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Unmanned Aerial Vehicles (UAVs) According to Engine Type

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Abstract

Unmanned Aerial Vehicles (UAVs) can be classified according to their civilian and military use and performance characteristics such as weight, distance to air, wing load, range and speed. In this study, the types of engine used in unmanned aerial vehicles and the advantages, disadvantages and differences between these types of engines are mentioned. Unmanned Aerial Vehicles(UAV) are used in many different tasks and need different engine types depending on the area they are used to perform these tasks. Two-stroke, Turbofan, Turboprop, Piston engine, Electric and Propeller types are different types of engines used in Unmanned Aerial Vehicles(UAV). Piston engines and electric engines are the most commonly used types. Unmanned Aerial Vehicles(UAV) also vary in engine size and type, as well as aircraft sizes and weights, as in humans. Electric engines are generally used in light and small models, while piston engines are used in heavy and large models.

Keywords: Unmanned aerial vehicles (UAVs) , Engine.

1. Introduction

They are, in their simplest terms, vehicles that can be manipulated by remote control, autonomously directing themselves or both, loading and unloading their useful cargo into their main body, and landing at the end of the mission. In other words, these tools are also called "drone". In recent years, "Unmanned Aerial Vehicle Systems" have just started to be used for these new unmanned vehicles, mostly known as "unmanned aerial vehicles" in the development process. The reason is that the unmanned aerial vehicle implies only the aircraft platform and cannot meet the entire system that is flying it. But both countries and institutions seem to use different terminologies for air vehicles. For example, while Israel's official open sources are often referred to simply as "unmanned aerial vehicles", British and European Union official open sources seem to use the concept of "Remotely Piloted Aircraft Systems (RPAS)", a sub-component of unmanned aerial vehicles. Despite this, the notion of "unmanned aerial vehicle system", which is used both by the sector representatives and by the country as the most

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accepted concept in the literature, stands out because it expresses the whole of the system. With the revolution in the military technology that lived in the 90s, the unmanned aerial vehicles that can be operated in any weather condition for a longer time, much more remotely controlled, have come to the point where intelligence, exploration and surveillance tasks are indispensable. From the beginning of the 2000's, the use of the armed versions started. The work of the world public to recognize and perceive these systems has also been influenced by the effects of armed versions. The unmanned aerial vehicle system has a complex structure and can perform its function by integrating various elements. In other words, it is a system that requires coordinated and coordinated operation of multiple components as shown in Figure 1. Unlike the flying of human systems, it is a system that brings together the sub-elements and works in a synchronized manner [1].

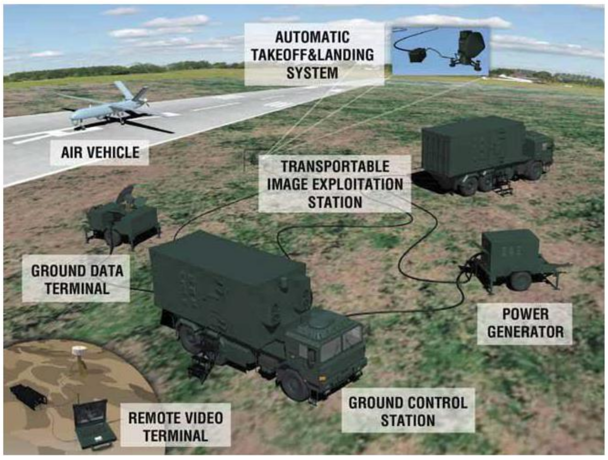

Figure 1. Unmanned Aerial Vehicle (UAV) Components [2]

2. Classification of Unmanned Aircraft System

Unmanned Aerial Vehicles (UAV) can be classified according to their civilian and military use and performance characteristics such as weight, distance to air, wing load, range and speed. UAVs can be classified according to their performance characteristics such as weight, wing load, endurance, range, wing span, maximum height and speed at which they can take off. Classifying UAVs according to their performance characteristics is useful for UAV designers, manufacturers and customers to meet their needs.

2.1. Classification by weight

UAVs have a wide range of micro UAVs weighing several kilograms in weight, up to the Global Hawk (Tier III), which weighs 11 tons, as shown in Figure 2.

Figure 2. Global Hawk (Tier III) [3].

Classification of UAVs was made by taking the weight ranges into consideration while classifying the weights. This classification is given in Table 1.

Table 1. Classification of UAVs weights [4].

Category	Weight Range	Sample UAVs
Too heavy	>2000 Kg	Global Hawk
Heavy	200 - 2000 Kg	A - 160
Middle	50 - 200 Kg	Raven
Light	5 - 50 Kg	RPO Midget
Micro	<5 Kg	Dragon Eye

2.2. Classification According to Duration And Range Of Air

Airborne duration and range are important factors to consider when classifying UAVs. These two parameters are usually interrelated for a long UAV operation. For UAV designers it is important to consider these two parameters when determining the UAV type. In addition, with these parameters it is possible to determine how long the UAV will be fueled regularly and how long it will remain in service. Three types of classification are possible, long, medium and short, depending on the duration of the air and the range. Table 2 summarizes the classification of UAVs according to the duration of airborne and range.

Table 2. Classification of Uavs According To The Duration of Flight and Flight Range [4].

Category	Endurance	Range	Sample UAVs
Long	> 24 Saat	> 1500 Km	Predator B
Middle	5 - 24 Saat	100 - 400 Km	Silver Fox
Short	< 5 Saat	< 100 Km	Pointer

2.3. Classification By Altitude

When some UAVs used for military purposes are selected, UAVs are required to fly at high altitudes in order to be detected and destroyed by the enemy, while UAVs that are used for civilian purposes are required to fly at UAV low altitudes. One of the important factors in the classification of UAVs is the ease of selection of the desired elevation of the exit elevation, which the end buyers need. The altitude at which UAVs can exit can be classified into three levels: low, normal, and high altitude. Table 3 gives the classification according to the height at which UAVs can occur.

Table 3. Classification of UAVs By Altitude [4].

Category	Maximum Altitude	Sample UAVs
Low	< 1000 m	Pointer
Middle	1000 - 10000 m	Finder
High	> 10000 m	Darkstar

2.4. Classification According to Wing Loading

Another classification method, wingletting, is one of the important factors in the classification of UAVs. For a UAV, the wing load calculation is obtained by dividing the total weight into the wing area. UAVs are classified into 3 types as shown in Table 4., considering the wing loading rates.

Table 4. Classification of UAVs According to Wing Loading [4].

Category	Wing Loading (kg/m^2)	Sample UAVs
Low	< 50	Seeker
Middle	50 - 100	X - 45
High	> 100	Global Hawk

2.5. Classification by Engine Type

UAVs are used in many different tasks and require different types of engines depending on the area they are used to perform these tasks. Table of UAVs is given according to the engine type used in Table 5. Two-stroke, Turbofan, Turboprop, Piston, Electric, and Propeller types are the different types of engines used in IHA. Piston and electric engines are the most widely used types. UAVs also vary in size and type of engine, in proportion to aircraft size and weight, as in human aircraft. Electric engines are generally used in light and small models, piston engines are used in heavy and large models.

Table 5. Examples of UAVs According To Engine Types [4].

Wankel	Turbophan	Turboprop	Piston	Electric
RQ-7A Shadow 200	Darkstar	Predator B	Neptune	Dragon Eye
Sikorsky Cypher	Global Hawk		Dragon Drone	Dragon Warrior
	Phoenix		Finder	Pointer
	X - 45		A 160	Raven
	X - 50		GNAT	Luna
	Fire Scout		Crecerelle	Javelin
			Seeker	
			Brevel	
			Snow	
			Goose	
			Silver Fox	
			Heron	

A classification with international validity for UAVs is not available at this time. Each country has its own classification. Some classifications are made by such factors as altitude, duration of air stay and departure weight. The classification of UAVs according to performance characteristics, such as duration of airborne occupancy, weight and altitude.

If the performance required by an Unmanned Aerial Vehicle (UAV) is similar to that of conventional aircraft, the drive system may be similar. Many unmanned aerial vehicles will fly at subsonic and supersonic speeds at altitudes of less than 1000 pounds, at altitudes below 60,000 feet, maneuver at a speed of 9 g or less, and will be protected in the same manner as existing military or commercial aircraft. These unmanned aerial vehicles will not need unique drive technology. Indeed, every new aircraft is designed to use existing engines to prevent the time and expense of developing new engines. In this section, the concepts of Unmanned Aerial Vehicles (UAVs) that need new drive technology are discussed. A few classes of Unmanned Aerial Vehicle (UAV) require unused engine innovation, modern plans, or indeed modern essential investigate and impetus concepts. For illustration, a Tactical Unmanned Aerial Vehicle (TUAV) may require a gas turbine engine that can work at much more than the 9g powers that constrain kept an eye on vehicles. For tall g loadings, the whole engine structure, particularly the rotor back, will have to be reevaluated. An engine able of maneuvering at 30g, for case, would require unused plan concepts that could require impressive building advancement but not modern essential inquire about. By the by, for a few UAVs, the drive framework is a basic restricting innovation. These incorporate subsonic Sound flying machine that must work over the elevation limits of current engine advances; micro aircraft vehicles; and exceptionally low-cost, high-performance vehicles. The Gas Turbine Engine is unfathomably prevalent to elective engines in all impetus measurements. This tall level of execution reflects the inborn merits of the concept and the $50 billion to $100 billion contributed in gas turbine investigate and advancement. The power-to-weight proportion of gas turbines is three to six times that of airplane piston engines. The contrast in unwavering quality is indeed more prominent [5] Vibration and noise, numerous moving parts, Seal and lubrication requirements, Cooling neccessities are some disadvantages of piston engines. Possibly light weight, Possibly small sizes, Supports forced-induction for high altitude use are some advantages of piston engines.

Table 6. Conceptual Decomposition of Piston Engines

Propulsion System	Conceptual Unit	Description
Reciprocating Piston Engine	Energy source	Petroleum distillates
	Energy transformer	Heat production and expanding volumes resulting from contained combustion of petroleum distillates
	Powerplant	Piston motion resulting from expanding volumes, which in turn, rotate the crankshaft
	Propulsion effecter	Propeller or fan unit driven directly or indirectly (geared) by the crankshaft
	Control effecter	Throttle, regulation of fuel flow

Table 7. Technical Issues of An Piston Engine

Technical Issue	Applicability to UAS Context
Crankshaft Weakness	For engines large enough for manned systems, this is largely covered in the CFRs. The issue here is with smaller engines, where it may be sufficient
Noise	Noise in manned aircraft interferes with in-flight communication and alerts ground personnel to engine activity. In small UAS, those issues may not apply. However, smaller engines are quieter and may not have loud enough launch personnel alerting volume. However, there is no effect on the nonexistent pilot's ability to hear in-flight communication.
Vibration	As in manned vehicles, vibration can affect long-term reliability.
Seals	Over time, seals can fail, which leads to power loss and/or potential critical failure
High Temperature	As in manned vehicles, the engine can fail or seize if heat is not removed from the engine fast enough.

The project, which was signed between TEI and the Undersecretariat of Defense Industry (SSM) on 27 December 2012, includes the development of a turbodiesel aviation engine with superior technical features in line with the needs of MALE class unmanned aerial vehicles. Qualification and certification of civil projects expected to be completed in 2018 with Turkey MALE class will have superior national turbodiesel engine that can be used in unmanned aerial vehicles. Detailed design studies have come to the prototype production stage in the ongoing project in the process of certification processes. EASA CS-E scope of the project on the basis of Airworthiness and Certification on the basis of EASA Part 21 Design Organization for Competency Assurance (Piston Engines) that will be a first in Turkey. The dual-stage turbocharged diesel PD170 UAV engine is shown in figure 3.

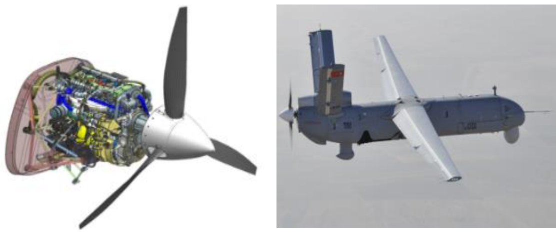

Figure 3. Dual Stage Turbocharged Diesel Aviation Engine PD170 [6].

The advantages of the Operational HVAC Engine compared to the existing MALE class HVAC engines are listed below:

• More Power, Higher Power / Weight Ratio

• More Altitude Power Capability

• Lower Fuel Consumption

• More Compact Design

• Certification of Fulfillment in Compatibility with Civil Hijacking Standards and Military Standards

• Original Engine Control System Software and Hardware (Open code, enhanceable)

• Fast Technical and Logistic Support

• Potential to increase power as needed

Like piston engines, Wankel revolving engines utilize the burning of oil distillates to produce warmth and work, and the coveted yield is the pivot of a power shaft that drives whatever is left of the framework. Wankel revolving engines contrast from customary responding engines in that their volume dislodging and related inner movement happens in a rotational manner, rather than a forward and backward way. An interior triangular center with bended sides separates a chamber with an epitrochoid-formed stator into three development territories. As the center turns a capricious shaft (figure 4.), the emptied sides of the bended triangular rotor (figure 4.) pack a vaporous volume against the sides of the fenced in area. A start occasion happens, extending this volume and propagating the turn of the center and shaft and proceeding with the burning cycle, creating usable work and waste warmth [7].

Figure 4. Wankel Rotary Engine Eccentric Shaft, Bathtub Face of Wankel Rotor, Wankel Rotor and Stator [7]

Higher power yield for comparative relocation, Iron rotor in aluminum lodging decreases probability of engine seizure, Lighter weight than heritage or pressure start engines, Much calmer than responding engines, Lower vibration than responding engines are som points of interest of the Wankel rotational engine. Fluid cooled engine adds to weight and many-sided quality, disappointment modes, half higher fuel utilization than practically identical diesel engines, Higher electromagnetic and warm marks contrasted with diesel engine, Limited data concerning specialized achievement of Wankel revolving engines, Potential trouble meeting outflow guidelines are a few weaknesses of the Wankel rotational engine [10].

A gas turbine engine is an internal combustion engine operating on a highly dynamic process, investing work to process air and fuel in a way that yields high-velocity output thrust as the return on investment. A gas turbine engine comes in various forms, and the three described in particular are the jet turbine engine, turbofan engine, and turboprop engine [7].

At the point when maybe a low-determination portrayal of a stream turbine, thoughtfully, the vitality substance of the items versus the reactants (deplete) is separated to deliver movement in a controllable response. Nonetheless, the immediate fly approach has enough proficiency downsides that, in a few applications, a turbofan is more proper. A turbofan takes a shot at a comparable guideline as a stream turbine, aside from that more work is sapped from the high energy fumes gas to drive a fan component, exchanging off some immediate push for extra fandriven push . A turboprop engine works on a comparable guideline as a turbofan, with the exception of that rather than a part, the majority of the high-vitality yield is utilized to drive a turbine that is equip coupled to a propeller. A turboshaft is like the turboprop aside from that the power is provided to a pole as opposed to a propeller [8].

Gas turbine engines are field tried and demonstrated solid impetus components, but are classically exceptionally huge and overwhelming. Advanced advancements have yielded the unused concept of microturbine engines, which are gas turbine engines little sufficient to be held by a single person and create pushed yields on the arrange of tens of pounds [9]. While occurrences exist of unmanned aircraft system that actualize each already said variation of the gas turbine engine, there are no known examples of little unmanned aircraft system that utilize a micro turbine engine. Be that as it may, industry producers have acknowledged the potential of micro turbine engines for Unmanned Aircraft System applications and have responded accordingly. Examples of gas turbine engines are shown in Table 8. [10].

Table 8. Properties of the Northrop Grumman RQ-4A Global Hawk (Gas Turbine)

UAS Characteristics		Propulsion Characteristics	
Vehicle Dimension	Length 44.4 ft Wingspan 116.2 ft	Propulsion Class	Gas turbine engine
Vehicle Gross Weight	26,750 lb	Propulsion Subclass	Turbofan
Payload Data	1,950-lb capacity	Propulsion Unit Make	Rolls Royce AE- 3007H '
Endurance RangeTime	5,400 nm/32 hr	Propulsion Unit Weight	Engine: 1,5861b
Ceiling	65.000 ft	Power Output	8,290-Ib thrust

Some advantages of turbine engines are:

High power density, Enormous thrust capacity, Not limited to sound barriers like propeller blades, Good efficiency at 30% load, Insensitive to fuel quality, Use of air bearings, auxiliary lubrication fluid or oil need [11].

Costly, Complex systems, High speed rotation, Working at high temperatures are some disadvantages of gas turbine engines. Electric engines work as a power source to generate rotational motion from electrical energy. For electrically driven drive systems, the electric engines are used as a power source because they can be easily combined with propellers as a propulsive effect; everything needed is a constant source of electricity [12].

Table 9. Solong Electric Engine

UAS Characteristics		Propulsion Characteristics	
Vehicle Dimension	Wingspan 4.75 m	Propulsion Class	Electric Motor
Vehicle Gross Weight	12.6 kg (28 lb)	Propulsion Subclass	DC motor
Payload Data	Unavailable	Propulsion Unit Make	Kontronik Tango 4506 3-phase, brushless, ironless motor with 4.2:1 planetary gear reduction
Endurance RangeTime	48+hr	Propulsion Unit Weight	300 g
Ceiling	8000 m	Power Output	Max motor power 800W

Low maintenance cost, Safe, Electrically operated, Robust, Less trouble surrounding overheating as opposed to thermodynamic engines, High torque power, Scalability, Silent operation are some of the advantages of electric engine systems.

Some of the disadvantages of electric engine based systems are that they are sensitive to large currents, electromagnetic field, water and other conductive fluids.

3. Results

For this study, Unmanned Aircraft System propulsion systems were investigated. The research results show that there are several types of drive systems with different power sources used in the Unmanned Aerial Vehicle System. Their dimensions range from fully certified turbine engines with fewer trailers used in transport category aircraft. As such new power supplies are often used to meet operational needs. In summary, many of these propulsion systems, which are unique to unmanned aerial vehicle systems, are not traditionally considered to be present at the present regulatory standards. It is largely due to the unique operational objectives of the unmanned aerial system with specific mission requirements that are significantly different from human aviation [13]. Piston engines and electric engines are the most commonly used types. Unmanned Aerial Vehicles (UAV) also vary in engine size and type, as well as aircraft sizes and weights, as in humans. Electric engines are generally used in light and small models, while piston engines are used in heavy and large models. It is anticipated that the data obtained in this way will be brought to the forefront of many driver frameworks that are required in order to implement administrative guidelines. In this archive, various technical topics related to each frame are displayed. In response to the desire for an unmanned aircraft system, it is recommended that current regulations be re-audited to understand and address the unused issues that arise with new technologies [14].

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