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Lifting Body Concepts for Unmanned Fixed-Wing Transport Aircrafts

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Abstract : Lifting body concepts were conceived as early as 1917 and patented by Roy Scroggs. It was an idea of using the fuselage as a lift producing body with no or small wings. Many of these designs were developed and even flight tested between 1920's to 1970's, but it was not pursued further for commercial flight as at lower airspeeds, such a configuration was incapable to produce sufficient lift for the entire aircraft. The concept presented in this contribution is combining the lifting body design along with a fixed wing to maximise the lift produced by the aircraft. Conventional aircraft fuselages are designed to be aerodynamically efficient, which is to minimise the drag; however, these fuselages produce very minimal or negligible lift. For the design of an unmanned fixed wing transport aircraft, many of the restrictions which are present for commercial aircraft in terms of fuselage design can be excluded, such as windows for the passengers/pilots, cabin-environment systems, emergency exits, and pressurization systems. This gives new flexibility to design fuselages which are unconventionally shaped to contribute to the lift of the aircraft. The two lifting body concepts presented in this contribution are targeting different applications: For a fast cargo delivery drone, the fuselage is based on a scaled airfoil shape with a cargo capacity of 500 kg for euro pallets. The aircraft has a span of 14 m and reaches 1500 km at a cruising speed of 90 m/s. The aircraft could also easily be adapted to accommodate pilot and passengers with modifications to the internal structures, but pressurization is not included as the service ceiling envisioned for this type of aircraft is limited to 10,000 ft. The next concept to be investigated is called a multi-purpose drone, which incorporates a different type of lifting body and is a much more versatile aircraft as it will have a VTOL capability. The aircraft will have a wingspan of approximately 6 m and flight speeds of 60 m/s within the same service ceiling as the fast cargo delivery drone. The multi-purpose drone can be easily adapted for various applications such as firefighting, agricultural purposes, surveillance, and even passenger transport. Lifting body designs are not a new concept, but their effectiveness in terms of cargo transportation has not been widely investigated. Due to their enhanced lift producing capability, lifting body designs enable the reduction of the wing area and the overall weight of the aircraft. This will, in turn, reduce the thrust requirement and ultimately the fuel consumption. The various designs proposed in this contribution will be based on the general aviation category of aircrafts and will be focussed on unmanned methods of operation. These unmanned fixed-wing transport drones will feature appropriate cargo loading/unloading concepts which can accommodate large size cargo for efficient time management and ease of operation. The various designs will be compared in performance to their conventional counterpart to understand their benefits/shortcomings in terms of design, performance, complexity, and ease of operation. The majority of the performance analysis will be carried out using industry relevant standards in computational fluid dynamics software packages.

Keywords : lifting body concept, computational fluid dynamics, unmanned fixed-wing aircraft, cargo drone
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