

Unmanned Aerial Vehicle

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Abstract: *The UAV is used for Unmanned Aerial Vehicle, which is an aircraft without pilot on board. UAV may be flown remotely by humans or may be capable of flying autonomously. UAVs are commonly used in both the military and police forces in situations where the risk of sending a human piloted aircraft is unacceptable, or the situation makes using a manned aircraft impractical. An unmanned aerial vehicle, commonly known as a drone and also referred to as an unpowered aerial vehicle and a remotely piloted aircraft (RPA) by the International Civil Aviation Organization (ICAO), is an aircraft without a human pilot aboard. UAVs could become the next major tech revolution to sweep the world and are already being used for all sorts of reasons that extend far beyond their original military and special operation purposes.*

Keywords: *Remotely Piloted, Aircraft, UAV, Radar.*

I. INTRODUCTION

The term UAV is an abbreviation of Unmanned Aerial vehicle, meaning aerial vehicles which operate without a human pilot. UAVs are commonly used in both the military and police forces in situations where the risk of sending a human piloted aircraft is unacceptable, or the situation makes using a manned aircraft impractical. One of the predecessors of today's fully autonomous UAVs were the "aerial torpedoes", designed and built during World War One. These were primitive UAVs, relying on mechanical gyroscopes to maintain straight and level flight, and flying until they ran out of fuel. They would then fall from the sky and deliver an explosive payload. More advanced UAVs used radio technology for guidance, allowing them to fly missions and return. They were constantly controlled by a human pilot, and were not capable of flying themselves. This made them much like today's RC model airplanes which many people fly

as a hobby. It is interesting to note that the government considers all aircraft UAVs, if they are unmanned and used by a government or business. After the invention of the integrated circuit, engineers were able to build sophisticated UAVs, using electronic autopilots. It was at this stage of development that UAVs became widely used in military applications. UAVs could be deployed, fly themselves to a target location, and either attack the location with weapons, or survey it with cameras and other sensor equipment. Modern UAVs are controlled with both autopilots, and human controllers in ground stations. This allows them to fly long, uneventful flights under their own control, and fly under the command of a human pilot during complicated phases of the mission.

II. UAV SYSTEM OVERVIEW

BLDC MOTOR: Brushless DC electric motor (BLDC motors, BL motors) also known as electronically commutated motors (ECMs, EC motors) are synchronous motors that are powered by a DC electric source via an integrated inverter/switching power supply, which produces an AC electric signal to drive the motor. In this context, AC, alternating current, does not imply a sinusoidal waveform, but rather a bi-directional current with no restriction on waveform. Additional sensors and electronics control the inverter output amplitude and waveform (and therefore percent of DC bus usage/efficiency) and frequency (i.e. rotor speed). The rotor part of a brushless motor is often a permanent magnet synchronous motor, but can also be a switched reluctance motor, or motor. Brushless motors may be described as stepper motors; however, the term stepper motor tends to be used for motors that are designed specifically to be operated in a mode where they are frequently stopped with the rotor in a defined angular position. This page describes more general brushless motor principles, though there is overlap.

ELECTRONIC SPEED CONTROLLER: An electronic speed control or ESC is an electronic circuit with the purpose to vary an electric motor's speed, its direction and possibly also to act as a dynamic brake. ESCs are often used on electrically powered radio controlled models, with the variety most often used for brushless motors essentially providing an electronically generated three-phase electric power low voltage source of energy for the motor. An ESC can be a stand-alone unit which plugs into the receiver's throttle control channel or incorporated into the receiver itself, as is the case in most toy-grade R/C vehicles. Some R/C manufacturers that install proprietary hobby-grade electronics in their entry-level vehicles, vessels or aircraft use onboard electronics that combine the two on a single circuit board.

POLYCARBONATE SHEET: Polycarbonates (PC) are a group of thermoplastic polymers containing carbonate groups in their chemical structures. Polycarbonates used in engineering are strong, tough materials, and some grades are optically transparent. They are easily worked, molded, and thermoformed. Because of these properties, polycarbonates find many applications. Polycarbonates do not have a unique Resin identification code (RIC) and are identified as "Other", 7 on the RIC. Products made from polycarbonate can contain the precursor monomer bisphenol A (BPA). Polycarbonate is also known by a variety of trademarked names, including Lexan, Makrolon, and others.

SERVOMOTOR: A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. Servomotors are not a specific class of motor although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system. Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.

RADIO CONTROL: Radio control (often abbreviated to R/C or simply RC) is the use of radio signals to remotely control a device. Radio control is used for control of model vehicles from a hand-held radio transmitter. Industrial, military, and scientific research organizations make use of radio-controlled vehicles as well.

III. BLOCK DIAGRAM

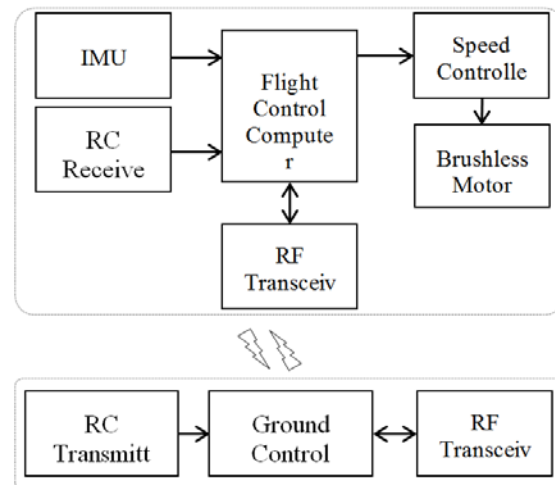


Fig. 1. Block Diagram

IV. WORKING AND PRINCIPLE

UAVs are complicated machines, and it's a true feat of engineering to be able to design and build them feasibly. To do so, however, requires an in-depth understanding of the underlying physics. A UAV has to be able to sense its position, velocity, acceleration, and many of the other variables that describe its motion. All of these ideas are clearly defined and described in the laws of physics, and understanding them can answer many questions about UAV flight characteristics. In this article, we'll focus on VTOL (Vertical Takeoff and Landing) UAVs like our Draganflyer X6, but the same concepts apply to all other air vehicles and UAVs.

SOME BASIC CONCEPT: Before we can explain more complicated ideas (like how airfoils and accelerometers work), an understanding of a few basic physical principles is needed. These include force, mass, and acceleration. We're going to skip a more thorough explanation (which would require calculus), and instead use a purely algebraic approach.

MASS: Mass is a quantity that defines how an object interacts with a gravitational field, and how acceleration, momentum, energy and similar concepts work. Mass is commonly associated with weight, and it's true that an increase in mass results in an increase in weight, but they are two separate concepts. Weight is a force – a push or pull on an object, while mass is a quantity intrinsic to a particular object. The SI (International System) unit of mass is the Kilogram, equal to a weight of 1000 grams. Kilograms are different from pounds – a pound is a unit of force, which we will describe shortly.

VELOCITY: Velocity is often used as a synonym for speed, but as with mass and weight, they are two separate ideas. Speed measures how fast something is moving, without reference to the direction that it's traveling. Velocity keeps track of both speed and direction, giving a more complete picture of the behavior of an object. The direction is given as an angle, measured with respect to some reference. Angle usually has units of degrees, of which there are 360 in a complete circle.

ACCELERATION: Acceleration describes the rate at which velocity changes. You can find the average acceleration of an object by dividing the change in velocity (ΔV) by the time interval in which that change takes place (ΔT). The result becomes more precise as you let ΔT and ΔV get smaller, and as they become infinitely small, the calculation becomes precise. Acceleration is measured by an electronic device called an accelerometer. Our Draganflyer X6 UAV has 3 accelerometers, which measure acceleration in the X, Y, and Z directions respectively. Acceleration takes into account both the change in speed and the change in direction, making it a vector quantity as well.

FORCE: Now that acceleration and mass are understood, we can define force. Loosely, force is a "push" or "pull" on an object. Mathematically, force is the product of mass and acceleration (also known as Newton's Second Law). This makes sense intuitively: the force required to move an object gets larger as the object gets heavier, and it also increases if you want to accelerate it faster. From this, we can see that applying a force to an object with mass will result in an acceleration, and in order to accelerate an object, a force must be applied. It may be hard to believe, but these few concepts are actually all you need to understand the basic physics of aircraft and UAV flight. New concepts are built upon them, but these same principals are fundamental.

UAV FLIGHT EQUILIBRIUM: Equilibrium is a state of motion where all forces balance, canceling each other out exactly. Because any force on an object causes an acceleration, so if an aircraft is to remain in one place all the forces acting on it must add to 0. So how does this happen? Let's start by imagining a generic aircraft that is currently hovering in one place. The forces acting on it are:

- Gravity, pulling downwards
- Thrust from the motors, pushing upwards

We will neglect airflow, torque from the propellers, or any other force that acts sideways. In order to hover without gaining or losing altitude, the thrust from the motors must equal the force of gravity.

This is shown graphically on the right. The gravitational force is represented by the green arrow, and the lift force provided by the motors is shown by the orange arrow. This concept becomes immediately useful. For example: the Draganflyer X6 weighs 1000 grams, so the motors and propellers need to provide exactly 1000 grams of thrust downwards to keep the UAV in a hover. Obviously, the forces don't always have to balance. If we wanted the UAV to turn, that imbalance has to be **created**. On the Draganflyer X6, this is done by spinning one of the propeller sets faster than the other two. This creates an excess force on one side of the aircraft, resulting in an acceleration. It's this acceleration of one side of the aircraft that allows the turn. Once the aircraft is banked, all the thrust from the motors is directed away from the downward direction, allowing it to move relative to the ground. When we desire the motion to stop, the UAV banks in the opposite direction.

V. APPLICATION

Security

- Security and Control
- Aerial Reconnaissance
- Aerial Policeman and Crowd Monitoring
- Aerial Traffic and Security Watch

Search and Rescue

- Maritime and Mountain Search and Rescue
- Life raft Deployment
- Rescue point marking

Monitoring

- Civil engineering sites
- Waterways and shipping
- Oil and gas pipeline
- Forestry
- Fishery Protection
- The countryside
- Pollution Control and Air Sampling
- Crop Performance
- Litter on beaches and in parks

Disaster Management

- Disaster effects management
- Rescue and clear up effort supervision
- Disaster damage estimation

Crop Management

- Countryside and Agriculture
- Agricultural Activities
- Crop Dusting

Communications

- Telecommunications
- Telecom relay and signal coverage survey

Survey

- Oil and Gas Exploration and Production
- Mineral exploration

VI. CONCLUSION & FUTURE

SCOPE

The overall system discussed in this paper proved to provide satisfactory performance, however there are shortcomings in the design and there is room for improvement. With additional effort, particularly in the wireless communication area, the effective operational range of the UAV could be significantly improved, further expanding the usability and usefulness of the system. Future uses of this UAV system could include aerial mapping, search and rescue and environmental monitoring, all of which would be available at a cost significantly lower than using traditional full-size aircraft for the same missions. The competition [3] took place in September 2008 in Kingaroy, Australia. Prior to the event the UAV was disassembled, crated, and flown to Australia with the two members of the team. Upon arrival the UAV was reassembled and finishing touches were added to the software. Originally 35 teams had applied for the competition, 10 were deemed flight worthy by the judges, and on the first day of competition only 3 teams were present with functional aircraft. Flight worthiness was evaluated by the judges and deemed satisfactory, following this evaluation, the capability to conduct safe and controlled autonomous flight had to be demonstrated. The demonstration flight consisted of a manual takeoff and then subsequent transfer to autopilot control which proceeded to guide the UAV in an oval shaped circuit, the capability to safely drop the water bottle was also demonstrated. After the demonstration flight was complete, the pilot performed a manual landing.

VII. ADVANTAGES

1. Does not contain, or need, a qualified pilot on board
2. Can enter environments that are dangerous to human life
3. Reduces the exposure risk of the aircraft operator
4. Can stay in the air for up to 30 hours, performing a precise, repetitive raster scan of a region, day-after-day, night-after-night in complete darkness, or, in fog, under computer control:
 - performing a geological survey
 - performing visual or thermal imaging of a region
 - measuring cell phone, radio, or, TV coverage over any terrain
5. Can be programmed to complete the mission autonomously even when contact with its GCS is lost

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