Synthetic Aperture Radiometry Kick-Off

IEEE Synthetic Aperture Radiometry Study Group

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Overview (1 of 4)

- Applications for Synthetic Aperture Radiometry
  - Early detection of fire
    - Forest surveillance
    - Imminent eruptions
  - Monitoring distribution and dynamics of ice
  - Monitoring of agricultural output
  - Heliospheric impacts on Earth's weather
  - Exploring potential biospheres of icy moons
  - Investigating causes for differences in evolution between Earth & Venus

Overview (2 of 4)

- Radiometers measure thermal noise within a limited bandwidth about some frequency of interest.
  - Water Vapor Radiometers (WVR) operating at 22 GHz
  - Zeeman radiometer operating at 183.75 GHz
- Thermal (black-body) noise conforms to Planck spectrum
  - Noise energy is quantized and noise samples are perfectly uncorrelated
  - Bandwidth is sufficiently narrow that noise energy = kT; k ≡ Boltzmann's constant
- Thermal noise generated by the radiometer itself may be many times greater than its sensitivity (T_{sys} ~ 500 K, Sensitivity, ΔT ~ 1 K)
  - Sensitivity determined by the time-bandwidth product of the noise output

Overview (3 of 4)

- Digitization of noise samples offers performance advantages
  - Superior suppression of image noise
  - Superior rejection of multiplicative noise
  - Superior cross-polarization rejection
- Quantization of noise samples has mitigatable disadvantages*
  - Amplitude quantization contaminates samples (B. Widrow)
  - Temporally-quantized samples are NOT perfectly uncorrelated (C. Bretherton)
  - Spectroscopic radiometry aggravated by temporal quantization

* One possible topic for proposed study

Overview (4 of 4)

- Challenges for Synthetic Aperture Radiometry Standard
  - Requirements that aperture synthesis imposes on individual radiometer elements
  - Morphology of array
    - Dense (redundant)
    - Thinned (non-redundant)
  - Array calibration (Polarization, Spectrometry, Spatial & Thermal resolution)
  - Optimum processing strategies (sequences) for aperture synthesis
    - Application dependencies
  - Handling platform (& scene?) motion
  - Terminology clean-up?

Proposed Study Plan - 1

- Survey of literature (example set of references)
  - Niels Skou, David Le Vine “Microwave Radiometer Systems: Design & Analysis,” Artech House 2006. Chapter 8 introduces synthetic aperture radiometry.
  - A. Camps “Tutorial on Synthetic Aperture Radiometry: Application to SMOS mission” IGARSS 2006. Extensive discussion of calibration from a moving space platform.
  - C. Ruf, C. Swift, A. Tanner, and D. Le Vine, “Interferometric Synthetic Aperture Microwave Radiometry for the Remote Sensing of the Earth,” IEEE Trans. Geo Rem. Sensing, **26**, 5, pp 597-611, Sep. 1988. Terminology clean-up?
  - B. Laursen, N. Skou, “Synthetic Aperture Radiometry Evaluated by a Two-Channel Demonstration Model,” IEEE Trans. Geo Rem. Sensing, **36**, 3, pp 822-832, May 1998.

Proposed Study Plan - 2

- Draw from experiences from ESA’s ESTEP & SMOS programs
- Invite practices & experiences from study group membership
- Invite synthetic aperture radiometry topics other than those listed on “Overview (3 of 4)” and “Overview (4 of 4)”

Proposed Study Plan - 3

- Develop a selection process to converge on candidates that produce a standard with the highest impact.
- Eliminate approaches that exceed the time line of standards development.

Questions?

Discussion