Wireless Sensor Networks in Harsh Electrical Environments

Project Overview

Background: During their development phase, gas turbine engines may be instrumented with up to 3000 sensors hardwired to a central data acquisition unit by over 12km of cabling. The aim of this project is to develop a Wireless Sensor Network (WSN) technology capable of replacing some of these hardwired sensors.

Motivations: The use of WSN technologies should lead to: reductions in cabling costs and installation time, greater flexibility in sensor deployment, and new methods for on-engine sensing.

Deliverables: The project will use Software Defined Radio (SDR) techniques to develop and evaluate a prototype WSN capable of operating in the harsh electrical environment between the engine casing and nacelle of a gas turbine engine. The project will consider the application of this technology to other electrically harsh environments.

Wireless Sensor Networks

In the context of this project, a Wireless Sensor Network (WSN) comprises a distributed set of autonomous sensor nodes which use wireless communication principles and data networking protocols to relay measurements to a base-station for subsequent storage and analysis. The performance of the WSN is characterised by: measurement sampling frequency, data rate, latency, and error rate (Quality of Service).

Software Defined Radio

In a Software Defined Radio (SDR), the components of the communication system that are typically implemented in hardware, are instead implemented in software. The advantages of using SDR over commercial wireless nodes include:

- Ability to implement a wide variety of modulation schemes and network protocols using a common hardware platform,
- Ability to analyse the internal signals of the physical layer of the communication system to better understand system performance,
- Ability to implement variations of modulation schemes utilised in current wireless standards.

In this project, National Instruments (NI) Universal Software Radio Peripherals (USRP 2921) and NI LabVIEW have been used to implement a SDR wireless test-bed.

Embedded Wireless Sensor Node

The WSN is to be deployed between the engine casing and the nacelle of a Trent 900 engine as shown in the figure to the right. Transmitted signals reflect off the many metallic surfaces and the lightning protection mesh in the nacelle.

Multiple copies of the transmitted signal simultaneously reach the receiving antenna. This is referred to as multipath propagation. This can be observed in the channel impulse response measurement presented in the graph to the left.

Operating Environment

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