Wireless sensors make aircraft maintenance more efficient

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The FLITE-WISE project has developed new wireless sensors to facilitate the constant monitoring of European aircrafts. The new system, which is expected to bring both cost and weight down, will be commercialised within the next three years.

Some 842 million passengers took a flight in the EU-28 in 2013. With such mind-bending figures, it hardly comes as a surprise that airplane safety is continuously monitored, with rules that keep being reviewed and improved based on the latest technologies and scientific knowledge. In fact, it is safe to say that flying is one, if not the, safest existing forms of transport.

Of course, this also means that monitoring the condition of an aircraft is costly and time-consuming. Maintenance typically accounts for 10 to 20 % of aircraft-related operating costs, and the use of wired sensors to monitor engines, airframes, structures, gearboxes and other key components of an aircraft is one of these things that contribute to bumping up the bill.

The EU-backed FLITE-WISE (FLite Instrumentation TEst WIreless SEnsor) project was set up with a view to moving away from the unnecessary burden presented by wires, and towards a 'Wireless sensor network' (WSN) relying on smart sensors using a radio interface to communicate with each other. The project, which is part of the Joint Technology Initiatives under Clean Sky (a public-private partnership between the Commission and the Aeronautical industry to reduce the environmental impact of aviation), was completed in December.

Jean-Dominique Decotignie coordinated the project on behalf of CSEM. In this exclusive interview for the research*eu magazine, he explains the technical advances made under FLITE-WISE and expands on its added value for the sector.

What were the main objectives of this project?

FLITE-WISE set out to develop a wireless sensor system to which acoustic and pressure sensors may be connected (with openness to other types of sensors), which is able to operate airborne for continuous flight test measurements. This translated into two use cases.

The first is a fully-integrated wireless sensor node dedicated to acoustic measurements along the fuselage of an aircraft. It is a circular, flexible patch designed to be applied to the aircraft skin and consisting of a sensor node packaged such that it can sustain the harsh environmental conditions of test flights. With its maximum thickness of less than 3 mm, it accommodates one acoustic sensor, communication capability, storage and energy for a 12-hour campaign. It is powered by ultra-thin batteries which can be wirelessly recharged by inductive coupling, making it possible to sample frequencies of up to 50 KHz with a maximum time-stamping error between two nodes of below 50 µs.

The second use case is the rotating use case, which contributes to the development and testing of a new generation of contra-rotating open rotor engines with an environmental performance significantly higher than that of traditional turbofans. The project remained at the demonstrator stage for this part. The sensor node is fully autonomous in terms of energy, with a specially-developed inductive energy harvester, and capable of acquiring data from eight sensors with synchronisation accuracy, relative to the propeller position, below 0.05°.

What are the main constraints posed by current wired sensors?

Wired sensors are currently used for monitoring the condition of aircraft engines, structures, gear boxes, and so on. The design of the sensor placement and its deployment and installation are cumbersome and thus costly. In addition, installing such sensors takes a lot of time, making it a major impediment to temporary installations. Finally, in some cases, for instance in moving parts such as engines, it is very difficult to wire sensors.

You claim that wireless sensors will bring down costs. How so?

A wireless sensor network, i.e. smart sensors with radio interfaces, promises unprecedented operational benefits. Lower airplane sensor wiring costs, lower weight (because cabling is highly reduced) and greater flexibility when deploying on airplanes, i.e. without the need to redesign the data wiring layout, are certainly some of the major arguments in favour of programmes such as the Smart Fixed Wing Aircraft under Clean Sky.

What is the added value of your technology for the aeronautic industry, this time in terms of effectiveness?

Besides the cost and weight reduction mentioned above, the technology allows us to install sensors almost anywhere on a plane, and thus sense different types of phenomena near their source (heat, stress, etc.). This can result in improvements in plane testing and aircraft maintenance.

What were the main difficulties you faced during the project and how did you resolve them?

The main challenges of the project were to produce: energy harvesting and electronics capable of withstanding very high accelerations and extreme (low and high) temperatures; a communication system resilient to radio interferences and jamming, with ultra-low energy consumption; a highly compact and slim design with fully wireless operations including charging for out-of-skin placement; and accurate synchronisation of sensor measurements between different nodes.

This was all achieved through a careful concurrent engineering approach thanks to the multidisciplinary team, Imperial College as a specialist in energy scavenging and storage, SERMA Ingénierie as an aeronautical electronics expert and CSEM for the low-power electronics, wireless protocols and wireless power supply. Energy scavenging required a new design based on magnetic induction. The communication protocol was improved to reduce further consumption by constantly adapting to the aircraft operational phase. Reduced consumption together with optimised energy storage and highly integrated electronics were key to size reduction. Finally, synchronisation resorted to very careful component selection and embedded implementation.

When do you expect your technology to be commercialised?

Given the application industry, aeronautics, in which development and certification cycles are between 5 and 10 years long, the technology will be available commercially in 2 or 3 years.

What are the next steps for the project, and do you have any follow-up plans after its end?

The technology has to pass the flight tests with the help of the topic manager Airbus Operation. This is planned for 2015. The prototypes will then be industrialised, to be manufactured in serial production. The technology will also be further developed for improved performances in terms of sampling rate and bandwidth as well as jamming protection.

More information: FLITE-WISE - FLite Instrumentation TEst WIreless SEnsor: cordis.europa.eu/project/rcn/108855_en.html

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