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Singularities and undefinitions in the calibration functions of sonic anemometers

A. Cuerva; A. Sanz Andrés; O. López García

Abstract-

A mathematical model of the process employed by a sonic anemometer to build up the measured wind vector in a steady flow is presented to illustrate the way the geometry of these sensors as well as the characteristics of aerodynamic disturbance on the acoustic path can lead to singularities in the transformation function that relates the measured (disturbed) wind vector with the real (corrected) wind vector, impeding the application of correction/calibration functions for some wind conditions. An implicit function theorem allows for the identification of those combinations of real wind conditions and design parameters that lead to undefined correction/ calibration functions. In general, orthogonal path sensors do not show problematic combination of parameters. However, some geometric sonic sensor designs, available in the market, with paths forming smaller angles could lead to undefined correction functions for some levels of aerodynamic disturbances and for certain wind directions. The parameters studied have a strong influence on the existence and number of singularities in the correction/ calibration function as well as on the number of singularities for some combination of parameters. Some conclusions concerning good design practices are included.

Index Terms-

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