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AI AND CLASSICAL APPROACHES TO ESTIMATING SOLID FUEL REGRESSION RATE IN HYBRID ROCKET ENGINES

Abstract

This study focuses on estimating solid fuel regression rates in hybrid rocket engines using classical approaches and state-of-the-art pre-trained Artificial Intelligence (AI) models, namely Grounding DINO and Segment Anything Model (SAM). Grounding-DINO provides high precision for object detection and labelling in an image, while Segment Anything (SAM) excels in segmenting and generating masks for detected objects. The primary objective is to segment the solid fuel region and predict the regression rate based on images from the combustion chamber of a flat flame burner. The methodology utilizes an experimental dataset from tests on a hybrid rocket slab-burner.

The results indicate that the employed model offers promising predictions for solid fuel segmentation, even without specific training for this purpose. The findings have significant implications for designing and optimizing hybrid rocket engines, enabling engineers to make more informed decisions regarding fuel composition and combustion chamber design. Subsequently, personalized training, along with additional refinements and model validation for solid fuel detection and segmentation, was implemented to improve the boundary limits of the solid fuel grain.

The application of advanced computer vision techniques and pre-trained AI models in the analysis of solid propellant combustion is crucial for obtaining the regression rate through an existing database. The development of a tool to extract the regression rate from high-speed videos enhances the regression rate acquisition process, effectively contributing to the advancement of solid fuel development in this specific field.