Seven-Hole Probe Calibration in a Low-Speed Wind Tunnel
En Yen Justin Chu | Dr. Zheng Zhang | Dr. J. Gordon Leishman
Department of Aerospace Engineering, Embry-Riddle Aeronautical University, Daytona Beach, FL

Introduction
The project is to calibrate a miniature seven-hole pressure probe designed to be utilized in the new wind tunnel of the Embry-Riddle Research Park.

The seven-hole pressure probe is designed to measure flow angularity, which has better sensitivity than five-hole pressure probe. However, the seven-hole probe requires finer calibration due to manufacturing tolerance and its small dimensions.

Experimental Setup
Subsonic Boundary Layer Wind Tunnel
- A new facility built in 2017
- 22 inches by 22 inches cross section
- Test location: 4 feet from inlet

64-Channel Miniature Pressure Transducer
- Accuracy: ±0.0003 psi
- Maximum measurement range: 1 psi

Motorized Rotary Tables (Fig. 4)
- 2-degree of freedom: pitching and yaw
- Accuracy: 100 arc-second (0.0278 deg)
- Automated for multiple pressure reading

Theory
- Pressure Coefficient: Based on Differences of Opposite Ports
  \[ C_{a1} = \frac{P_4 - P_1}{P_7 - P_{1-6}} \]
  \[ C_{a2} = \frac{P_3 - P_6}{P_7 - P_{1-6}} \]
  \[ C_{a3} = \frac{P_2 - P_5}{P_7 - P_{1-6}} \]
- Angular Pressure Coefficients
  \[ C_\alpha = \frac{1}{3}(2C_{a1} + C_{a2} - C_{a3}) \]
  \[ C_\beta = \frac{1}{\sqrt{3}} (C_{a2} + C_{a3}) \]

Conclusion & Future Plan
- A high-precision calibration stand was designed and built
- A calibration was performed in BL wind tunnel
- Advance to multiple seven-hole probe rake for new subsonic wind tunnel flow qualification

References

Acknowledgements
The seven-hole probe was manufactured by William Russo at College of Engineering machine shop