Smart and Intelligent Sensors

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Rocket engine testing is the primary mission for Stennis Space Center. Test stand facilities include the B-1/B-2 complex built for the Apollo Program, which is now used to test the RS-68 engine. A number of smaller test stands are available for testing components and lower thrust rocket engines. A-3 is a new test stand under construction that will have the capability to simulate high altitude conditions. For each test article, the customer expects to receive high quality measurements to support their engine design, validation, and certification requirements. Making these measurements requires hundreds or thousands of sensors.

Beginning with design, specification and acquisition, sensors must be calibrated, installed, configured, and maintained. Sensor problems detected during readiness reviews or as part of post-test data analysis require troubleshooting to determine what has failed—it could be the sensor, the sensor mount, the interconnect, or any other element in the data acquisition chain. These are all labor-intensive activities incurring substantial engineering and technician costs.

Technology Needs

Better approaches are needed to simplify sensor integration and help reduce life-cycle costs.

1. *Smarter sensors.* Sensor integration should be a matter of "plug-and-play" making sensors easier to add to a system. Sensors that implement new standards can help address this problem; for example, IEEE STD 1451.4 defines transducer electronic data sheet (TEDS) templates for commonly used sensors such as bridge elements and thermocouples. When a 1451.4 compliant *smart* sensor is connected to a system that can read the TEDS memory, all information needed to configure the data acquisition system can be uploaded. This reduces the amount of labor required and helps minimize configuration errors.
2. *Intelligent sensors.* Data received from a sensor be scaled, linearized, and converted to engineering units. Methods to reduce sensor processing overhead at the application node are needed. Smart sensors using low-cost microprocessors with integral data acquisition and communication support offer the means to add these capabilities. Once a processor is embedded, other features can be added; for example, *intelligent* sensors can make a health assessment to inform the data acquisition client when sensor performance is suspect.
3. *Distributed sample synchronization.* Networks of sensors require new ways for synchronizing samples. Standards that address the distributed timing problem (for example, IEEE STD 1588) provide the means to aggregate samples from many distributed smart sensors with sub-microsecond accuracy.
4. *Reduction in interconnect.* Alternative means are needed to reduce the frequent problems associated with cabling and connectors. Wireless technologies offer the promise of reducing interconnects and simultaneously making it easy to quickly add a sensor to a system.

Technology Challenges

The emergence of core technologies and associated standards make possible new sensor strategies that offer many system engineering and operational advantages. Among the key technology challenges are determining whether smart and intelligent sensors can offer cost-effective solutions. Are there quantifiable advantages gained from savings in power and mass among others to make smart/intelligent sensors competitive for ground and space operations? Similarly, wireless sensors appear to offer unique advantages if problems with power consumption, effective conversion rates, and signal interference can be solved.

More Information

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Example wireless sensor.