Intelligent Fused Multisensor Environmental Imaging & New Generation Sensor Concepts

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Abstract

- **Scientific Challenge** ⇒ Development and investigation of an intelligent signal processing (SP) perspective for collaborative remote sensing (RS) and distributed sensor network (SN) data acquisition, intelligent processing and information fusion for the purposes of high-resolution RS imaging, search, discovery, discrimination, mapping and problem-oriented analysis of spatially distributed physical remote sensing signature (RSS) fields.
- **Objectives** ⇒ Enhancement of RS capabilities based on information-theoretic approach to a general problem of unique RS image and related RSS recovery based on two novel developed paradigms: ⇒
  - **(1) DEDR** [descriptive experiment design (DED) - regularization (R)] strategy and
  - **(2) FBR** [fused Bayesian (FB) - maximum entropy regularization (R)] method.
- ***Predominant challenge*** ⇒ to solve the RS-SN imaging and RSS recovery inverse problems in the context of uncertain remote sensing environment:
- ***Model-level uncertainties*** ⇒ are associated with unknown statistics of perturbations of the random signals in turbulent environment.
- ***System-level uncertainties*** ⇒ are attributed to the imperfect multisensor array calibration, finite dimensionality of recorded measurements, uncontrolled antenna vibrations and random carrier trajectory deviations in the case of SAR.
- **Methodology** ⇒ Aggregated DEDR and FBR approach for reconstructive RS imaging and RSS recovery based on incorporating into the minimum risk nonparametric spectral estimation strategy the experiment design-motivated constraints of RSS identifiability and uncertain data-agreement model coupled with the worst-case statistical performance optimization-adopted regularization.
- **Neural Network-Based Implementation** ⇒ Development and simulation study of a new maximum entropy neural network (MENN) computational paradigm for efficient numerical implementation of a variety of DEDR and FBR-related descriptive and statistical robust regularization techniques for solving different fused/aggregated high-resolution multisensor environmental RS imaging and RSS recovery problems.
- **Simulation Tools** ⇒ Specialized end-user-oriented software (Virtual RS Laboratory) for extensive simulation studies and verifications of diverse RS image formation, reconstructive processing and post-processing techniques with interactive access and processing control abilities.
- **Perspective ⇒ Next Generation Sensor Concepts ⇒** Development of robust adaptive knowledge-based collaborative RS-SN strategies, SP algorithms design structures and simulation software for different search and discovery problems with intelligent fusion of information provided by the mobile high-resolution multisensor array radar/SAR system and the local distributed SN in the uncertain RS operational scenarios.

Author

Yuriy Shkvarko (*IEEE Member*'1995, *IEEE Senior Member*'2004) received the Dip. Eng. (Hon.) degree in radio engineering in 1976, the Candidate of Sciences degree (Ph.D. equivalent in the ex USSR) in radio systems in 1980, and the Doctor of Eng. Sciences degree (doctoral grade of excellence in the ex USSR) in radio physics, radar and navigation in 1990, all from the Supreme Evaluation Commission of the Council of Ministers of the ex USSR (presently Russia). From 1976 to 1991, he was with the Scientific Research Department of the Kharkov Aviation Institute, Kharkov, ex USSR, as a Research Fellow, Senior Fellow and finally as a Chair of the Research Laboratory in information technologies for radar and navigation. From 1991 to 1999 he was a Professor at the Department of System Analysis and Control of the Ukrainian National Polytechnic Institute at Kharkov, Ukraine. From 1999 to 2001 he was a visiting professor in the Guanajuato State University at Salamanca, Mexico. In 2001, he joined the Guadalajara Unit of the CINVESTAV (Center for Advanced Research and Studies) of Mexico as a Titular Professor. His research interests are in applications of signal processing to remote sensing, imaging radar, navigation and communications. He holds 12 patents of the ex USSR, and has published two books and some 120 papers in journals and conference records on these topics. He is a Senior Member of the Mexican National System of Investigators and a Regular Member of the Mexican National Academy of Sciences.