Technique for Radiometer and Antenna Array Calibration — TRAAC

This technique provides a unique and accurate method to calibrate an antenna and radiometer system.

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Highly sensitive receivers are used to detect minute amounts of emitted electromagnetic energy. Calibration of these receivers is vital to the accuracy of the measurements. Traditional calibration techniques depend on calibration reference internal to the receivers as reference for the calibration of the observed electromagnetic energy. Such methods can only calibrate errors in measurement introduced by the receiver only. The disadvantage of these existing methods is that they cannot account for errors introduced by devices, such as antennas, used for capturing electromagnetic radiation. This severely limits the types of antennas that can be used to make measurements with a high degree of accuracy. Complex antenna systems, such as electronically steerable antennas (also known as phased arrays), while offering potentially significant advantages, suffer from a lack of a reliable and accurate calibration technique.

The present innovation provides a method to perform an end-to-end calibration of a radio frequency (RF) receiver system comprised of an antenna and a receiver. Traditional calibration techniques cannot eliminate errors in measurement introduced by variations in antenna characteristics. The proposed invention provides a method to quantify the instantaneous, as well as long-term, variations in antenna characteristics. This technique will enable improved accuracy in measurements made using passive receiver systems and phased array systems in particular, by monitoring the performance of the antenna array by measuring the gain of the antenna electronics in real time.

The proximity of antenna elements in an array results in interaction between the electromagnetic fields radiated (or received) by the individual elements. This phenomenon is called mutual coupling. The new calibration method uses a known noise source as a calibration load to determine the instantaneous characteristics of the antenna. The noise source is emitted from one element of the antenna array and received by all the other elements due to mutual coupling. This received noise is used as a calibration standard to monitor the stability of the antenna electronics.

The proposed calibration technique makes use of five measurements. These are observations of an internal warm load, cold load (both internal to the radiometer/receiver), the scene of interest, the scene of interest with the noise source emitted from the center element of the antenna array, and a known noise source injected directly into each element of the antenna array. The noise source, coupled from the central element in the array to all other elements in a square array will be symmetric. With the noise source being emitted from the central element, the mutually coupled signal will be received on the other antenna elements, combined, and used as a calibration signal to monitor any change in the RF components (low-noise amplifiers, phase shifters, attenuators, and power combiners) in front of the radiometer. Based on these observations, a calibrated estimate of the scene can be obtained.

This work was done by Paul Meyer, William Sims, Kosta Varnavas, and Jeff McCracken of Marshall Space Flight Center; Karthik Srinivasan, Ashutosh Limaye, and Charles Laymon of Universities Space Research Association; and James Richeson of ICRC. For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-32783-1.

Real-Time Cognitive Computing Architecture for Data Fusion in a Dynamic Environment

This architecture can enable smart instrumentation for automotive, security, and intelligent robotics applications.

NASA's Jet Propulsion Laboratory, Pasadena, California

A novel cognitive computing architecture is conceptualized for processing multiple channels of multi-modal sensory data streams simultaneously, and fusing the information in real time to generate intelligent reaction sequences. This unique architecture is capable of assimilating parallel data streams that could be analog, digital, synchronous/asynchronous, and could be programmed to act as a knowledge synthesizer and/or an "intelligent perception" processor. In this architecture, the bio-inspired models of visual pathway and olfactory receptor processing are combined as processing components, to achieve the composite function of "searching for a source of food while avoiding the predator." The architecture is particularly suited for scene analysis from visual data and odorant