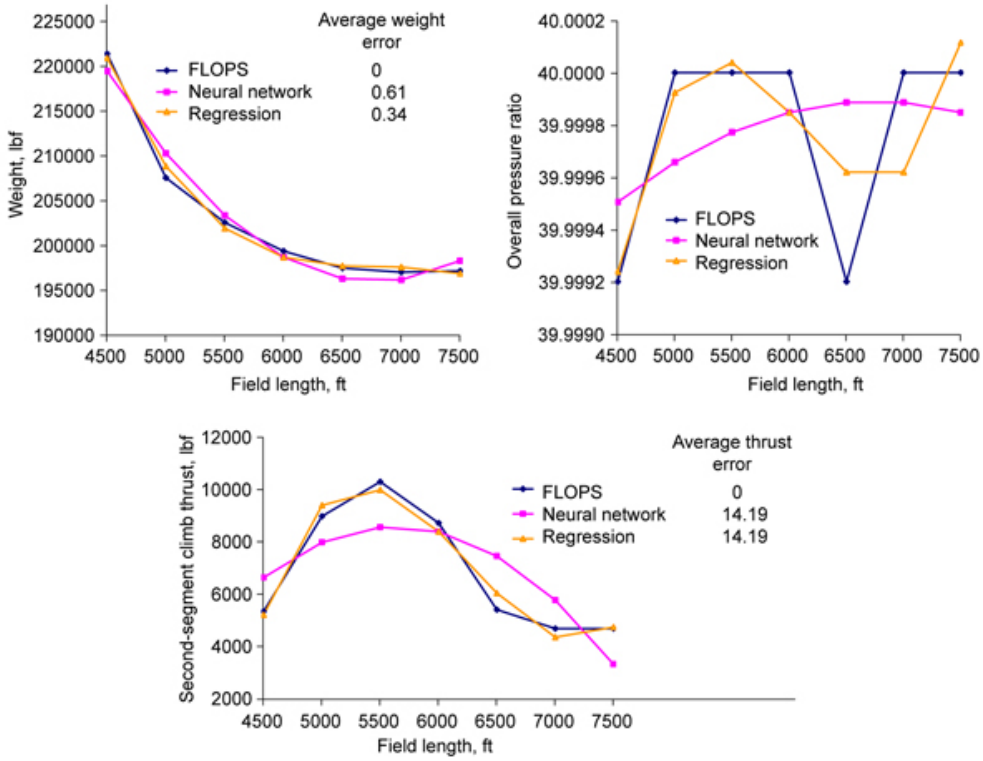
Design Sensitivity for a Subsonic Aircraft Predicted by Neural Network and Regression Models

A preliminary methodology was obtained for the design optimization of a subsonic aircraft by coupling NASA Langley Research Center's Flight Optimization System (FLOPS) with NASA Glenn Research Center's design optimization testbed (COMETBOARDS with regression and neural network analysis approximators). The aircraft modeled can carry 200 passengers at a cruise speed of Mach 0.85 over a range of 2500 n mi and can operate on standard 6000-ft takeoff and landing runways. The design simulation was extended to evaluate the optimal airframe and engine parameters for the subsonic aircraft to operate on nonstandard runways. Regression and neural network approximators were used to examine aircraft operation on runways ranging in length from 4500 to 7500 ft.



Top left: Gross aircraft weight in pounds force. Top right: Overall pressure ratio. Average error, 0. Scale magnified. Bottom: Second-segment climb thrust.

The graphs depict typical solutions: aircraft weight versus the field length (top left), overall pressure ratio (top right), and second-segment climb thrust (bottom). Optimum aircraft weight increased for the shorter field length and decreased for the longer length, as expected. The overall pressure ratio exhibited a discontinuity at a field length of 6500 ft. The neural network model negotiated the discontinuity by following a mean path (top

right graph). The regression approximation had a tendency to hug the data. The behavior of the second-segment climb thrust (bottom graph), is similar to that of the overall pressure ratio. The error in the neural network and regression models was in the range of 1 to 5 percent. The time needed to generate one set of optimum solutions was about 1/2 hr when the FLOPS code was used. It was reduced to about 1 min with the neural network method and to 1 sec with the regression method. The performance of the neural network and regression methods is considered satisfactory for the design sensitivity of the subsonic aircraft.

Bibliography

Patnaik, S.N., et al.: A Subsonic Aircraft Design Optimization With Neural Network and Regression Approximators. NASA/TM--2004-213059 (AIAA-2004-4606), 2004. http://gltrs.grc.nasa.gov/cgi-bin/GLTRS/browse.pl?2004/TM-2004-213059.html

Glenn contact: Dale A. Hopkins, 216-433-3260, Dale.A.Hopkins@nasa.gov
Authors: Dr. Surya N. Patnaik and Dale A. Hopkins
Headquarters program office: OAT
Programs/Projects: Ultra Safe, UEET, HSR