Challenges of Rotary Aircraft Rotating Component Instrumentation

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Presented to:

ITEA

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Overview

- Introduction
- Rotational to Stationary Transition
- Slip Ring
- Remote with PCM pass through
- Wireless Slip Ring
- Conclusions

Introduction

- Instrumentation of Rotary Aircraft Rotating Components Presents Challenges
  - Large number of channels required
  - High sample rates required for data collection
  - These parameters are typically safety of flight parameters.
  - The biggest challenge: Transition from the rotational side to the stationary side.

Rotational to Stationary Transition

- Common methods used to make the rotational to stationary transition
  - Slip ring
  - Power and Data stream through a slip ring
  - Wireless
- We will now look at the advantages and disadvantages of the slip ring and the PCM pass through and the considerations for a wireless solution.

Slip Ring

- The individual channel slip ring has been the most commonly used method for the transition.
- This implementation of a slip ring required the installation of a stand pipe to allow the wiring to pass through the gearbox

Slip Ring

Advantages

- Standard wired connection on each side of the transition.
- Analog method: no limitation on channel sampling rate or data rates
- No impacts to channel signal conditioning as it is done by Data Acquisition Unit (DAU) located on the stationary side.

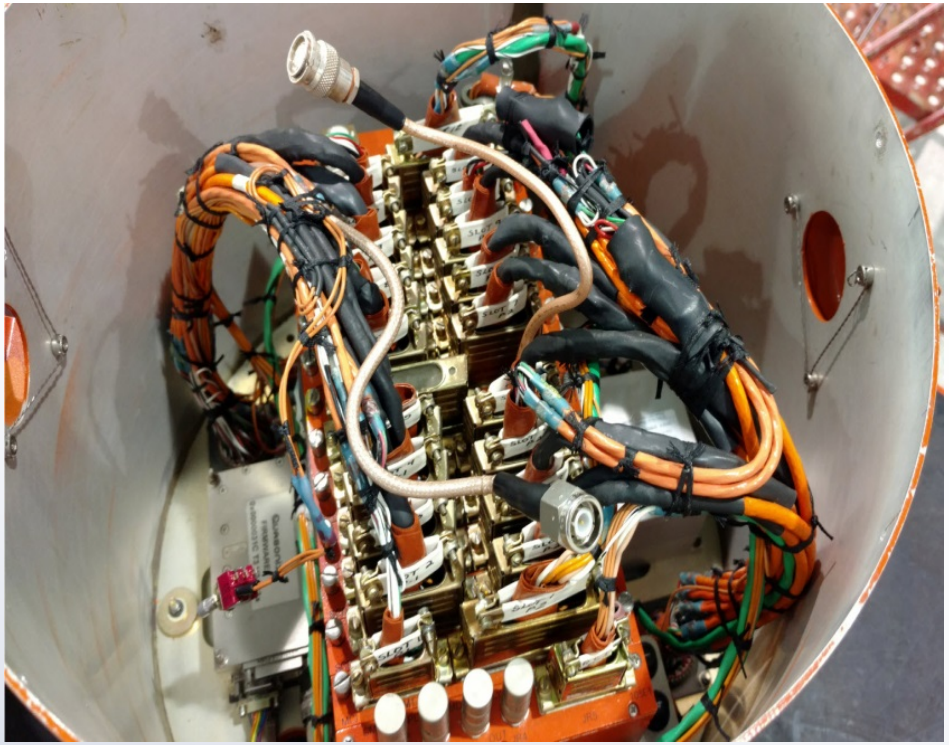
Disadvantages

- Typically requires modifications to the gearbox for installation. This can be complicated, time consuming, and expensive
- Requires regular cleaning and periodic overhaul
- Can require significant maintenance support to remove the slip ring

Remote with PCM pass through

- Rotor head package
- Power and PCM data stream pass through the production main rotor slip ring.
- This package was designed to replace a large instrumentation slip ring used during a previous structural test.

Remote with PCM pass through



- Package allowed for Redundancies:
  - Onboard recorder
  - Telemetry Transmitter (This package sent TM from the aircraft directly to the ground station)
  - GPS antenna for backup time input
  - Multi ring implementation of power and PCM channels through slip ring

Remote with PCM Pass through

Advantages

- Minor modification to install
- No modifications needed for an instrumentation slip ring as the production slip ring was used
- No impacts to sample rate or signal conditioning as the DAU is on the rotating side.
- 500Kbps Differential PCM stream did not suffer degradation over the 200 hour flight test program
- This is a “Less wire” system compared to instrumentation slip ring

Disadvantages

- Required significant design and precise balancing
- Reliability of production slip ring
- May not be scalable to support higher bit rate PCM streams through Slip ring.
- On a smaller helicopter this may be a solution on the main rotor head but will not work on the much smaller tail rotor.

Wireless Slip Ring

- For years, there has been a push to move toward a wireless slip ring solution. This would eliminate a large amount of wiring and the maintenance requirements of the traditional slip ring.
- There are several factors that need to be considered when looking to a wireless slip ring solution.

Wireless Slip Ring

- Two definitions of a wireless system
  - Powered through slip ring with wireless data to fuselage
    - Will work on main rotors or large aircraft tail rotors that have production slip rings
    - Would require installation of slip ring on smaller tail rotors negating some of the benefits of wireless
  - True wireless with use of battery for power
    - Weight of battery
    - Ability to charge battery on aircraft?
    - Ease of battery swapping
    - Operational time on battery

Wireless Slip Ring

- There are several technical hurdles that must be overcome for a wireless system to replace a traditional slip ring.
  - Size and weight of the unit
    - Small amount of space in installation areas
    - Weight can be an issue on tail rotors
  - Sampling rates
    - Typically large number of parameters with data frequency of interest of 100, 200 and 400 Hz
    - These parameter types lead to high sample rates and large total bit rates.
  - Number of filter poles
    - Less than the standard 6 pole filters will increase sample rates needed to ensure no aliased data
    - A much lower number of poles may cause comparison issues to parameters collected on the non wireless portion of the instrumentation system.
  - Use of battery
    - Swapping/charging of the battery
    - Operational time on battery

Wireless Slip Ring

- Additional hardware consisting of a receiving antenna and receiver would need to be installed to support the on aircraft data transmission. Finding a mounting location with line of sight to the DAU may be challenging.

Conclusions

- As rotary aircraft advance, the data requirements of the parameters on the rotating components increase.
- The instrumentation community has made strides in moving forward from the days of individual channel slip rings to “less wire” systems
- As technology advances, we strive to achieve a completely wireless slip ring solution

Conclusions (Cont.)

- As discussed previously there are a few technical considerations that need to be addressed when looking to a wireless DAU solution
  - Sampling: channel sample rate, total number of channels, and total bit rate
  - Signal Conditioning: number of poles on filter (less # of poles leads to much higher sample rates), configurable cutoff frequencies

Conclusions (Cont.)

- NAWCAD would like to solicit collaboration from the Aircraft Instrumentation community for potential dedicated investment efforts. We would like to develop a requirements document to use in an Investment proposal.

Questions?