Sandia: Embedded Sensing Device

Category: UUR

Project description:

Today we live in a technology-driven world, where real-time sensing is feasible for a range of applications and environments. The data collected is invaluable, it can be used to improve future designs, enhance security, increase efficiency, assess health, and track performance, to name a few of the potential advantages of embedded sensing hardware. Sandia has many systems that could benefit from real-time monitoring at the system and component level.

Systems and components designed at Sandia are designed to function in an array of environments during their lifetime. Lifetimes range from a few days to tens of years. Sensors are sought that can detect a broad range of the environment space. Ideally, such sensors would be small, lightweight, low power, robust, and would operate both passively and actively. In the passive state the device would have minimal influence on the environment. However, in the active state the device would respond to the environment, such as, cooling device if it gets too hot or warming the device if it gets too cold.

Objective:

Design, build, and test a fully integrated sensing device, report and present all results to the Sandia mentors. The device is required to sense the environments in the table below. Stretch-requirements, not required, are included as well. The device will be evaluated on its; ease of integration of the hardware and software, ability to accurately sense environments, volumetric footprint, power usage, date-rate, cost, weight-to-capability ratio, uses of additively manufactured components, novelty, and robustness.

Device requirements:

The designed device must sense the environments within the specified ranges, listed in the table below. All sensors should be integrated using a Raspberry Pi Data Acquisition and Controller Pi-Plate card or something with similar capabilities. The sensors can be powered wirelessly or wired. The device must function without supplemental power up to four days. Fit within the mechanical envelope of a ¼ pie piece, with a 14.7 inch diameter and 6.5 inches tall.

Table 1. Required sensing environments.

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Environments	Operating range
Vibration	20 to 5000 Hz
Light irradiation	0 to 1 W-m^{-2}
Temperature	-20 to 70 ^{o}C
Relative humidity	5 to 90 % RH
Linear acceleration	0 to 10 G
Orientation	Orthogonal coordinate frame
Proximity (sense within)	0.028 m^3
Air composition	O, H, CO_2, CO, N
Shock	0 to 10 G

Stretch requirements:

- Actively respond to 1 to 3 of these environments (such as, cool device if it get hot, warmer the device if it get to cold, shading a device if exposed to more 100 W-m^{-2})
- Sense material changes with time (aging)
- Wireless capability
- Sense pH
- Synchronous sampling and timestamping

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