Literature Review

Technology advances have attracted scientists, engineers, and computer experts to design and advance drone technology. Drone technology is commonly denoted to as unmanned aerial vehicles (UAVs), rotorcraft systems, or unmanned aircraft systems (UAS) [1]. The UAVs are described as aircraft which do not use a human pilot aboard [2]. The UAVs can be grouped into two categories, rotatory-wing, and fixed-wing UAVs, depending on the task at hand.

Notably, UAVs are used in architecture. The increase in complexity of structures was a precursor to the modernization of architecture, creating multi-disciplinary specialization in this field. Among the disciplines is the technology which utilizes UAVs that are specifically designed to be used in D-cube missions (Dangerous-Dirty-Dull) [3]. As the field of architecture is wide, they are also utilized in remote environment assessment and research, security, and pollution assessment monitoring. Typically, a UAV in this field should have the power to implement most of the missions with limited reconfiguration time and overhead to be economically stable. Additionally, the UAV should have 360^0 panoramas to relay real-time scenarios that can be shared with personnel on site, the company, and sub-contractors [4]. Notably, the UAVs' data can be utilized by architectures in planning and constructing 3D models usually employed in monitoring construction progress [5]. When monitoring, issues arising in the operations are highlighted early by their location in 3D, allowing the management to mitigate potential risks ahead of their schedules [5].

Additionally, several suggested applications of UAVs in architecture include the integration of sites' sensed data into the incorporated UAV software. There is also automated crack detection by the UAVs and automated construction tasks that require rapid decision-making [5].

Among UAV applications include military use, industrial engineering, mobile 3-D mapping, entertainment, and aerial photography [6]. In research done, UAVs are essential in post-seismic areas [7]. They are used in data acquisition through aerial photography and acquisition of facades for buildings surrounding the photogrammetry acquisition [7]. Flight flexibility plays a major role by virtually accessing any place, and since they can be remotely controlled, the operators are not at risk.

Design and Analysis

This research will study the solar-powered UAV design. These kinds of UAVs have been embraced as they use unlimited renewable energy sources [8] [9]. Connecting these solar cells through an electric circuit will help provide sufficient power to run the motors and electronics composing the UAV. When the energy provided by these cells is in surplus, it can be stored for further use in the battery and used in 3-D cube environments [8]. Additionally, their endurance is better than other designs as there is no need for increasing fuel size system, which increases the mass of the UAV, affecting their flight time.

The main working principle of the solar-powered UAV design is integrating available and limitless renewable energy by transforming it into other forms of electricity using solar cells [8] [9]. After solar cells are stroked by sunlight rays in the UAV, they create electrons and holes, which are used to generate current. Electrons flow to recombine with the holes, which are charge carriers. These solar cells are typically set in a series manner to get sufficient voltage used for cautiously charging the UAV battery. These cells should be carefully wrapped on top of the wing to increase their surface area to the sun rays and enhance their safety during the flight.

The designing process of the solar-powered UAV involves both preliminary and conceptual designing [8] [9]. For the latter, basic configurations such as size, weight, and performance are evaluated, while evaluations of meeting the desired targets and maximizing them are done in preliminary designing. For maximization of the UAV design, weight balance and energy balances must be configured [8]. Parameters such as gross weight, payload, altitude, average air density, clearness factor, and take-off distance are essential when designing UAVs.

Calculation of average air density utilizes the formula below to determine the maximum and minimum altitude the UVA can fly.

$$p = P/RT$$

Where p is the air density, R is the ideal gas constant, and T is temperature.

To calculate for take-off distance, we can use the formula

$$s = V_t^2 / 2a$$

where s is take-off distance, V_t is the velocity for take-off at $C_l = C_{LF,}$ and a is the acceleration of the airplane.

The number of cells chosen must be configured to help achieve the required voltage, stimulate the battery's charging process, and achieve a good climbing rate. Achieving the maximum number of cells is essential in calculating the minimal wing area. It is then used to cut down the weight, maximize power efficiency, and ease controlling the UAV and usually depends on where the cells are arranged. Upon selecting the wing, airfoil selection is made depending on requirements such as low drag coefficient, high lift coefficient, and less camber for cell placement [10]. Typically, a maximizing airfoil has a high lift to drag coefficient ratio Cl/Cd [10].

To obtain a high wing efficiency during configuration, the solar cells in the wing should be parallel to the ground, and the center of the wing should form a 90^0 with the fuselage. The latter increases chances of having a great field performance at very low speeds.

The wings should be extended and make an obtuse angle by making a dihedral angle of about 7^0 to the centre of the wing. The taper ration of the wing should also be computed as it helps in improving lift distribution features resulting in an easier lateral control with the human pilot of the UAV.

$\lambda = C_t / C_r$,

where, C_t = tip chord and C_r =root chord.

For the middle wing part, it comprises of spars, ribs and the skin all designed with an aim of achieving minimal deflection. The spars can be made of carbon fiber and are majorly utilized in handling tension of the wing and its compression forces should be attached to the fuselage for easier transfer of forces. The ribs should make the UAV stable and shape the airfoil to a desired shape. The last part, skin, should be made to resists forces acting on the wing and give the UAV stability.

The power needed for level flight should also be calculated using the formula

$P_{req} = T \times V$

Where T is the axial thrust and V is the cruise velocity of the UAV.

The lift force generated by the wings should be able to compensate the weight, propeller thrust and drag force.

$W = mg = L = (p/2) C_L S V^2$

Where L is the lift force, m is the mass of the UAV, *p* is the air density, S is the wing surface area and V is the velocity of the cruise of the UAV.

The power available from the solar energy should also be computed since it serves as the main source of energy.

Notably, the fuselage is paramount in improving the lift-to-drag ratio. It should be computed using and analyzed in a software and mainly the SST *k*- *w* viscous model should be preferred. The payload in the fuselage: propulsion system, and electronics should be arranged in a manner to stabilize the centre of gravity o the UAV.

Additionally, the tail can be vertical, horizontal, or vertical, depending on each tail coefficient. Configuration of each part of the UAV should be done to achieve a light-weighted UAV, although robust enough to sustain all the design loads in position. Finally, the software can be used to find deflections of the UAV and help navigate and solve the problem, such as fuselage stress levels using other software analytical results.

Conclusion.

Unmanned aerial vehicles (UAVs) have been widely discussed in this paper; specifically, UAVs are used in construction. These kinds of UAVs play major roles in architecture, including environmental assessment and monitoring. Experts must continue searching for ways to solve UAV's problems, such as flight autonomy and how to maximize lift/drag ratio. Additionally, experts need to devise software applications that can be used in configuring preliminary and conceptual designs to maximize the benefits of a UAV. Additionally, UAVs that consume the least energy and help conserve the environment should be embraced. Experts should be devoted to discovering other UAVs in the architecture field that are efficient in conserving energy and are economically stable.

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