# Embedded Data Acquisition Tools for Rotorcraft Diagnostic Sensors

***To monitor and diagnose harmful vibration effects inherent to flight operation***

Rotorcraft drive trains must withstand enormous pressure while operating continuously in extreme temperature and vibration environments. Captive components, such as planetary and spiral bevel gears, see enormous strain but are not accessible to fixed instrumentation, such as a piezoelectric transducer. Thus, it is difficult to directly monitor components that are most susceptible to damage.

This innovation is a self-contained data processing unit within a specialized fixture that installs directly inside the rotating pinion gear in the gearbox. From this location, it detects and transmits high-resolution prognostic data to a fixed transceiver. The sensor is based on microelectromechanical systems (MEMS) technology and uses innovative circuit designs to capture high-bandwidth data and transmit it wirelessly from inside an operational helicopter transmission.

With Ridgetop's advanced MEMS-based sensor, researchers have, for the first time, been able to extract high-resolution acoustic signatures wirelessly from sensors within the transmission that would otherwise be muffled by background gear noises. Ridgetop's innovative instrument will help researchers perform dynamic analysis of gear interaction and develop improved designs for gear components. In addition, data from this instrument can be used to validate new algorithms that detect and predict faults based on external acoustic signatures, for prognostic purposes. The result of this work will be an improvement in safety, performance, and cost for future generations of rotating components.

## Applications

### NASA

- Subsonic Rotary Wing Project:
  - Improved vibration sensors to help monitor and diagnose harmful vibration effects

### Commercial

- Rotorcraft operators:
  - Real-time, efficient analysis of critical diagnostic data and routines
- Rotorcraft manufacturers:
  - Field testing measurements of vibration and accumulated stress
- Railway abnormal condition detection
- Real-time monitoring of downhole drill vibration in oil and gas exploration
- Sensing tool wear, chatter, or spindle balance in computer numerical control applications


## Phase II Objectives

- Build and demonstrate module and acquisition system
- Tie in data collection with prognostics and advanced diagnostic approaches, and show an improvement in failure detection horizon times
- Develop a data interface between the wireless sensor port and a standard health and usage monitoring systems (HUMS) communication bus
- Demonstrate the technology with airframe manufacturers

## Benefits

- Monitors structural and electronic stress due to vibration during flight
- Detects wear in the drive gears inside helicopter gearboxes
- Provides IoT (Internet of Things)-compatible wireless technology
- Supports hundreds of nodes in a sensor network
- Downloads data quickly

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