Design and Development of a Dismantle-able Semi-Rigid Remotely Controlled Airship

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Abstract

Airships fall within one of the three types of structural configurations, viz., Rigid, Non-rigid and Semi-Rigid; each having its own advantages and disadvantages. For remotely controlled airships, the non-rigid configuration is normally used worldwide due to its simplicity, and ease in transportation. However, the manoeuvrability and C. G. margin of such airships are severely restricted, since all the heavy items, viz., Engines, Avionics and Payload have to be placed in Gondola, which is mounted below the envelope. To improve the manoeuvrability, and the ability to operate in disturbed wind conditions, the engines need to be mounted on the side of the envelope, at the maximum possible lateral distance. This would necessitate a semi-rigid structure, which is heavier and difficult to transport. However, in this case the Avionics and Payload can be distributed over the supporting structure instead of the Envelope. Such a system also allows the skeleton of the system to maintain its shape even after loss of LTA gas (due to leakage or permeability of fabric) through the envelope.

'Lotte' was one such remotely controlled semi-rigid airship built in 1992 at the University of Stuttgart. It was a 16 m long airship with maximum diameter of 4m. Solar cells were placed on the envelope to generate energy supply for propulsion units, on-board electronics and payloads. Structural elements were used in those areas of the envelope, where the low internal pressure was unable to create enough tension to carry design loads. However a special trailer had to be designed for transporting the ship without deflating the envelope.

This paper will provide the details of design, analysis, fabrication and flight testing of a remotely-controlled semi-rigid airship, which has a quickly dismantle-able structure to enhance its transportability. The structure of this airship consists of four longerons mounted symmetrically on seven supporting frames around an axi-symmetric envelope. Three pairs of frames are mounted at the front and rear end of nose battens, gondola, and fins, and one frame is mounted in front of the tail-cone structure. The structure will be designed to handle dynamic loads that are expected while operating due to ambient winds upto a speed of 10 m/s. Structural analysis will be carried out using finite element analysis to ensure that adequate margin of safety exists at all heavily loaded components of the structure.

A sizing methodology for design of a semi-rigid airship given some user-specified mission and operation related parameters will be developed, and applied to develop a working prototype of such an airship. Lessons learnt and experience gained during the design, fabrication, system integration and flight trials of such an airship will be shared in the paper. Several non-rigid airships have been designed fabricated and flight tested at the Lighter-Than-Air Systems Laboratory of IIT Bombay, through which sufficient data on the behaviour and limitations of non-rigid airships has been collected. This study will compare the efficiency of semi-rigid and a non-rigid airship for meeting the same payload and mission requirements, which will permit a systematic comparison between the two types.

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