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Author: Mr. Roy Ramirez
Purdue University, Costa Rica

Mr. Carlos Rodríguez
Costa Rica
Mr. Olman Quiros Jimenez
Instituto Tecnológico de Costa Rica (TEC), Costa Rica
Mr. Mauricio Alfaro Benavides
University of Costa Rica, Costa Rica
Mr. Manfred Hernandez
Instituto Tecnológico de Costa Rica (TEC), Costa Rica

ZURQUI: THE FIRST CENTRAL AMERICAN LIQUID ROCKET ENGINE, A REPLICABLE AND ACCESSIBLE PROPOSAL FOR THE ACADEMIC AND EXPERIMENTAL STUDY OF LIQUID PROPULSION

Abstract

Propulsion technologies, especially liquid rocket engines, demand high levels of complex engineering, which has made them almost exclusive to big aerospace organizations that can afford the cost of manufacturing and design. This has made Liquid Rocket Propulsion (LRP) engines almost inaccessible to a wide range of demographics, including students and engineers from developing countries, isolating them from further space development. By taking advantage of modern technological resources, a cost-effective engine can be designed as a model of replicability for the academic study of propulsion.

This paper focuses on the progress of a method of development that uses additive manufacturing and software to design a replicable, relatively low-cost engine. To contribute to the feasibility of this kind of propulsion system, the Zurqui Engine was devised to operate with non-cryogenic propellants (nitrous oxide and kerosene) for a five-second static fire test, by using a pressure-fed system. The expected thrust was determined to be around 700 N, using a relatively moderate chamber pressure of 450 psi, and a theoretical specific impulse of 245.5 s. To simplify its design stage, an in-house, user-friendly software, the 'Rocket Engine Designer' (RED), was developed by using Python language. The RED used thermochemical data from NASA's CEARUN to solve the rocket equations and linked with spreadsheets to manipulate data. It then optimized the engine's parameters and generated a 2D sketch. The 3D model was designed in Autodesk Inventor and imported to COMSOL Multiphysics to perform the heat transfer simulation. Due to the Zurqui's small dimensions (about 130 mm long and 70 mm of diameter), metal additive manufacturing it in stainless steel, and the use of off-the-shelf components would lower the expected construction budget to approximately $10,000, resulting in an accessible liquid rocket engine.

This paper describes the first results of the Zurqui engine as a proof of concept, and the steps that are to follow in proving its accessibility and replicability.