Sensors Requirements and Roadmaps Part 1

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ABSTRACT

The lecture starts with a brief overview of the state-of-the-art of the sensing technologies. Principles of detection and the stage of integration in conjunction with the need are discussed. Based on the projected sensor requirements to accomplish propulsion systems with distributed active control, the existent gaps and selected types of sensor technologies are addressed, which are foreseen to deliver the required sensitivity, the resolution, the range, and the bandwidth in classes of sensors and which will allow operation under harsh environment conditions. By changing the packaging and/or design of the current sensors, operation environments of 750°C may be possible, which would meet requirements for sensors located towards the engine intake, compressor and in some cases low-pressure turbine.

Sensing represents one of the vital components of the control schemes with the sensors providing the physical signal to enable the control loop and monitoring of engine condition. Since the reliability of the sensing element is often the lowest link in the control elements, development of appropriate sensor systems is critical to affordable and reliable implementation of the technologies for more intelligent gas turbine engines.

The different sensor functions impose different requirements for the sensors. For example for controls, sensors have to demonstrate a proven extended reliability, which means that sensor failure is unlikely. For health monitoring, on the other hand, monitoring sensors with less proven reliability can be used given the non-critical role of such sensors. While some of the identified sensors will be available or almost readily available, others sensors require significant research and development efforts.

Sensors development has followed the overlapping between the need of the users and technical capability for the supplier. There have been developments of sensors that have followed a specific requirement imposed by the user. However, such sensors are further used by other industries that find the packaging as suitable. Moreover, a platform of sensors could be used in multiple applications either by changing the packaging or the adjustable features of the system. Besides the temperature sensors, all other sensors are usually built to operate within an environment that corresponds to the temperature limits of the surroundings. Under these circumstances, there are few sensors which could detect for example pressure under high temperature. Even if such sensors exist, they may not satisfy other essential conditions to operate within the propulsion system in flight missions, namely high reliability and reduced mass. The reasonable cost is another aspect to be considered when the selection of a sensor is made.

This lecture will focus on sensor requirements for more intelligent engines with the objective to identify the status of current and future potential sensing technologies. In the second part of the lecture the generic requirements covering all sensing variables based on the performance requirements of previous lectures will be presented. Further, the lecture will explore which of these requirements can be met with current technologies. Standard sensing principles are briefly summarized and detailed information on current sensors will be described. MEMS technologies will be introduced as a very feasible alternative for the future sensing technologies used in the Gas Turbine Engines as the intrinsic advantages associated with small mass, low power consumption, high integration and high reliability are all significant advantages for the aerospace industry in general.