HYPERSONIC INLET FOR A LASER POWERED PROPULSION SYSTEM

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Statement of originality

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Abstract

The idea of laser powered lightcraft was first conceptualised in the early 1970's as a means of launching small scale satellite payloads into orbit at a much lower cost in comparison to conventional techniques. Propulsion in the lightcraft is produced via laser induced detonation of the incoming air stream, which results in the energy source for propulsion being decoupled from the vehicle. In air breathing mode the lightcraft carries no onboard fuel or oxidiser, allowing theoretically infinite specific impulses to be achieved. Recently interest has been renewed in this innovative technology through cross-continent and industry research programs aimed at making laser propulsion a reality.

In a ground launched satellite, the vehicle must travel through the atmosphere at speeds greatly in excess of the speed of sound in order to achieve the required orbital velocities. Supersonic, and in particular hypersonic, flight regimes exhibit complicated physics that render traditional subsonic inlet design techniques inadequate. The laser induced detonation propulsion system requires a suitable engine configuration that offers good performance over all flight speeds and angles of attack to ensure the required thrust is maintained throughout the mission. Currently a hypersonic inlet has not been developed for the laser powered lightcraft vehicle.

Stream traced hypersonic inlets have demonstrated the required performance in conventional hydrocarbon fuelled scramjet engines. This design technique is applied to the laser powered lightcraft vehicle, with its performance evaluated against the traditional lightcraft inlet design. Four different hypersonic lightcraft inlets have been produced employing both the stream traced inlet design methodology, and traditional axi-symmetric inlet techniques. This thesis outlines the inlet design methodologies employed, with a detailed analysis of the performance of the lightcraft inlet at angles of attack and off-design conditions. Fully three-dimensional turbulent computational fluid dynamics simulations have been performed on a variety of inlet configurations. The performance of the lightcraft inlets have been evaluated at differing angles of attack. An idealised laser detonation simulation has also been performed to verify that the lightcraft inlet does not unstart during the laser powered propulsion cycle.

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