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Reviews on Design and Development of Unmanned Aerial Vehicle (Drone) for Different Applications

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ABSTRACT

The modern designs and their developments are essential based on their application; hence, UAV's can be built with specific design and loading conditions. In this review for the first, a basic idea about UAVs considering required engineering aspects has been studied. The existing literature has been critically reviewed to extract the fundamental idea of UAVs such as fabrication method, design, materials, structures, classifications and so on. The UAVs in multiple applications such as the use of drones by law enforcement agencies, military, search, and rescue missions, etc. was highlighted. Based, on the existing work in drone technologies a critical analysis was made to extract the research gap and recommended accordingly. As result, with these guidelines, the drones can be built for specific purposes and applications like COVID-19 pandemic missions, policing surveillance, and large-scale sanitation of remote access areas.

KEYWORDS

Unmanned Arial vehicles; drones; Design; and applications

INTRODUCTION

Engineering and technology are developing at a rapid pace in the modern era. Research and development of products are done at ease due to the availability and accessibility of tools. One of the areas where the research is moving at a faster pace in modern times is the development of aerospace engineering technologies focusing on the design and modelling of drones or unmanned aerial vehicles (UAV) for various applications. The UAVs are aircraft that carries no human pilot or passengers. Significant interest in developing UAV’s which can be operated in diverse environments and perform various missions at remotely accessible locations autonomously. The COVID-19 pandemic is one leading example of how UAVs were used by researchers, law enforcement and researchers to study various localities and perform various operations. The extensive usage of these drones and UAVs has gained interest in recent decades, leading to the invention of several models and types of various sizes and weights. Table 1 summarizes the engineering fields involved while designing a UAV/drone for a special mission or application. The first consideration during the design of the UAVs has to be based on their mechanical systems. The designer can analyze the idea using commercial tools with computational analysis rather than accuracy in the fabrication method. The next parameter in the design is the selection of materials that can withstand the payloads to be carried by the UAVs; Lightweight materials are generally preferred in the design as it will be easy for takeoffs and flights for a longer duration considering the power source in the battery is limited as we can see in the commercially available UAV model [1] and flying saucer [2].

Another important aspect in the design to be considered is the electrical/electronic equipment that will be used in the stability and control. The stability and the controlling are done usually by a remote control system with a limitation of range and endurance. Transducers are used in the UAVs for actuation or sensing purposes while the electric motor is used to generate thrust or power for UAVs, micro-UAVs, or drones. For larger UAVs, engines have been used as a power source, which can eliminate the need to limit the payloads. The other crucial part used in modern UAVs is the soft computing technologies such as IoT, AI and the likes. The drones for reconnaissance missions or military surveillance purposes require advanced technology systems. Such as artificial intelligence (A.I.) systems, the internet of things (IoT), and machine learning (ML) etc. During the COVID-19 Pandemic, soft computing technology helped enforcement agencies with crowd control and also to manage larger geographical areas to help control the spread of the virus without being physically present in the location. The built-in AI in the UAVs and drones also helped the transfer of medical equipment, conducting body temperature checks, surveillance, etc.

Table 1. UAV (Drone) technologies.

UAV (Drone)	**Mechanical Systems**	**Structural**
		Computational
		Fabrication
	Communication Systems	**IoT**
		AI
		Navigation
	Materials	**Metallic**
		Non-Metallic
		Light Weight
	Electrical/Electronic Systems	**Electrical Motors**
		Control
		Transducer

This study summarized the design principle, which covers the basic idea about modelling and design with an overview, limitations, and classification based on some crucial aspects. This review is organized as follows: the design principle of UAVs/drones are presented in section 2. In section 3, the various applications of these UAVs/drones are highlighted and discussed. Section 4 explores the importance of drones and design methodologies that are used to enforce crowd control and maintain social distancing during the COVID-19 Pandemic. Section 5 summarizes the critical analysis of UAV's and drones and the potential research gap with design and application. Section 6 presents the conclusion and recommendations for current research industries on UAVs/Drones technologies.

DESIGN AND DEVELOPMENTS OF UAVS/DRONES

This section classified the different aspects in which all phenomenon and fundamental information of UAVs/Drones design and developments are illustrated.

Background: Design Principles

The UAV is an aircraft that does not have a pilot on board, and generally, it is called a drone. It is a part of an unmanned aircraft system that consists of a drone, a system of communications between the two, and a ground-based controller. These vehicles are semi-autonomous or completely autonomous aircraft that may carry cameras, sensors, communications equipment, and other payloads. Since the 1950s, UAVs have been the focus of military study. The advanced defense research projects agency conducted numerous projects to enhance UAVs in military applications in the previous decade. Additionally, diverse civilian, government sectors, and commercial uses, including traffic monitoring, have recently sparked increased attention [3].

The criteria and specifications, which are generally a list of the essential mission parameters such as payload, endurance, range, and speed, are the first step in designing UAVs [4]. An initial sizing based on similar aircraft applications to narrow down potential airframe concepts, followed by the efforts to investigate the aerodynamic efficiency of the chosen configuration. Then the geometrical layout provides adequate volume for the systems and calculates structural responses based on the expected load shown in Fig. 1. Similar to general aviation aircraft, the ultimate aim of UAV design is to fly as efficiently as possible. As a result, two of the most critical design considerations are to build flyable and controllable solutions and improve performance in the given mission [5].

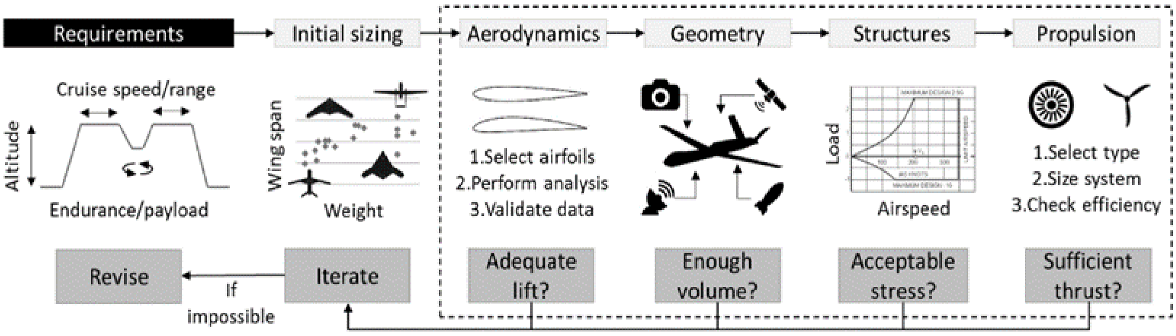

Figure 1. The fundamental iterative loops in the design of UAVs are depicted in this simplified interdisciplinary development process [6].

UAVs have the same components as manned aircraft in terms of systems design, with the difference that there is no requirement for a cockpit or any type of environmental control or life support systems [5]. Although this saves weight, it is frequently offset by the need for modern guidance, navigation, and control systems, which may be pretty demanding depending on the size of the aircraft and the amount of mission autonomy desired [4]. In addition, the so-called "payload," which generally defines the purpose of UAVs and consists typically of different instructions and mission-specific materials, imposes an additional weight penalty. The payload in surveillance and search missions typically consists of EO/IR sensors and LOS communication systems. In contrast, weapon systems (military operations), commercial cargo (transportation), and first aid supplies are some other types of standard payload in UAVs (rescue missions).

The maximum takeoff weight may be expressed by Eqn. 1 in its simplest form. At the same time, the range can be specified by Breguet's formula (Eqn. 2), where C_t is the engine's specific fuel consumption, V is the cruising speed, and L, D is the aerodynamic lift and drag forces. Overall, Eqns. 1 and 2 emphasize the necessity of a high-performance design, emphasizing how low structural weight, strong aerodynamics, and high engine efficiency may lower fuel weight, enhance range, and allow for even more usable payload to be included in the mission.

$$W_{Takeoff} = W_{Empty} + W_{Payload} + W_{Fuel} \tag{1}$$

$$R = \frac{V}{C_t}\frac{L}{D} ln \frac{W_{Takeoff}}{W_{Takeoff} - W_{Fuel}} \tag{2}$$

Various types of UAVs can be used to visually survey structures, divided into two types: rotary and fixed-wing. Fixed-wing vehicles are easy to operate, have a more extended range, and are ideally suited for wide-area surveillance and monitoring. Fixed-wing vehicles also have the benefit of being able to detect images across great distances. However, one disadvantage is that it requires enough time to respond since rotating a fixed-wing vehicle needs time and space before it regains its course. The rotary-wing UAVs utilized in these experiments have fewer flight criteria and restrictions, allowing them to be deployed in urban areas and on construction sites. These vehicles are often easy to fly, with a set of engines controlled by a sophisticated electronic system that ensures the aircraft's stability and allows for vertical takeoff and landing. As a result, they are the best option for transporting cameras and other items across short distances from the launch site without requiring many landing areas. They have excellent maneuverability and can hover. The disadvantage of such vehicles is that their rotational motion causes vibration [7]. Figure 2 depicts the recommended minimum equipment features for the visual examination of facades.

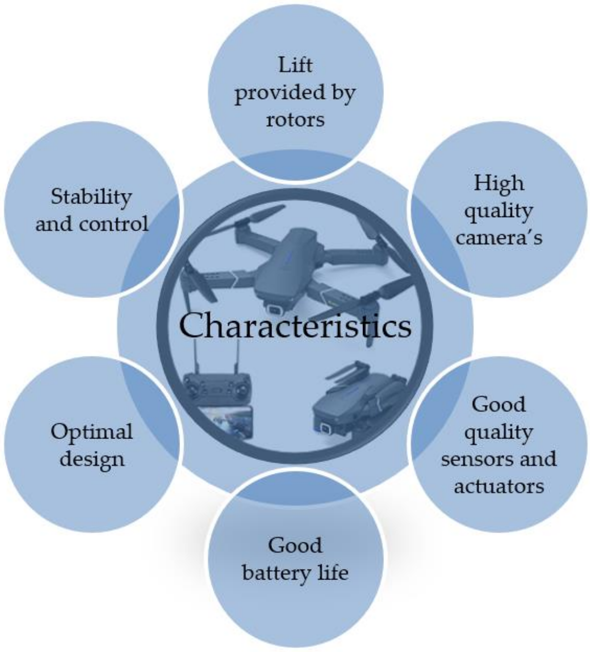

Figure 2. Characterization of minimum equipment for design.

Compared to fixed-wing aircraft, those with rotating wings aircraft allow for faster displacement and more flying variety and are successful in gathering horizontal pictures in regions of medium extension, as in the case of [8]. Similarly, the aircraft's flexibility allows it to move along all possible axes, making it useful for visual inspection of vertical facades or, as in the case studies of [9]–[11]. Identifying specific surfaces or features is a helpful tool for visual examination of vertical facades or, as [12] show in their case study, a visual tool for construction site management. The primary benefits and drawbacks of vehicles with fixed and rotating wings are summarized in Figure 3 [13].

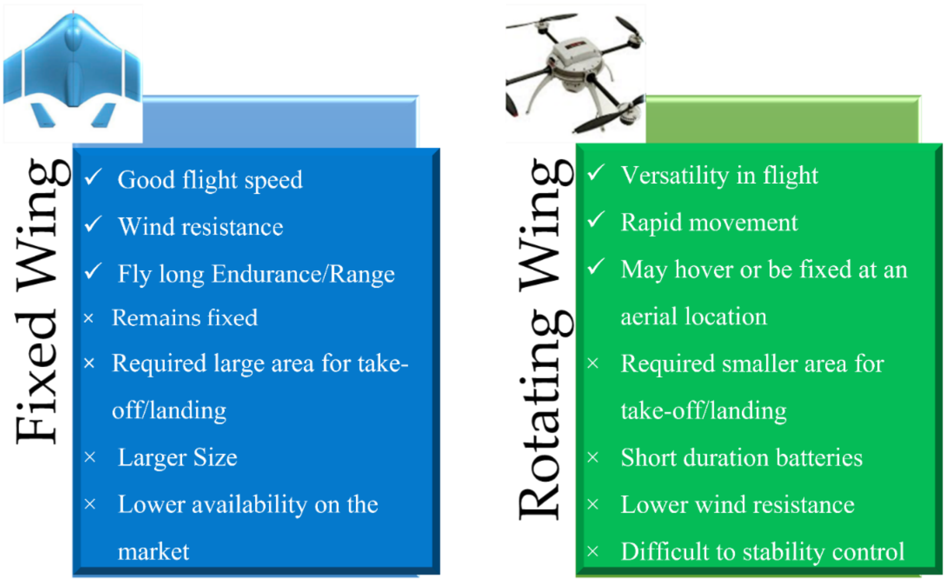

Figure 3. Type of wing with most relevant advantages '✓' and disadvantages '×'.

UAVs' payload weight carrying capability varies substantially with their space (volume, environment), mission profile (altitude, range, duration), and command, control, and data gathering capabilities. As indicated in Table 2, a summary of UAV capabilities and features was provided in [14].

Table 2. Capabilities and characteristics of UAV systems [14]

UAV	Weight (Kg)	Endurance (hr)	Payload (kg)	Range (Km)	Wingspan (m)
Desert Hawk	3	1	1	10	1
AV Dragon eye	2	1	0.5	5	1
AV Pointer	4	1	0.9	2	3
Luna	40	4	10	80	4
Raven	84	4	17	100	3
Herron	1087	40	227	3300	17
Dark star	3900	12	454	925	21
Dragon drone	41	3	11	148	2
Global Hawk	11600	30	900	22000	35
Gnat	516	40	63	4818	11
Neptune	36	4	10	75	2
A160	818	30	136	4625	11
Fire Scout	1159	6	90	400	9
Finder	26	10	6	648	3
Pioneer	125	5	64	373	5
Predator	1020	20	600	740	15
Shadow	149	5	75	125	4
Shadow 600	273	14	41	200	7

Classifications

The classification of UAVs/drones can be seen differently, such as categorized by the parameters like altitude, endurance, maximum takeoff, etc. [15]. In such cases, the UAVs are recognized with their parameters, either structural or aerodynamics or other sources. With these, it is significant for the particular application and the author [15] tabulated each UAV with parameters specification considering the example with mission and systems. A wide range of metrics has been used to classify UAVs, including size, capabilities, or any combination of these and other characteristics. While some of these metrics have an insignificant effect on the system's safety performance requirements, they are still important from an operational, commercial, legal, commercial and possibly another standpoint [16]. Table 3 presents a comprehensive classification of UAVs that demonstrates both the wide variety of UAV systems and capabilities as well as the multiple dimensions of differentiation.

Table 3. General classification of UAV systems for differentiation [17]

Categories		Mass (kg)	Range (km)	Flight alt. (m)	Endurance (hr)
Tactical	Micro	<5	<10	250	1
	Mini	<20/25/30/150	<10	150/250/300	<2
	Close range (CR)	25-150	10-30	3000	2-4
	Short range (SR)	50-250	30-70	3000	3-6
	Medium range (MR)	150-500	70-200	5000	6-10
	MR endurance (MRE)	500-1500	>500	8000	10-18
	Low altitude deep penetration (LADP)	250-2500	>250	50-9000	0.5-1
	Low altitude long endurance (LALE)	15-25	>500	3000	>24
	Medium altitude long endurance (MALE)	1000-1500	>500	3000	24-48
Strategic	High altitude long endurance (HALE)	2500-5000	>2000	20000	24-48
	Stratospheric (Strato)	>2500	>2000	>20000	>48
	Exo-stratospheric (EXO)	TBD	TBD	>30500	TBD

Special task	Unmanned combat AV (UCAV)	>1000	1500	12000	2
	Lethal (LET)	TBD	300	4000	3-4
	Decoys (DEC	150-250	0-500	50-5000	<4

Similarly, the classification has been made by Korchenko, and Illyash [18] considering 16 sixteen fundamental features of UAVs such as control and fuel system, aircraft and wing type and many more, which gives the basic idea about the requirement is helpful in design the UAVs. Classification of UAVs also shown by the Singhal et al., [19] in which it has been divided into three different types: aerodynamics, landing and weight and range, which gives the idea of how the drones have been modelled with challenges in these fields and they show the applications of such drones in practical use. Additionally, their number of studies has been reported over the last two decades in which shows the challenges, application and classification in any engineering fields to explore the mechanism and meaningful use [7, 13, 18–23].

Based on performance characteristics

UAVs are classified based on a variety of performance characteristics. Weight, range, endurance, and wing loading are important specifications that distinguish different types of UAVs and give rise to useful classification systems, as shown in Table 34.

Table 4. Classification of UAV performance characteristics [14].

Classification by Weight			
Designation	**Range**		**Example**
Super Heavy	>2000 kg		Global Hawk Heavy
Heavy	200 – 2000 kg		A-160
Medium	50 – 200 kg		Raven
Light	5 – 50 kg		RPO Midget Micro
Micro	<5kg		Dragon Eye
Classification by Range and Endurance			
Category	**Endurance**	**Range**	**Example**
High	>24 hours	>1500km	Predator B
Medium	5 – 24 hours	100 – 400 km	Silver Fox
Low	< 5 hours	< 100 km	Pointer
Classification by Maximum Altitude			
Category	**Max Altitude**		**Example**
Low	< 1000 m		Pointer
Medium	1000 – 10000 m		Finder
High	10000 m		Darkstar
Classification by Wing Loading			
Category	**Wing loading kg/m2**		**Example**
Low	< 50 m		Seeker
High	50-100		X-45
Medium	>100		Global Hawk

Based on aerodynamics

In response to forwarding increasing speed, fixed wings are the primary lift producing components. The lift created is controlled by the velocity and higher angle of air flowing over the fixed wings. Fixed-wing drones need a more incredible starting speed and a thrust-to-load ratio of less than one [24,25] for taking off. When comparing fixed-wing and multirotor drones with the same payload, fixed-wing drones are more comfortable, using less power and having a thrust loading of less than 1. To control the orientation of an aircraft, rudders, ailerons, and elevators are employed to manage yaw, roll, and pitch angles. The force imparted to fixed-wing aircraft is seen in Figure 4. With a larger L/D ratio and a higher Reynolds number, fixed-wing drones are more compatible. On the other hand, fixed-wing drones are less visible for L/D 10 since the Reynolds number and efficiency of smaller drones drop.

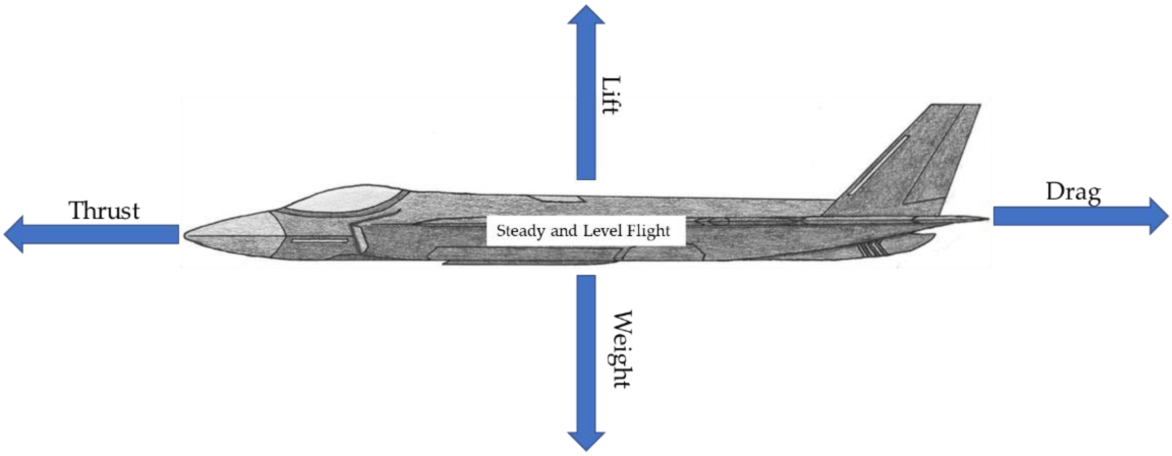

Figure 4. Fixed-wing UAV aerodynamics loads.

Insects such as tiny hummingbirds and giant dragonflies [26] are the primary inspiration for flapping-wing drones. The lightweight and flexible wings are modelled after the feathers of insects and birds, which show how the weight and flexibility of wings may help with aerodynamics. These flapping wings, on the other hand, are complex due to their intricate aerodynamics. Unlike fixed-wing drones, flapping drones can maintain steady flight in windy conditions. Light, flexible, lightweight flapper wings offer an actuation mechanism for the flapper motion. Because of their unique maneuverability benefits, the drone community and biologists have been conducting an extensive study on flapping wings [27]. The integrated action of the fixed and flapping mechanisms is employed, with fixed wings generating lift and flying wings generating propulsion [28]. The dragonfly, which utilizes two wings to maximize lift and thrust forces, is the inspiration for these drones. Fixed and flapping wing hybridization improves overall efficiency and aerodynamic balance [28].

The thrust produced by the main rotor blade is employed for both lifting and pushing. Unlike fixed-wing aircraft, multirotor unmanned aerial vehicles may take off, land vertically, and hover in a position [29]. The number and place of motors and propellers on the frame determine the design of a multirotor. Their hovering capabilities and their ability to keep a constant pace make them excellent for surveillance and monitoring. The main issue with Multirotor is that they require more power, which limits their durability. In multirotor aircraft, governing equations are utilized to calculate the real power and thrust required.

$$W = 5.33 \times 10^{-15} P D^4 m^3 \tag{3}$$

$$T = 10^{-10} P D^3 m^2 \tag{4}$$

Where, W = Power, T = Thrust, P = Pitch, D = *Rotor* Diameter, and m = RPM.

Based on structures

The UAVs has different types in recent applications, and each UAV has a different design based on the fixed and rotating wing. Generally, fixed-wing UAVs has designed like manned aircraft having primary structures such as fuselage, wing, horizontal and vertical stabilizer, in addition, it also consists secondary component: flaps, aileron, winglets, rudder, elevator, etc. in other words fixed UAVs is aircraft with no cockpit. Rotating wing UAVs is also called drones, in which their several design and structural component are uploaded. The drone's structure is classified based on multi-copters into specific categories constructed on the number and placement of motors. Each class corresponds to a particular mission [5][5]. They are classified into various configurations based on the mission requirements, such as Mono copter, Tri copter, Quadcopter, Hex copter Mode, and Octa copter. The drone center part has a variety of designs such as flying saucer [1], square shape [30], circular shape [31], rectangular shape [10], etc. Fig. 5 shows the drone types based on the design type and structures.

Figure 5. Drone types and designs are based on structures.

Significant studies have been made in drone investigation via software components such as uploading cameras, sensors, actuators, and electric motors. Hence, hardware or mechanical component the importance only made on using lightweight materials and minimum structural parts. Therefore, 3D printed drones have been made in recent years [30], [32]. When we reviewed recent-research-report based on the structures of UAVs and drones, it has been detected that there are several studies have been done on UAVs (fixed wing). Kessler and Spearing [33] investigated the WASP vehicle's structural design and the manufacture of components that could withstand 15,000g launch stresses. Because these components must be as light and durable as possible, they are made of sophisticated composite materials. Rathinam et al. [34] approach for monitoring these systems using an autonomous UAV that relies on visual feedback. The researchers presented a single structure identification method to recognize and localize diverse features such as highways, roads, and canals.

Insuyu [35] used MSC/PATRAN software to study the aero-structural design and analysis of a UAV and its mission adaptable wing. Under defined flying circumstances, the UAV's structural static and dynamic analyses were performed. Harasani [36] used stress analysis various estimate the UAV characteristics' strength. Different structural panels of UAVs, such as truss, hexagonal, and cross pyramidal, have been examined in adaptable mission lightweight materials strength [37]. A UAV was developed, evaluated, and built for an international aircraft design competition to fulfil design specifications and complete the task. The objective was to create a well-balanced design with good, demonstrated flight handling capabilities, feasible and economical production needs, and high vehicle performance [38].

One study [39] was done to stimulate research into renewable energy sources for aviation, considering the fundamental problems that a solar-powered aircraft has, such as the geographical region of operation, energy collecting and storage, payload, and design characteristics. As a result, a plane is constructed for 2 kg, including cargo, and different elements are examined. Furthermore, the design is optimized for more extraordinary performance from the airfoil to the entire structure. A low-order composite structure module by Alsahlani et al. [40] has been introduced. For a given aerodynamic load, this module can design the wing structure. The wing structure is divided into spars and non-spar components. Non-spar elements' weights are calculated using empirical formulae developed by NASA for solar-powered high-altitude UAVs. Researchers compared terrestrial laser scanning and unmanned aerial vehicle structure from motion [41].

The design, analysis, and construction of a small size UAV composite frame structure are discussed by Azarov et al. [30]. The frame comprises a composite lattice structure of continuous carbon fibres 3D printed with two matrix materials: thermoset for joining the elementary fibres in the tow and thermoplastic for consolidating the cured tows into a unidirectional composite. The work includes a description of the 3D printing method, an F.E. analysis of the structure, and test results for the structural elements' mechanical characteristics and the manufactured frame. The analyses' findings are in good accord with the results of the experiments. Fig. 6 illustrated the simulation models of the UAV frame for structural analysis purposes.

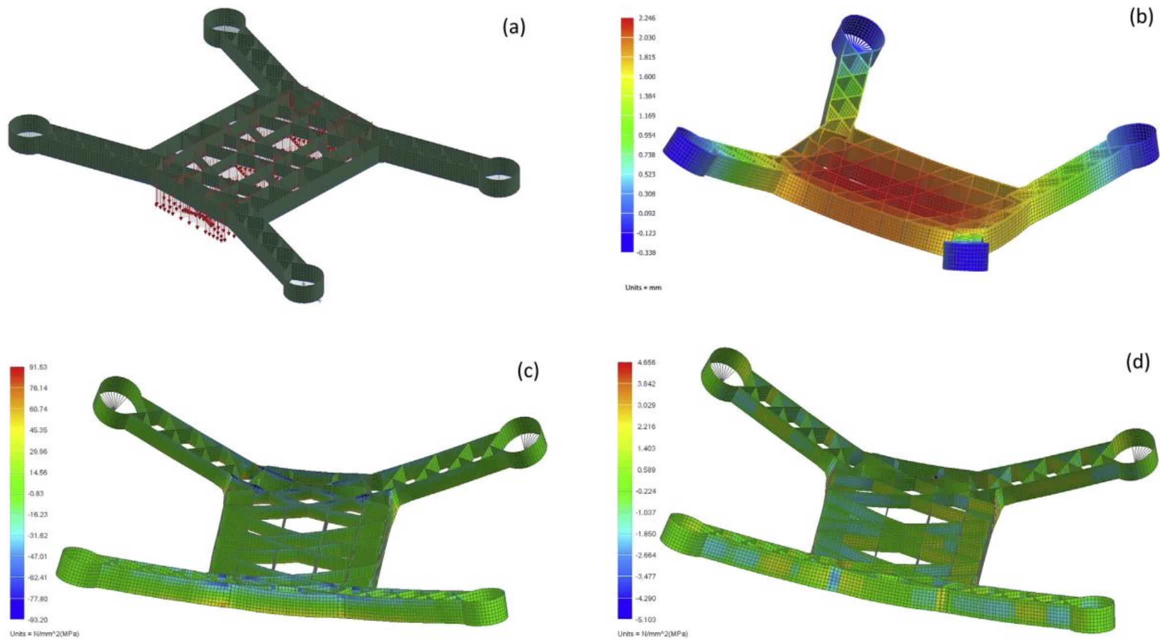

Figure 6. FE modelling of the small size UAV frame [30].

Topology-optimized unmanned aerial vehicle structures made from additively manufactured continuous carbon fibre-reinforced thermoplastic [32]. Using an F.E. model, analyzed the maritime surveillance UAV's composite wing structure. The load is assumed to be static and distributed using the Schrenk method along a semi-span. The wing is represented using the quad4 element in a finite element model, and the boundary condition is the pin in the areas where bolts will be placed. To achieve satisfactory results from finite element model application, verification, validation, and mesh convergence tests are considered [42].

Based on Autonomy

UAVs can also be classified based on the level on their level of autonomy [16]. UAVs exhibit autonomy in certain functions and this trend is expected to increase. The autonomous control levels (ACL) are proposed and are based on the that was based on requirements like situational awareness, analysis, coordination, decision making, and operational capability [43]. Each ACL is determined by three factors: the degree of autonomy from human intervention, the mission's complexity, and the environment's complexity [44]. It's important to note that as autonomy grows, so will new regulatory concerns. Highly autonomous systems may display non-deterministic behaviour, which is likely forbidden based on existing regulatory methods. It is also clear that responsibility issues for highly autonomous systems will raise concerns that must be addressed. Table 4 mentions the control levels and their capabilities with a description for UAV autonomous levels [45].

Table 4. Autonomous control levels with description [45]

Levels	Levels description	Functions
0	Remotely piloted vehicle	Controls flight by sensing via On Board Camera
1	Execute pre-planned mission	Preprograms the mission or aborts plans
2	Changeable mission	Executes preplanned programs in response to health and status of UAV
3	Robust response to real-time faults/ev ents	Senses health and external events of UAV to accomplish th e mission

4	Fault/event adaptive vehicle	Is responsible for Off-board Awareness and friendly syste ms communicate data
5	Real-time multi-vehicle coordination	Coordinates information between UAV and ground operations through local sensors
6	Real-time multi-vehicle cooperation	Responsible for onboard sensing without input from ground
7	Battlespace knowledge	Individual task execution to meet goals
8	Battlespace single cognizance	Coordinates tactical group planning, individual task planni ng and execution, choose targets of opportunity
9	Battlespace Swarm Cognizance	Distributes tactical group planning and chooses targets
10	Fully Autonomous	Consciously performs without any assistance or information

Based on types of engines

UAVs are employed for various functions and require different types of engines based on the environment in which they are operated. Turbofans, Two Strike, Piston, Rotary, Turboprop, Push and Pull, Electric, and Propeller are some of the types of engines shown in Table 5 are found in UAVs [46]. The electric and piston engines are the most prevalent engine types utilized in the UAVs examined in this research. The most common types are pistons and electric engines—the size of the engine increases as the weight of the UAV increases. Piston engines are utilized in heavy and more oversized models, whereas electric engines are used in light and miniature models. Endurance and range are two other UAV categories influenced by the type of engine used in the UAV. A well-chosen engine will enhance a UAV's endurance and range [16], [47].

Table 5. UAVs with different engine types.

UAV	Engine type
Desert Hawk	Electric motor
AV Dragon eye	Twin electric motors
AV Pointer	Electric motor
Luna	Electric motor
Raven	Electric
Phoenix	Turbofan
Herron	4-stroke turbo
Dark star	Turbofan
Dragon drone	Piston engine
Global Hawk	Turbofan
Gnat	Rotax piston
Neptune	2-stroke piston
A160	Piston engine
Fire Scout	Rolls Royce Allison
Finder	Piston
Pioneer	Two-stroke
Predator	Piston engine
Shadow	UEL Rotary
Shadow 600	Rotary
LEWK	Prop

UAVS/DRONES FOR DIFFERENT APPLICATIONS

UAV’s technology finds a scope in various military, civil, and agriculture purposes. It can be used for indoor and outdoor missions, especially in difficult situations [48]. It can also be armed with numerous electronic gadgets such as sensors and cameras for intelligence, surveillance, and reconnaissance missions.

This study also emphasizes recent developments and growth in designing drones for current applications and categorized into different fields as per the recent studies with soft computing and communications systems which includes IoT [49]–[51], 5G communications [52], A.I. [53], pest management [54], routing problem [55], and many more [56]–[62]. Apart from this, they studied and explained about UAV's that included drones that can fly at different ranges and endurance depending on the drone capability. Some of the literature has highlighted the development of drones using the latest technologies and materials [63], [64]. Considering aerospace aspects for the study of drones, Muraoka et al. [65] illustrated UAV's design, which featured the aerodynamic configurations and loads to test the prototype flight and aerodynamic characteristics. It is designed with a minor quad tilt-wing UAV to demonstrate the idea and transition for the vertical and horizontal flight using remote manual control. They summarized the wind tunnel data to characterize the importance of aerodynamic of the QTW. A tandem wing idea was achieved and applied for both cruising and hovering stability to design UAV's prototype model. The flight control system permitted continuous movement via phases of all flights to accomplish a vertical takeoff, cruise, accelerating and decelerating transition, and hover landing with sufficient flying qualities. Salih et al. [66] designed the UAV for a quadrotor crewless air vehicle. They used a proportional-integral-derivative (PID) controller. They aimed to create the model of the vehicle as realistic as possible with a stable and accurate controller and enhancing the four input forces to generate the thrust from each Propeller, which was connected at a fixed angle.

When we talk about drones' current technologies and future trends, Haddal and Gertler [67] elaborated on this. These were referred to as UAV's, pilotless aircraft, remotely piloted aircraft/vehicles, robot planes, and other footings that define flying vehicles as the ones that can fly with a remote-control operator with no person onboard. They are more frequently called UAVs, and when they join with the stations of ground control and data links, they form unmanned aerial systems (UAS). UAVs are of different sizes, shapes, and capacities. For example, they can have a wingspan as broad as a Boeing-737 or smaller than a typical radio-controlled airplane [68]. However, they are mostly accompanied by military/defense activity. Also, local law implementation, the private sector, and unethical enthusiasts. This is mainly because of UAV technology's reduced cost and discrete functional compensations over human-crewed vehicles. Cavoukian [64] explained the UAV international community's reference standards to categorize structures depending upon parameters such as flight altitude, takeoff weight (MTOW), endurance, speed, maximum, size, etc. Fig. 7 shows the percentage of UAV use in the last five years.

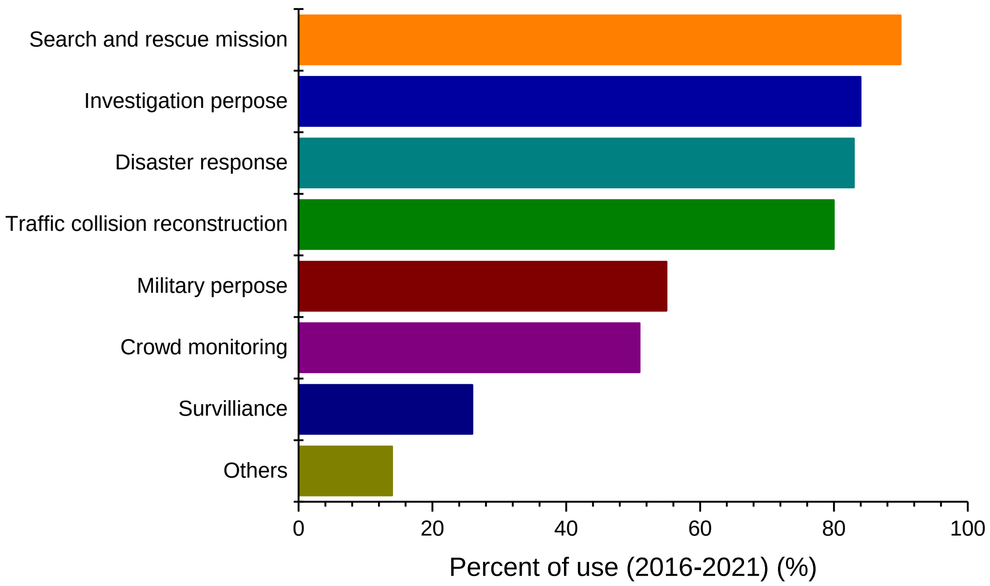

Figure 7. UAV/Drone uses in recent years [67].

CRITICAL ANALYSIS OF LITERATURE

The UAV or drones can be designed with many possible combinations of equipment/gadgets called target-based design. The researchers can fill the gaps and introduce a new type of drone or UAV. Based on the previous study, it has been observed that the drone has many kinds such as UAVs, micro-UAVs, quart copters drones, hex copter drones, etc. These types of drones can be applied to different fields, which were mentioned in section three of this article. Moreover, drones have not only mechanical based design but also involves other engineering disciplines.

The equipment used is related to electronics and communication, such as cameras, control devices, batteries, sensors, actuators, transducers, and many more, are utilized during the drones' design and fabrication. Computer science is being used for coding and monitoring purposes, and some other engineering disciplines, too, were involved. But it is interesting to know that the designing and development of drones requires multidisciplinary knowledge or researcher from different fields, thereby combining their expertise and developing UAVs with advanced features.

Figure 8 illustrates a bucket model that can contain a considerable advantage in three significant aspects. UAV's successful design can result in safe or feasible for any risk, especially cost-efficient drones and use effective techniques compared to practical observation. One of the significant purposes of drones is that they can be used for intelligence gathering, innovative solutions, and as a quick observer. The above techniques fit for a successful design of drones for such applications and missions.

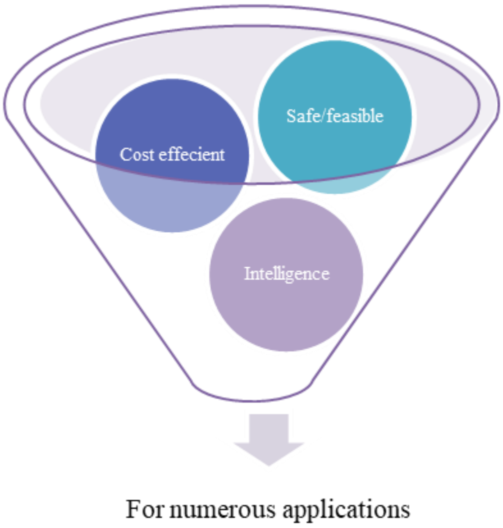

Figure 8. UAV (Drone) benefits.

Furthermore, this review article also introduced soft computing methods on drone performances with few technical backgrounds and enhancements. The IoT enabled drones to help to control the Pandemic. The deep learning algorithms with advanced vision systems enhance drones' features remotely to practice social distancing and wear a mask. The various other services like sanitization, temperature checking, surveillance, and transportation were carried out with advanced cameras and sensors. As this COVID-19 is a contagious disease, the drones with soft computing and artificial intelligence effectively work for contactless services to control and prevent the transmission of this deadly virus.

Challenges and limitations confronted by UAVs/drones technology

1. For drones' safer movement, there is a need to develop collision avoidance algorithms and incorporate them into drone technology to facilitate the delivery of medicines to longer distances without any disruption.
2. There is a requirement to develop an integrated medical system where patient information can be saved and shared with any medical facility; moreover, it can serve for data collection with security according to government policies.
3. The use of UAVs faces political constraints. Legislative uncertainties exist in the rules for regulating drone movement and protecting property from aerial trespassing are still being developed. Thus, UAV technology operates in a legal grey area. There are numerous conflicts between governmental regulations and any state or city laws governing airspace property rights, which may cause drone operators to violate rules they are unaware of. Some countries, such as the United States, have debated the domestic use of drones [104], and several states have banned the use of UAV technology in their airspace. Several governments, including the United Kingdom (UK), EU member states, South Africa, and the US [105-108] have issued a

warning to drone owners, urging them to obtain official licenses to fly their drones for photography purposes. Such issues, however, must be at the forefront of any policy discussion to avoid unintended consequences and achieve the best possible policies.

4. Telecommunication drones are used in rural areas for diagnosis, perioperative assessment, and telemetry. Drones can be reliable medical delivery systems for microbiological and analytical tests, pharmaceuticals, vaccines, emergency care supplies, and patient transport. However, the drones cannot be operated during unfavorable weather conditions which might be quite risky sometimes.

CONCLUSION

The applications of drones are increasing day by day in engineering disciplines as well as in other areas. The drones are primarily used in civil and military applications, carrying out intelligence, surveillance, and reconnaissance missions. Drones can be equipped with numerous electronic devices such as sensors, actuators, and high infra-red cameras for improving their performances in various critical applications. Drones contribute significantly to the area of aerospace engineering research and development. Furthermore, with advanced technology and soft computing methods, drones can be utilized for many practical research purposes with artificial intelligence and the internet of things approach. The study also recommends ideas for future studies on the subject to investigate the gaps, which is the usage of drones in transportation. This review article provides the strategies that can help the investigators, predominantly within the initial stage of this field, arise with new innovative concepts.

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