Comfort Mode for Helicopters

- Reducing noise and vibrations in helicopters
- Additional, piezoelectrically controlled flaps in the rotor blades
- dSPACE prototyping system for real-time control of the additional flaps

To reduce helicopter noise and vibrations, Eurocopter Germany has developed piezoelectrically controllable flaps for the rotor blades. The deflections of the flaps are controlled by dSPACE equipment, and reduce noise by almost 50% and vibrations by virtually 90%. Dieter Roth, in charge of testing at Eurocopter, spoke to dSPACE NEWS about his experience with dSPACE tools in developing this technology.

Could you briefly explain what the piezoflap rotor is all about?

Helicopters often develop a kind of chugging noise, which is caused by one rotor blade colliding with the trailing vortex of the rotor blade in front. This is particularly loud during landing, because in this situation each rotor blade can be completely immersed in the trailing vortex. Vibrations are another problem and occur during travel flight. They are caused by the forward-moving rotor blade cutting through the air faster than the backward-moving blade because the flight speed of the helicopter is added to its rotational speed, giving it greater lift. As a consequence, the rotor blades beat up and down as they rotate, and this is transmitted to the cockpit as vibrations. We use the piezoelectrical flaps in the rotor blades to minimize the noise and vibrations. During the landing approach, the flaps deflect the air vortex away from the following rotor blade, and during travel flight their deflections generate additional forces that help to counteract the vibrations. There are approximately 35 flap deflections per second, which we control with a dSPACE prototyping system.

▶ *Dieter Roth, in charge of testing at Eurocopter Germany: "The dSPACE tools play a decisive part in our control tasks."*

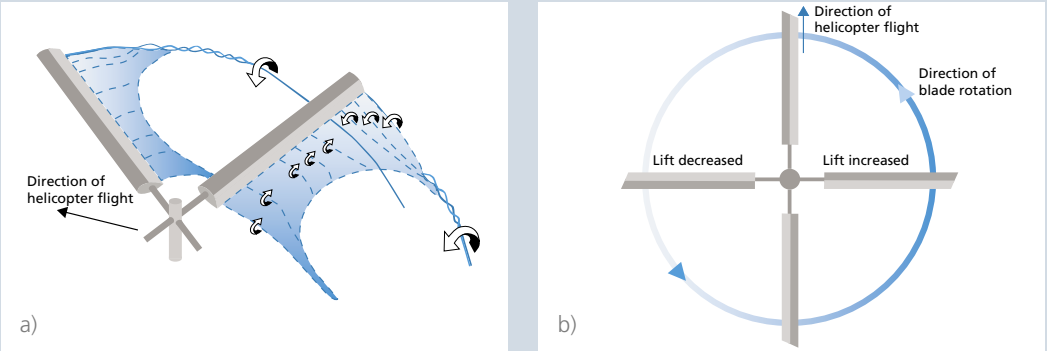
"If I had to give school grades, I would say the dSPACE development environment is the top of the class."
Dieter Roth, Eurocopter Germany

In the race to develop adaptive rotor systems, you have left strong competitors from the USA and Japan far behind. What part do the dSPACE tools play in this?

A decisive part. Because we need to perform very many different control tasks with our test helicopter, we must be flexible in programming. This is where the dSPACE tools can really show their true strengths. Controller designs under MATLAB®/Simulink® are easy to implement and then very easy to handle via ControlDesk. All the declared variables are available and above all changeable online. Access to the hardware is very simple, and the solution for monitoring individual tasks – we often have three tasks with different sampling rates – is excellent.

Do the dSPACE tools interact smoothly with your other tools?

We try to use as many dSPACE components as possible, but we do have some other hardware components which we cannot "marry" directly to our



▲ *During landing, noise is caused by collisions between rotor blades and vortices (a). The reason for strong vibrations during travel flight is that rotor blades have different lift depending on whether they are moving forward or moving backward (b). Eurocopter has minimized both problems by means of additional flaps.*

dSPACE tools. However, the solutions provided by dSPACE Support for such problems have all been excellent.

What is your overall impression of the development environment with dSPACE tools?

If I had to give school grades, I would definitely say they were the top of the class. We often had problems with other hardware, but none so far with dSPACE tools.

Are there any plans to use the piezoflaps for the primary control of helicopters?

This is the object of the INROS project (innovative rotor control) currently being funded by the German Federal Ministry of Research. The plan of action is twofold: We aim to replace parts of the primary control – control rods and swash plate – with a combination of actuators, and also use the piezoflaps in a supporting role. A prototype for the rotor test bench will be ready by the end of 2009.

Will the level of electronics in helicopters continue to grow in the future?

Oh, yes. At the moment, for example, we have built a "special helicopter" for the German Aerospace Center (DLR). This helicopter has a new kind of "fly-by-light" control and is monitored by computers. The issue of flight control will also increasingly come to the fore, though that has safety-critical aspects that also have to be considered, of course.

Does Eurocopter use dSPACE tools in any other projects?

Yes, there are currently two other projects: A new modern flight control (AFCS) for the military transportation helicopter CH53 and the use of active force generators in place of passive mass dampers in the helicopter cell to minimize vibrations, called Active Control of Structural Response (ACSR).

▲ *The rotor blade tip with the additional flaps. There are approx. 35 flap deflections per second, which Eurocopter controls with a dSPACE prototyping system.*

What about the future, are you planning any other projects?

We are currently designing control algorithms to implement rotor stabilization for damping enhancement. This could mean that we could do without passive damping mechanisms in the future, which would in turn reduce costs and maintenance. In addition, we are looking into a performance booster for fast forward flight and turning with high load multiples. This uses a control to reduce the load on the rotor, which is under extreme stress in these flight states, achieving not only less vibration but also a lower power requirement.

Mr. Roth, thank you for talking to us.