

Surrogate models for helicopter loads problems

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One of the main activities of the EUROCOPTER flight test department is to measure static and dynamic loads for different helicopters, different flight configurations (including maneuvers, mass, Center of Gravity location, altitude, temperature), with corresponding input machine parameters (velocity, mass, acceleration, etc.). Information, obtained from this activity, is stored in a special database.

The goal of this study is to construct a behavioral (surrogate) model using the abovementioned database. This model should allow predicting maximum static and dynamic loads for a given helicopter as a function of PCM parameters. The challenge is to build automatically accurate and robust surrogate model using a very limited set of data.

This challenge has been efficiently solved using MACROS software tool, in particular, using Generic Tool for Approximation (GT Approx). GT Approx is used for construction, evaluation and analysis of surrogate models. Among the features of the tool are a wide range of well-known techniques (e.g., splines, linear regression, Kriging) and original techniques (e.g., HDA - High Dimensional Approximation), an automatic selection of the appropriate approximation technique based on built-in decision tree and data properties, a flexible support for accelerated training, smoothing, handling multiple output components, etc.

The work consisted of two parts:

- predict maximum static and dynamic loads for a number of load cases (66 in total) and maneuvers families (32 in total),
- predict loads for dynamic process as a functions of PCM parameters.

A set of surrogate models was constructed for various configurations, described above. In each case an appropriate type of the surrogate model was chosen by MACROS GT Approx automatically. Approximation has been constructed simultaneously for all output components of the response function, which ensures a significant time savings. The accuracy of the models is good.

As a result a this study special software tool, CHAMALO (Calculation of Helicopter Approximated MACros LOads) has been developed and deployd in EUROCOPTER flight test department.