Nano Unmanned Aerial Vehicles - Drone or Helicopter in Military

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Abstract:- **An unmanned Aerial vehicle (UAV) (or un crewed aerial vehicle, commonly known as a Drone) is an aircraft without a human pilot on board and a type of unmanned vehicle. The nano is a military micro unmanned aerial vehicle (UAV) in use by the armed forces of the United States, France, the United Kingdom, Germany, Australia, Norway, the Netherlands and India. The unit measures around 10*2.5 cm (4*1 in) and provides troops on the ground with local situational awareness. They are small enough to fit in one hand and weigh just over half an ounce (16 g, including batteries). The UAV is equipped with triple cameras(one looking forward, one looking straight down, one pointing downward at 45 degrees), which gives the operator full-motion video and still images. An operator can be trained to operate the nano UAV in as little as 20 to 25 minutes. Top speed is 11 mph (18 km/h).**

INTRODUCTION:

An unmanned Aerial vehicle (UAV) (or un crewed aerial vehicle, commonly known as a Drone) is an aircraft without a human pilot on board and a type of unmanned vehicle. UAVs are a component of an Unmanned Aircraft System (UAS); which include a UAV, a ground-based controller, and a system of communications between the two. The flight of UAVs may be operating with various degrees of autonomy (i.e., either under remote control by a human operator or autonomously by onboard computers. Compared to crewed aircraft, UAVs were originally used for missions too "dull, dirty or dangerous" for humans. While they or we originated mostly in military applications, their use is rapidly expanding to commercial, Scientific, recreational, agriculture, and other applications, such as policing and surveillance, product deliveries, aerial photography, smuggling, and drone racing. Civilian UAVs now vastly outnumber military UAVs, with estimates of over a million sold by 2015.

TERMINOLOGY:

Multiple terms are used for unmanned aerial vehicles, which generally refer to the same concept. The term **drone**, more widely used by the public, was coined in reference to early remotely-flown target aircraft used for practice firing of the battleships' guns, and the term was first used with the 1920s Fairey Queen and 1930s de Havilland Queen Bee target aircraft. The term unmanned aircraft system (UAS) was adopted by the United States Department of Defense (DoD) and the United States Federal Aviation Administration in 2005 according to their Unmanned Aircraft System Roadmap 2005-2030. The International Civil Aviation Organization (ICAO) and British Civil Aviation Authority adopted this term, also used in the European Union's Single-European-Sky (SES) Air-Traffic-Management (ATM) Research (SESAR Joint Undertaking) roadmap for 2020. A UAV is defined as a "powered, aerial vehicle that doesn't carry a human operator, uses aerodynamics forces to provide vehicle lift, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or nonlethal payload". Therefore, missiles are not considered UAVs because the vehicle itself is a weapon that is not reused, though it is also uncrewed and in some cases remotely guided.

HISTORY:

The earliest recorded use of an unmanned aerial vehicle for warfighting occurred on July 1849, serving as a balloon carrier (the precursor to the aircraft carrier) in the first offensive use of air power in naval aviation. UAV innovations started in the early 1900s and originally focused on providing practice targets for training military personnel. UAV development continued during World War I, when the Dayton-Wright Airplane Company invented a pilotless aerial torpedo that would explode at a preset time. CAPECON was a European Union project to develop UAVs, running from 1 May 2002 to 31 December 2005. As of 2012, the USAF employed 7494 UAVs – almost one in three USAF aircraft. The Central Intelligence Agency also operated UAVs. In 2013 at least 50 countries used UAVs. China, Iran, Israel, Pakistan, and others designed and built their own variants.

CLASSIFICATIONS OF UAVS:

UAVs typically fall into one of six functional categories (although multi-role airframe platforms are becoming more prevalent):

- Target and decoy – providing ground and aerial gunnery a target that simulates an enemy aircraft or missiles
- Reconnaissance – providing battlefield intelligence
- Combat – providing attack capability for high-risk missions (see: Unmanned Combat Aerial Vehicle (UCAV))
- Logistics – delivering cargo
- Research and development – improve UAV technologies
- Civil and commercial UAVs – agriculture, aerial photography, data collection

Vehicles can be categorized in terms of range/altitude. The following has been advanced as relevant at industry events such as ParcAberporth Unmanned System forum:

- Hand-held 2000 ft (600 m) altitude, about 2 km range
- Close 5000 ft (1500 m) altitude, up to 10 km range
- NATO type 10000 ft (3000 m) altitude, up to 50 km range
- Tactical 18000 ft (5500 m) altitude, about 160 km range
- MALE (medium altitude, long endurance) up to 30000 ft (9000 m) and range over 200 km
- HALE (high altitude, long endurance) over 30000 ft (9100 m) and indefinite range
- Hypersonic high-speed, supersonic (Mach 1 – 5) or hypersonic (Mach 5+) 50000 ft (15200 m) or suborbital altitude, range over 200 km
- Orbital low earth orbit (Mach 25+)
- CIS Lunar Earth-Moon transfer
- Computer Assisted Carrier Guidance System (CACGS) for UAVs

Other categories include:

- Hobbyist UAVs – which can be further divided into
  - Ready-to-fly (RTF)/Commercial-off-the-shelf (COTS)
  - Blind-and-fly (BNF) – require minimum knowledge to fly the platform
  - Almost-ready-to-fly (ARF)/Do-it-yourself (DIY) – require significant knowledge to get in the air
  - Bare frame – requires significant knowledge and own parts to get it in the air
- Midsize military and commercial UAVs
- Large military-specific UAVs
- Stealth combat UAVs
- Crewed aircraft transformed into uncrewed (and Optionally Piloted UAVS or OPVs)

Classifications according to aircraft weight are quite simpler:

- Micro air vehicle (MAV) – the smallest UAVs that can weigh less than 1 g
- Miniature UAV (also called SUAS) – approximately less than 25 kg
- Heavier UAVs

UAV COMPONENTS:

Crewed and uncrewed aircraft of the same type generally have recognizably similar physical components. The main exceptions are the cockpit and environmental control system or life support systems. Some UAVs carry payloads (such as a camera) that weigh considerably less than an adult human, and as a result can be considerably smaller. Though they carry heavy payloads, weaponized military UAVs are lighter than their crewed counterparts with comparable armaments. Small civilian UAVs have no life-critical systems, and can thus be built out of lighter but less sturdy materials and shapes, and can use less robustly tested electronic control systems. For small UAVs, the quadcopter design has become popular, though this layout is rarely used for crewed aircraft. Miniaturization means that less-powerful propulsion technologies can be used that are not feasible for crewed aircraft, such as small electric motors and batteries. Control systems for UAVs are often different than crewed craft. For remote human control, a camera and video link almost always replace the cockpit windows; radio-transmitted digital commands replace physical cockpit control. Autopilot software is used on both crewed and uncrewed aircraft, with varying feature sets.

BODY:

The primary difference for planes is the absence of the cockpit area and its windows. Tailless quadcopters are a common form factor for rotary wing UAVs while tailed mono-copter and bi-copters are commonly for crewed platforms.

POWER SUPPLY AND PLATFORM:

Small UAVs mostly use lithium-polymer batteries (Li-Po), while larger vehicles rely on convectional airplane engines. Scale or size of aircraft is not defining or limiting characteristic of energy supply for a UAV. At present, the energy density of Li-Po is far less than gasoline. Battery elimination circuit (BEC) is used to centralize power distribution and often harbors a microcontroller unit (MCU). Costlier switching BECs diminish heating on the platform.

COMPUTING:

UAV computing capability followed the advances of computing technology, beginning with analogy controls and evolving into microcontrollers, then system-on-a-chip (SOC) and single-board computers (SBC). System hardware for small UAVs is often called flight controller (FC), flight controller board (FCB) or autopilot.

SENSORS:

Position and movements sensors give info about the aircraft state. Exteroceptive sensors deal with external information like distance measurements, while expropriceptive ones correlate internal and external states. Non-cooperative sensors are able to detect targets autonomously so they are used for separation assurance and collision avoidance. Degree of freedom (DOF) refers to both the amount and quality of sensors on-board: 6 DOF implies 3-axis gyroscopes and accelerometers (a typical inertial measurement unit – IMU), 9 DOF refers to an IMU plus a compass, 10 DOF adds a barometer and 11 DOF usually adds a GPS receiver.

ACTUATORS:

UAV actuators include digital electronic speed controllers (which control the RPM of the motors) linked to motors/engines and propellers, servomotors (for planes and helicopters mostly), weapons, payload actuators, led's and speakers.

SOFTWARE:

UAV software called the flight stack or autopilot. UAVs are real-time systems that require rapid response to changing sensor data. Examples include Raspberry Pis, Beagleboards, etc…, shielded with NavIO, PXFMini, etc…, or designed from scratch such as Nuttx, preemaptive-RT Linux, Xenomai, Orocos-Robot Operating System or DDS-ROS 2.0.

LOOP PRINCIPLES:

UAVs employ open-loop, closed-loop or hybrid control architectures.

- Open Loop – This type provides a positive control signal (faster, slower, left, right, up, down) without incorporating feedback from sensor data.
- Closed Loop – This type incorporates sensor feedback to adjust behavior (reduce speed to reflect tailwind, move to altitude 300 feet). The PID controller is common. Sometimes, feed forward is employed, transferring the need to close the loop further.

FLIGHT CONTROLS:

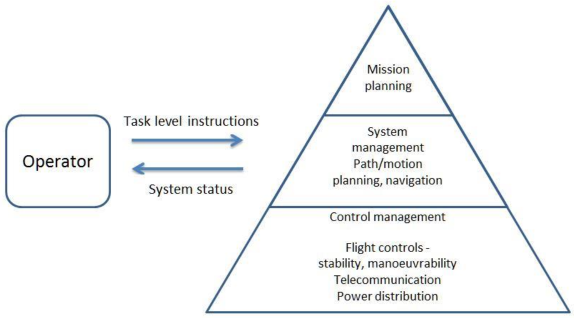
UAVs can be programmed to perform aggressive maneuvers or landing/perching on inclined surfaces, and then to climb toward better communication spots. Some UAVs can control flight with varying flight modelisation, such as VTOL designs. UAVs can also implement perching on a flat vertical surface.

COMMUNICATIONS:

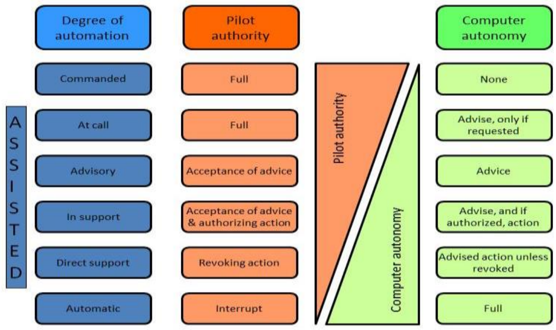
Most UAVs use a radio for remote control and exchange of video and other data. Early UAVs had only narrowband uplink. Downlinks came later. These bi-directional narrowband radio links carried command and control (C&C) and telemetry data about the status of aircraft systems to the remote operator. For very long range flights, military UAVs also use satellite receivers as part of satellite navigation systems. In cases when video transmission was required, the UAVs will implement a separate analog video radio link. The radio signal from the operator side can be issued from either:

- Ground control – a human operating a radio transmitter/receiver, a smartphone, a tablet, a computer, or the original meaning of a military ground control station (GCS).
- Remote network system, such as satellite duplex data links for some military powers. Downstream digital video over mobile networks has also entered consumer markets, while direct UAV control uplink over the cellular mesh and LTE has been demonstrated and are in trails.
- Another aircraft, serving as a relay or mobile control station – military manned-unmanned teaming (MUM-T).
- A protocol MAVLink is increasingly becoming popular to carry command and control data between the ground control and the vehicle.

AUTONOMY:



ICAO classifies uncrewed aircraft as either remotely piloted aircraft or fully autonomous. Actual UAVs may offer intermediate degrees of autonomy. E.g., a vehicle that is remotely piloted in most contexts may have an autonomous return-to base operation.



APPLICATIONS:

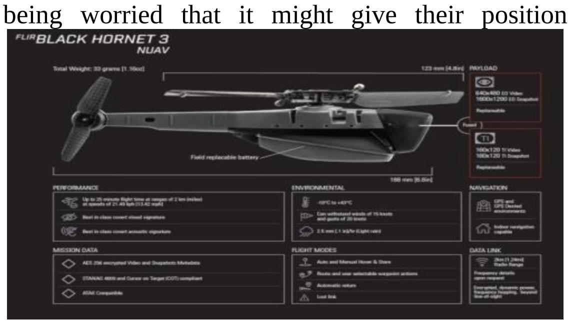
These are numerous civilian, commercial, military, and aerospace applications for UAVs. These include:

- *CIVIL*
  Disaster relief, Archeology, conversation of biodiversity and habitat, law enforcement, crime, and terrorism.
- *COMMERCIAL*
  Aerial surveillance, filmmaking, journalism, scientific research, surveying, cargo transport, and agriculture.

- *MILITARY*

  Reconnaissance, attack, demining, and target practice.

"The equipment is getting smaller and the reason its getting smaller is so the Soldier can be equipped with this", "This thing, you can really pocket it and just carry it". All of this, along with a number of the other more minor parts, as well as the user's manual, comes inside a foam-lined, ruggedized container. For its compact size and weight, the system, which the Army officially calls the Soldier Borne Sensor (SBS), offers impressive capabilities. Each nano UAV has two daytime video cameras, as well as a thermal imager. All of these systems can capture still images for further analysis, too. During nighttime operations, the drone fuses the feeds from both its electro-optical the thermal imaging system to create higher fidelity imagery. It can stay aloft for up to 25 minutes and has a maximum range of 1.24 miles, allowing the operator to send it well ahead of their position to look for threats and other items of interest. It's very quiet, too, allowing troops to use it regularly, day or night, without being worried that it might give their position away.



CONCLUSION:

"This nano UAV is smallest size of those UAVs and easy to carry and take it inside in soldier's back-pack. All of this, along with a number of the other more minor parts, as well as the user's manual, comes inside a foam-lined, ruggedized container. For its compact size and weight, the system, which the Army officially calls the Soldier Borne Sensor (SBS), offers impressive capabilities. Vision-based navigation I an autonomous mode where the drone uses the feeds from its cameras, coupled with a computer algorithm, to determine is relative position and avoid obstacles. This nano UAVs is sustained with various conditions (Weather Proof). In this Nano UAVs is very useful to Defense Sector (Military Purpose). i.e., easily to rescues people in terrorist, easily to attack, easily to identify the enemies, where they located, etc…,

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