Improvement of Air Bearings Load Capacity and Stability using Mechatronics

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INTRODUCTION

This project concerns experimental investigation and improvement of a controllable air lubrication in a hydrodynamic bearing. The traditional choice of lubrication in a hydrodynamic bearing is oil, but as the modern turbo machinery applications demands operation at higher rotational speeds, greater reliability and clean environment, air lubrication is a great alternative. When comparing air and oil lubrication air is both cleaner and cheaper which in many ways makes it competitive to oil.

One of the major concerns in hydrodynamic bearings are the relatively low damping of vibrations. This means that operational speeds close to the critical rotational speeds of the system becomes very dangerous, as the resonance enhancement can become very large. The damping in a air bearing is even lower than in a oil bearing which makes the concern even larger. Moreover another disadvantage of air lubricated bearings is the low load capacity. Both problems, vibration instability and low load capacity, are addressed in this project. Such problems are compensated via controllable lubrication (mechatronics).

The project includes experimental modal analysis of the rotor for different input signals to the air bearing. Moreover the optimizing of the active control mechanism for the air bearing is initiated. Improvement of the active control system will be the purpose of a master thesis which will be conducted in continuation of this project.

THEORY & METHODOLOGY

The theory involved in the project is used to analyze experimental data and is linked to the following subjects: Machine dynamics, mechanical vibrations, fluid mechanics, instrumentation, control techniques and signal processing.

The experimental investigation uses a test rig already designed and improved by S. Morosi, I. Santos and others. The experimental setup is a simple supported overhung rotor with a disc mounted at one end of the rotor. The overhung rotor setup is widely used within machine dynamics and corresponds for example to a part of a wind turbine, a compressor and a pump.

To measure the vibrations of the rotor two displacement sensors are mounted at the location of the disc. To control the pressurized air injection into the bearing, two piezo actuators is applied at the inlet of the air bearing.

RESULTS AND CONCLUSION

By combining mechanics, electronics and informatics new machine components can be designed to operate sustainable and eco-friendly by changing the lubrication fluid in hydrodynamic bearings from oil to air. Through this study some of the disadvantages of air lubrication have been minimized. Through active control of the inlet flow in an air bearing, load capacity and operating speeds have increased.