A JOINED WING SYSTEM FOR SUBSONIC AERIAL VEHICLES

IITM Technology Available for Licensing

Problem Statement

- Future commercial airliners, Intelligence, Surveillance & reconnaissance aerial vehicles (ISR UAVs) & vehicles for loitering munitions will face stringent aerodynamic design requirements, thus necessitating augmented flight performance & enhanced aerodynamic efficiency.
- **Conventional single wing designs** constrain flight efficiency due to strong wing-tip vortices, structural stability of the wing under high bending moments and complex high subsonic shock features, requiring fundamental aerodynamic vs structural trade-offs.
- In earlier designs with joined wings, the aft wing is attached to the vertical-stabilizer, which constrains the independent design of parts of the aerial vehicle and maintains structural stability.
- The proposed invention presents two joined-wing designs, OP & IOP, that are detached from the vertical stabilizer. They can be independently designed, generalized, scaled and attached to an aerial vehicle with a safe margin for aerodynamic stability.

Intellectual Property

- IITM IDF Ref **3450**
- IN **202541097025** Patent Application

TRL (Technology Readiness Level)

- **TRL 4 Technology Validated in Lab**

Technology Category/ Market

- **Category-** Aerospace & Defense Technologies
- **Industry:** Aerospace, Aviation & Commercial Aircraft
- **Applications:**

Aerial platforms, unmanned aerial vehicles (UAVs) and commercial airlines.

- **Market report:** Aero Wing Market size is estimated to reach over USD 22,354.60 Million by 2031 from a value of USD 12,887.39 Million in 2023 & is projected to grow by USD 13,576.35 Million in 2024, growing at a CAGR of 7.1% from 2024 to 2030

Research Lab

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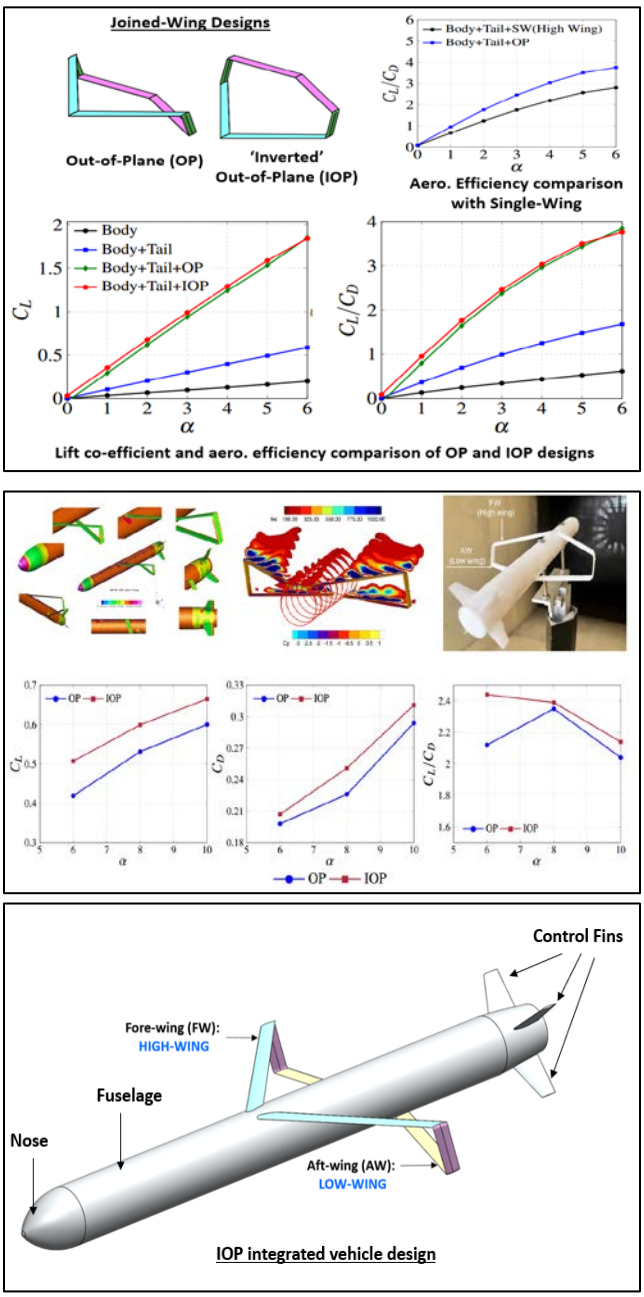

Figure 1: (a) Aerodynamic design of the joined-wing system illustrating the fore-wing, aft-wing, and vertical wing on a generic aerial vehicle **(b)**system design **(C)** Aerodynamic design

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Technology

The invention uses a tandem fore-wing (FW) and an aft-wing (AW), attached directly to the fuselage and independent of the vertical stabilizer of aerial vehicle. A vertical wing (VW) connects the wing-tips of the FW and AW, forming a closed joined-wing structure.

Design variants consists of (i) Out-of-plane (OP): FW is 'low-wing', AW is 'high-wing' and (ii) 'Inverted' Out-of-Plane (IOP): FW is 'high-wing', AW is 'low-wing', with both designs mounted on the fuselage of the aerial vehicle and thus decoupling with the vertical stabilizer. This design feature makes it a versatile, generalizable and independent wing system which can be mounted on any aerial platforms.

The swept-back and swept-forward design also performs efficiently at higher subsonic/ near –critical Mach numbers, leveraging from combined downwash-upwash phenomenon which enhances the aerodynamic performance compared with mono-wing designs

Adjusting the stand-off distance, and the sweep-angle between the FW and AW, using appropriate actuation mechanism, performance augmentation can be carried out in-flight in terms of stability, controllability, and maneuverabiltiy for application for multi-role, multi-regime (MR-MR) flight operations

The system is designed to be platform-agnostic and thus can be integrated into any aerial platforms including UAVs, loitering munitions, or commercial aircraft, making it versatile wing design adaptable across a wide range of aerospace and defence applications

Key Features / Value Proposition

Dual-Wing + Vertical Wing Structure	**Fore-wing (FW) and aft-wing (AW) both** attached directly to the fuselage, independent of the vertical stabilizer. Connected by a **vertical wing (VW),** forming a closed **joined-wing system.** Provides aero-structural stiffness and minimizes wing-tip vortices and significant induced drag reduction.
Out-of-Plane Configurations (OP & IOP)	Designs include OP and IOP configurations, with options of 'high-wing' and 'low-wing' arrangement, which offers flexibility and wider application potential to aerial platforms, such as **UAVs, expendable vehicles**, and **commercial aircraft**.
Swept Wing Geometry	**Swept-back and swept-forward wing** of FW and AW, respectively, allows design adjustments and **design tuning** features, which can be adapted to optimal design performance for augmented flight performance
High Aspect Ratios for Efficiency	High AR design of FW AR = **11.9**, and AW AR = **13.8** ensures excellent lift characteristics even at low angle of attack operations. This leads to enhanced range and performance improvements.
Stability & Performance Gains	The proposed design is made statically stable which can be **'tuned'** as per flight requirement, a feature missing in conventional single-wing designs. In present design, more than **50% lift generated by wing-system alone** and tail-fins sized appropriately for vehicle controllability, ensuring a safe, versatile and agile aerodynamic configuration for futuristic aerial vehicle platforms.

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