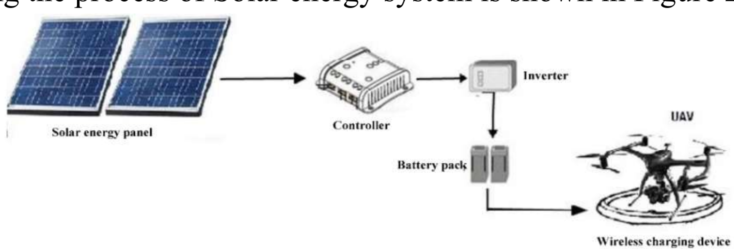

Figure 2: Flow chart of solar energy system [24]

Shiau et al. [25] introduced the creation of a prototype unmanned aerial vehicle's solar power management system (SPMS) (UAV). They primarily utilised the MPPT, battery management, and stages of power conversion of the power management system. The MPPT step makes an effort to extract all of the electricity possible from the solar cell panels. They have come to the conclusion that the Li-Ion polymer battery modules' charge, discharge processes are monitored and managed by the battery management stage. Mohsan et al. [26] conducted an analysis of unmanned aircraft (UAVs). They talked about how UAVs may be used for military operations, power line suspicion, farming, sensing, delivery services, traffic suspicion and other things. For missions to be successful, a lot of their constraints and serious issues must be resolved. Charging UAVs is one of the most challenging and time-consuming procedures.

3.4 Benefits of solar power in the drone

Lin et al. [27] found out that the solar cells produce good amount of power than conventional power and it is used for aerial vehicles. Considering the limitations of engine utilization and solar power production, they carried out a concise mathematical model. In that one has achieved an outside airtime of more than three hours with the solar cells being carried as weightless, which is 48 times longer than it can last on the batteries alone and significantly extends drone operation. Figure 3 represents solar quadcopter with 5S solar modules.

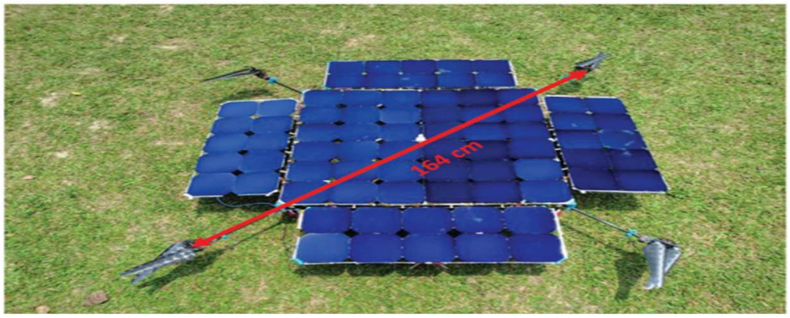

Figure 3: Photo of the solar quadcopter with 5S solar modules [27]

Kumar et al. [2] investigated the potential for integrating reasoning into drones for detecting and recording information, as well as the usage of drones in solar power facilities. They took into account different drone kinds, their settings, and dynamics. They came to the conclusion that RT, AI, and ML could enable drones and facilitate the monitoring of massive solar power installations. Rohi et al. [28] developed extensive air pollution control to get rid of contaminants that are already in the environment. With this technique, eco-friendly drones are used to automatically check the air quality in a specified area. They assessed the levels of gases in the air, were able to identify whether were too high, and implemented on-board pollution abatement strategies as necessary. When there is excessive pollution, they can detect it, but they can also automatically deal with it and reduce it above the earth. An Air Quality Health Index (AQHI) map of the area is created when many E-drones are employed in various areas. This map utilized both immediate and nature survey.

Further, Zhang et al. [29] conducted a case study using a solar drone with an 18-m wingspan, and the outcomes of the experiment confirmed outcomes of the optimization. Additional research was done based on three factors: The impacts of properties on sandwich box beam design are discussed. They came to the conclusion that the research approach could enable the development of a drone. Cosson et al. [30] showed the production of photovoltaic energy and its storage in Li-ion batteries for an autonomous drone with four wings covered by solar panels made of thin-film gallium arsenide photovoltaic cells has been predicted using an effective simulator. Input parameters for the flight are things like irradiance, sun inclination angles, and drone Euler angles.

4. Conclusions and future scopes

The literature review on different research works has completed and from that the below mentioned inferences have been drawn.

- Drones are used by the mining industry for labor-intensive tasks as well as search and rescue missions. A thorough analysis of the numerous challenges that humans faced in farming highlighted the use of drones to prevent issues. To discover terrorists facilitates the process and gave a thorough review of human detection during disasters drones are used.
- These soaring drones are capable of carrying out a variety of civil and military tasks. These potential missions, including space exploration, postal delivery, environmental preservation, and search and rescue, were looked at. The employed design techniques and associated problems are discussed. Optimization methods have had a substantial impact on the lengthening of flight time. These algorithms priorities optimizing the drone's path while maximizing the quantity of solar energy gathered. The additional solar energy should more than make up for the additional electricity needed to run these operations.
- Numerous drone configurations and types were researched so that people may choose the best drone for their needs. Although more testing must be done to perfect the technology, e-drones can be utilized to carry out automated aerial pollution identification and abatement. The sandwich box beam, based on the suggested two-stage optimization design method, may increase the night cruise time of the solar drone by 4.33% while reducing weight by 20.4% compared to the laminated box beam. The forecast of the power generated by the solar panels during flight might be improved.

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