COLORED-GRID BACKGROUND ORIENTED SCHLIEREN (CGBOS) METHOD FOR THE 3D-CT RECONSTRUCTION OF SUPERSONIC OR CONVECTIVE FLOW FIELDS

K. MAENO

Graduate School & Faculty of Engineering, Chiba University, 1-33 Yayoi, Inage-ku, Chiba # 263-8522, Japan

[c]Corresponding author: Tel. & Fax: +81-43-290-3220; Email: maeno@faculty.chiba-u.jp

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ABSTRACT: In this paper novel quantitative approach of background oriented schlieren (BOS) method to three-dimensional flows using colored-stripes or colored-grids will be described. In the field of fluid dynamics the BOS image processing has been rapidly developed, where the random dot patterns, monochromatic or colored, are generally used as a background image for BOS-based indoor experiments. This process depends on the deviation of dots between two designated regions, and by comparison of these designated regions between two images, image without flow as reference and the second image with flow [1], the integrated distribution of density gradient can be obtained. This technique is commonly employed in PIV and PTV measurements. In our BOS method, colored-stripes or grids are employed. Then with separation process of colors, enough information for the flow can be obtained. Different from the PIV-related BOS, the CGBOS needs only one image, which includes the expected location of the colored-stripes for designated directions. These stripes begin to deviate with the density gradient distribution caused by shock waves in supersonic flow, or natural convective flow. Under the assumption of linear relation between density and temperature, we can estimate the temperature gradient for the natural convection. As an example of our CGBOS for the supersonic flows, Fig.1 shows the asymmetric model in supersonic wind tunnel of JAXA-ISAS, and the processed color image of deviations of stripes from colored-grids background by Mach 2 flow field. These images are calculated to reconstruct the three-dimensional CT distribution of the density gradients by ART, and further integrated to obtain the 3D density flow field. We access closer to the model boundary in CGBOS imaging, while conventional BOS suffers from the hidden dots deviation behind the model boundaries. Time-dependent 3D-CT of CGBOS can be tried by using the high-speed camera in shock tunnel, where the huge calculation loads still remain the bottleneck to the satisfactory 4D results.

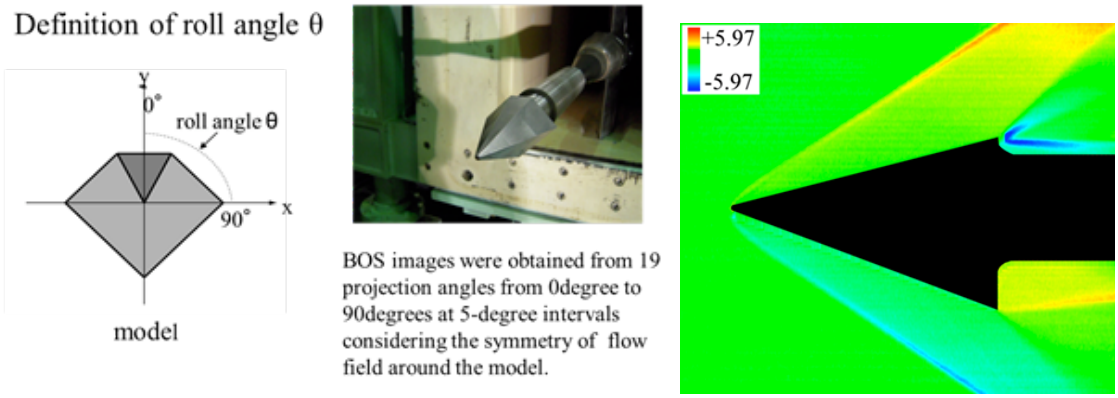

Fig. 1 The model in supersonic wind tunnel (left), processed image after calculating stripe deviation (right).

References

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