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Author: Dr. Junling Song
Academy of Equipment, China

Prof. Yanji Hong
China
Prof. Guangyu Wang
China
Dr. Hu Pan
China

MEASUREMENTS OF TWO-DIMENSIONAL TEMPERATURE DISTRIBUTION IN COMBUSTION USING DIODE LASER ABSORPTION SPECTROSCOPY

Abstract

In the scramjet isolator/combustor, temperature diagnose is one of the most important factor to estimate the engine performance. Traditional tools such as thermocouple and temperature probe, is limited in disturbing the flow and standing against the harsh environment. Tunable diode laser (TDL) sensor with the merits of fast response, sensitivity, and non-invasiveness is deployed in a wide range of practical application. However, one of the drawbacks of the TDL sensor is the line-of-sight property which limits the technique of producing uniform flow fields.

- In the present work, the absorption spectroscopy technique combined with image reconstruction technique to obtain the internal distribution of the region of interest. Two beam distributions, the parallel and irregular arrangement were applied to shown the influence on the reconstruction accuracy. The reconstruction accuracy strongly depends on the beam distribution. Therefore, an optimal design of the beam arrays can reduce the experimental cost and maximize the beam potentiality. The grid weight factor (*GridWF*) was introduced to evaluate the beam distribution relating to the discrete region.

- The simulation results show that the error of the reconstruction is less than 15% using optimal beam distribution, which is lower than the results of non-optimization. As an increase in the number of emitters, the error can be obviously reduced. Time division multiplexing method was adopted to scan two H2O absorption transitions (7205.25 cm-1 and 7416.05 cm-1) simultaneously at 1 kHz repetition rate in the validation experiment. Two-dimensional temperature reconstruction with optimal beam distribution and different number of emitters are demonstrated, showing the optimal design of the beam array having excellent reconstructed performance.

The conclusions may provide useful information for the design of TDL sensors combustion diagnose. The future work can focus on optimization of the reconstruction algorithm to improve the calculated efficiency.