Book Reviews

Handbook of Compressible Aerodynamics

J. Delery

John Wiley and Sons, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK. 2010. 744pp. Illustrated. £130. ISBN 978-1-84821-141-4.

This book is not a handbook in its usual meaning but more an introduction to key concepts and theories behind compressible aerodynamics, with a strong emphasis on the development and application of the *method of characteristics* for gas dynamics. As stated by the author, a prominent researcher and educator in this field, the book aims to enhance understanding through theoretical analyses, extracting sound physical interpretation from observations. With the fast development of modern computational modelling and simulations, in particular for computational aerodynamics, more often than not the physical insight of the flow problems can easily be lost. This book serves an excellent addition to the existing literature in compressible aerodynamics with such a focus.

The book can be divided into five distinctive parts. The first (Chapters 1-8) is more of introductory material from classic aerodynamics, associated thermodynamics, to basic governing flow equations, including some essential fluid mechanics concepts and flow classification. It lays the foundation for the topic and for the latter parts of the book.

The second part (Chapters 9-12) limits the scope to one-dimensional steady flows. This is the area where there is an abundance of theoretical results. In addition to the main development in inviscid flows, this part also includes a chapter on the effects of friction and heat transfer on one-dimensional gas dynamics. It ends with an application of the theories to the calculation of supersonic ejectors.

The next part (Chapter 13-16) elaborates the subjects of shock waves (normal and oblique), slip lines and various interactions of shocks. After the introduction of the theories, it ends again with an application to supersonic aircraft engine intakes, an excellent illustration of how compressible aerodynamic theories are applied to practical design problems.

The main focus of the last part (Chapters 17-25) is the description, presentation and application of the *method of characteristics* to supersonic two-dimensional or axisymmetric inviscid flows. The method itself can be viewed as an elegant way to solve the Euler equations, requiring good understanding of compressible aerodynamics. Within its limitations, the method is of course very efficient in comparison with the direct numerical solution of the Euler equation by finite-volume, finite difference or finite element methods in computational aerodynamics. Although its application to practical complicated three-dimensional geometries is actually more challenging than the now conventional CFD methods, the theories and applications do give more physical understanding of the flow problems regarding shock waves, slip lines, compression and expansion waves and their interactions.

The book reflects the author's extensive experience in experimental and theoretical aerodynamics for compressible flows and wind-tunnel flow visualisations – with a strong French flavour from the ONERA wind-tunnels – have been included to illustrate shock waves, contact lines, shear layers and vortical flows.

For postgraduate students and researchers interested in physical insight into compressible aerodynamics in general, and in the method of characteristics in particular, this book serves a very useful reference.

Professor N. Qin FRAeS

Co-operative Path Planning of Unmanned Aerial Vehicles

A. Tsourdos *et al*

John Wiley and Sons, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK. 2011. 219pp. Illustrated. £75. ISBN 978-0-470-74129-0.

This slim, reader-friendly, 190-page volume is another in the John Wiley 'Aerospace' series. The text centres on mathematical treatments describing how unmanned air vehicles can move from one 'pose' to another. From this, the treatment develops techniques to avoid flying into obstacles with vertical extent, the ground and other air vehicles. The book has a concise index, although its utility is limited by the authors' terminology: for example, if interested in the treatment of flight envelope one needs to look under 'constraint, kinematic' or 'kinematic limit'.

The book reviews a range of articles and conference papers and extracts the key techniques. The 'Dubins equations' (1957) are extensively covered because they are a building block for modern flight planning systems. The concept of 'internal' and 'external' tangents is introduced and the pilot among us now understands why when an aircraft moves from one waypoint to another, it sometimes turns in an unexpected direction.

Considerable space is devoted to calculating the length of different paths from one pose to another, even though in many cases it is not practicable to present the result as a closed formula. The authors develop their arguments by use of mathematical equations. There are inconsistencies; for example, the connecting vectors as, af, ac are stated to form an orthogonal set (p41) when actually af is a multiple of as; again (p45) 'the second derivative of a curve with respect to a path parameter q represents acceleration' which is only true if q corresponds to time. This is not to suggest that the conclusions are wrong but the reader needs to focus on what the authors meant to write rather than what they actually wrote.

When moving from theory to practice, the book is less authoritative. There is no discussion on the effect of gravity in vertical manoeuvres and the need to avoid stall or overspeed. There are references to 'traffic collision avoidance systems'; such devices are not approved for sense and avoid. Discussions on avoiding other air vehicles implicitly consider that these vehicles maintain a straight-line path. How autonomous systems which avoid 'controlled flight into terrain' would benefit from a chapter on geoids, ellipsoids and a description of limitations of digital terrain elevation data.

The co-operative path planning promised by the title appears in Chapter 6. This is concerned with ensuring simultaneous arrival at a point (presumably a target) without collisions. Any practical instance of this would normally involve other constraints, on separation of directions of arrival or on avoiding counter-detection, but there is no indication how the solution offered might be adapted to consider these. Nor is consideration given to any alternative task such as having three vehicles placed to have good cross-cuts on a range of potential targets, while staying within range bracket and bank-angle constraints. Therefore, the title promises rather more than the book delivers.

As a source document for the practical construction of flight paths the book fails to hit the mark. As a review of the learned papers to support flight path planning this is an effective resource and would be a worthwhile addition to a library.

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