

Vertical Take Off & Landing Vehicles

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Abstract - Vertical Take Off and Landing Vehicles (VTOL) are the ones which can take off and land from the same place without need of long runway. This can give the brief idea about numerous types of VTOLs and their advantages over traditional aircrafts. They can either be of manned type or unmanned type and can be in various sizes and scales. In this we have study, design and implementation of control system of a vertical take-off and landing (VTOL) unmanned aerial vehicle (UAV) with level flight capability is considered. The platform structure includes both multi-rotor and fixed-wing (FW) conventional aircraft control surfaces; therefore named as VTOL-FW. The proposed method includes implementation of multi-rotor and airplane controllers and design of an algorithm to switch between them in achieving transitions between VTOL and FW flight modes. Thus, VTOL-FW UAV's flight characteristics are expected to be improved by enabling agile maneuvers, increasing survivability and exploiting full flight envelope capabilities.

Key Words: Aircraft control, autopilot, STOL, VTOL, UAV, PVTOL, UAV systems.

1. INTRODUCTION

Vertical takeoff and landing vehicles came into existence due to experiments carried out during the years 1950 – 1970 and almost all came out to be failures. Sometimes it used to have short run before the take-off hence they were also called STOL, Short run Take Off and Landing vehicle. The flight control and stability of VTOL/STOL is very difficult and is of prime area of research presently in this field. This paper focuses on how the VTOL emerged gradually over the years and depicts the current advancement in the field of aerospace. VTOL has basically three configurations up till current development in this field, wing type configuration, helicopter type configuration and ducted type configuration. Wing type has fixed wings with vector thrust engine or moving wings with engine, ducted type has ducted rotor which helps to provide lift, helicopter type has rotor mounted above it to provide lift. Initially the VTOL developed were of wing type configuration, primarily for military purposes and were man operated but later their importance was known and more and more advanced designs of it came into existence. The Hover eye platform from Bertin Technologies was first major step in direction of unmanned VTOL. The Hover eye platform brought breakthrough in the field of ducted type configuration of VTOL. Recent trends for unmanned aerial vehicles in the field of aerospace and photography application is well known. Various helicopter type configurations used for UAV are explained along with their advantages over other

configuration here. The latest ongoing research in this field is hover-bike which is a hybrid machine. It uses ducted rotors to attain required lift in order to achieve its objectives. It can be either manned or unmanned. Its concept emerged from the Hovercraft which has hybrid capability and used ducted fan to hover and maneuver. Design with single engine has problems of stability and the design with multi engine has problem of managing multi engines effectively. Engine with exposed rotors proves to be dangerous and so it should be very well considered. The need of the hour is to design a quiet, low cost, low weight, high power to weight and effective control for VTOL and optimize its performance. Such VTOL can be used for anti-terrorist activity, for complete surveillance purposes.

1.1 What Is Vertical Take Off & Landing Vehicle?

Vertical Take Off and Landing Vehicles (VTOL) are the ones which can take off and land from the same place without need of long runway.

Vertical takeoff and landing (VTOL) aircraft include fixed-wing aircraft that can hover, take off and land vertically, as well as helicopters and other aircraft with powered rotors, such as tilt-rotors. Some VTOL aircraft can operate in other modes as well, such as CTOL (conventional takeoff and landing), STOL (short takeoff and landing), and/or STOVL (short takeoff and vertical landing). Others, such as some helicopters, can only operate by VTOL, due to the aircraft lacking landing gear that can handle horizontal motion.

1.2 How Vertical Take Off & Landing Vehicle Work

USING THRUST TO OVERCOME WEIGHT

Rockets use thrust to reach orbit, but they aren't the only type of vehicles that direct thrust down to create vertical flight. However, relying on the brute force of thrust to counteract weight requires far more fuel and energy than using the force of lift. Even so, an aircraft that can take off and land vertically can hover, fly slowly, and land in tight spaces-things conventional aircraft cannot do.

To take off or land vertically, the powerful exhaust streams from a jet engine can be directed downward as well as backward, and their direction can be changed in mid-flight. This allows fixed-wing aircraft, such as the Harrier or the F-35B, to take off vertically, fly forward, stop in mid-air, back up, and land vertically. They can also take off and land like a normal airplane. A helicopter's spinning blades create thrust like a large propeller, but the thrust is directed vertically.

This allows the vehicle to take off and land vertically and to hover. To move forward, the helicopter tilts slightly to direct some of its thrust forward. A tilt-rotor is an aircraft that uses pair tilt-rotors mounted on rotating engines at the end of a fixed wing to generate vertical and horizontal thrust. It combines the vertical capability of a helicopter with the speed and range of a fixed-wing aircraft. For vertical flight, the rotors are angled so the plane of rotation is horizontal, like a helicopter. As the aircraft gains speed, the rotors are tilted forward, with the plane of rotation eventually becoming vertical. The wing then provides lift, and the rotor provides thrust like a propeller.

2. LITERATURE REVIEW

Most of the initial inventions of VTOL were of short run take off type or jump type vertical take-off and landing vehicles. Some of examples are Yak-38, MV-22 Osprey, NASA Puffin, Lockheed XFV-1 and Hawker.

A. Yak-38

The Yakovlev Yak-38 was developed in Russia by Soviet National Aviation. Its first prototype was completed on 14th April 1970; it looked similar to Hawker P.1127 but had different working principle. In difference to Hawker P.1127 it had two smaller engines. It was the only VTOL vehicle of Russia and used for military purpose.



Fig -1: Yak-38

B. MV-22

The Bell Boeing V-22 Osprey was developed by United States department of defense in 1981. It comprised of dual function of VTOL and STOL combined. It came into existence due to the failure of the Iran hostage rescue mission in 1980. The V-22 was finally evaluated in June 2005. It is a tilt rotor aircraft which while take-off and landing behave as helicopter. It had helicopter type configuration.



Fig -2: MV-22

C. Lockheed XFV-1

Lockheed manufactured XFV-1 in May 1951 and Convair manufactured XFV-1 pogo in 1951.both were experiments and completed their test flight.



Fig -3: Lockheed XFV-1

D. Hover-eye micro UAV

Going to unmanned small scale VTOL vehicles also termed as Micro Unmanned Aerial Vehicle (UAV). They have more than one rotor hence named as multi-rotor systems. They have fixed pitch propellers in compare to variable pitch propellers in helicopters. Presently more research is done in this field owing to the advantages of it to its size. The Hover-eye micro UAV manufactured by Bertin Technologies was single rotor UAV platform for short range surveillance in military application. It had ducted type configuration.



Fig -5: Hover-eye Platform Bertin Technologies

E. The Harrier

The Harrier was a jump style VTOL and was developed in Britain. It was also named as Harrier Jump Jet. Hawker Aircraft Company came out with this design in 1957. It was mainly used for military purpose. It could take off vertically if it is under its maximum loading limit. It can also take short run take off for better fuel efficiency.



Fig -6: The Harrier

3. RECENT ADVANCEMENT

In VTOL has led to research for hover-bike. It is concept of two rotors used to provide vertical thrust by air channel duct and can be used by a person to ride like a bike. Several designs are depicted in the US patent (Sanders Jr. John K, Sanders J Kenneth, Aviles Jr Arturo, Aviles Arturo F). It is similar to dual-copter, Owing to its disadvantage, it is difficult to control it and very unstable. Research is done in order to get stable and easily controllable flight. It's a ducted type configuration of VTOL and major area of research in the field of aerospace and automotive.



Fig -: Hover-bike

4. APPLICATIONS

VTOL vehicle can be used for various purpose like military applications, Surveillance application for Defense, Aerial photography, Payload caring, in Aerospace application, as a mode of transportation, as material delivery system, as AGV (Automated Guided Vehicle) in industries, for photography purpose, It can be used during natural calamities like flood, earthquakes etc. to know the whereabouts of the victims and to provide them with food packets, for rescue missions, etc. Amazon is thinking of providing their product delivery through such mini VTOL vehicles recently.

5. CONCLUSION

This gives information about recent advances in VTOL. Thus we can get the rough idea about the Initial history of VTOL and the recent advancement in this field. It also depicts various configurations of modern UAV and its pros and cons. This can enables next generation of vertical lift vehicles with aggressive goals for efficiency, noise, and emissions to expand current capabilities and develop new commercial markets.

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