# Guest Editorial
# Special Issue on Remote Sensing of Building Interior

IT is our pleasure to have this opportunity to organize the first IEEE special issue on the subject of "seeing through the wall." We are very proud to have the IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING as the home of such an issue. The issue includes a selection of key contributions on the subject which broadly address radar remote-sensing methods and technologies for imaging through the wall. The objectives of through-wall imaging can be the determination of the building layouts, discerning the intent of activities inside the building, or locating, tracking, and imaging of building interiors. These three capabilities are highly desirable for a range of applications including police, fire and rescue, first responder, and military applications.

Traditionally, the IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING has published papers that report on advances in sensing instruments and techniques used for the acquisition of geoscientific information as well as techniques for processing, enhancing, and interpreting information derived from remote-sensing instruments. The content of such papers covers a wide range of disciplines including instrumentation and their calibration and validation for geosciences, signal processing, data fusion, random media optics, and electromagnetic theory. Such knowledge and expertise are much needed to solve a complex problem like standoff detection of obscured targets and mapping of the interior of a building.

The primary intention of this Special Issue is to draw attention to a new and emerging application area that makes use of techniques and approaches that are commonly employed and adopted by the Geoscience and Remote Sensing community. However, due to the nature of the problem, there are significant differences between traditional imaging radars and radiometers and those needed for localization and imaging of targets behind walls and inside enclosed structures. For example, to allow signal penetration through lossy walls and to suppress scattering caused by the wall structure itself, the lower part of the electromagnetic spectrum must be used. Moreover, to achieve a reasonable range resolution, ultrawide bandwidth signal waveforms are used. Since radar sensors are expected to operate in close proximity to building structures, wide-angle near-field focusing is needed to achieve the desired cross-range resolution. As such, system design, image formation methods, signal analyses, array processing techniques, detection, image sharpening, and clutter and multipath identification and rejection paradigms must work in concert and be reexamined in view of the specificities of the underlying sensing problem and the particularities of the new imaging challenge.

This issue includes both invited and submitted papers totaling 15 contributions. Topics of the papers cover most, if not all, aspects the problem and can be categorized into: 1) system design and instrumentation; 2) advanced imaging techniques for elimination of glint from large flat wall structures; 3) radar polarimetry; 4) passive microwave radiometry; 5) advanced forward models based on high-frequency methods as well as full-wave solutions based on finite-difference time-domain technique for large-scale problems; and 6) detection and identification techniques of behind the wall stationary and moving concealed and unconcealed targets.

The progress reported in this Special Issue on remote sensing of building interior using microwaves is substantial and noteworthy. However, many challenging scenarios and situations remain unsolved with the current techniques. Enhanced imaging of building interiors and improved indoor target detection, classification, localization, and tracking still require further research and development. However, with the advent of technology that brings about better hardware (low phase noise oscillators, compact nondispersive ultrawideband antennas, efficient power amplifiers, and processors) and improved system architectures, such as multistatic or distributed sensor architectures, opportunities for handling more complex building scenarios will increase. As progress in this application area evolves, it is expected that the techniques and algorithms will find utility in other application areas such as subsurface sensing and medical imaging using acoustic and nonionizing radiation sources. The stage is set for future Special Issues.

We close this Editorial by expressing our thanks to all the authors and to the 60-plus reviewers, who completed their effort in a mere eight months, thus ensuring the timely publication of this Special Issue. We are very grateful for the two Editor-in-Chiefs, Dr. J. A. Benediktsson and Dr. C. Ruf, as well as the Editorial Assistant, S. Gillespie, for their advice, help, and the occasional nudge. Their immeasurable guidance in forming the vision, core, and objectives of this Special Issue is greatly appreciated.

Moeness Amin, *Guest Editor*
Center for Advanced Communications
Villanova University
Villanova, PA 19085-1603 USA

Kamal Sarabandi, *Guest Editor*
Department of Electrical Engineering and Computer Science
University of Michigan
Ann Arbor, MI 48109 USA

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**Moeness Amin** (F'01) received the Ph.D. degree from the University of Colorado, Boulder, in 1984.

He has been a member of the faculty of Villanova University, Villanova, PA, since 1985, where he is currently a Professor with the Department of Electrical and Computer Engineering and the Director of the Center for Advanced Communications. He has over 400 publications in the areas of wireless communications, time–frequency analysis, smart antennas, interference cancellation in broadband communication platforms, direction finding, GPS technologies, over-the-horizon radar, and radar imaging. He was the Guest Editor of the September 2008 special issue of the *Journal of Franklin Institute* (Elsevier) on advances in indoor radar imaging, and is the Co-Guest Editor of the May 2009 special issue of the IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING on remote sensing of building interior.

Dr. Amin is a Fellow of the International Society of Optical Engineering. He was a Distinguished Lecturer of the IEEE Signal Processing Society for 2003–2004. He is a member of the Franklin Institute Committee on Science and the Arts and was a member of the IEEE Signal Processing Society Technical Committee on Signal Processing for Communications during 1998–2002 and of the IEEE Signal Processing Society Technical Committee on Statistical Signal and Array Processing during 1995–1997. He was the recipient of the IEEE Third Millennium Medal; the 1997 Villanova University Outstanding Faculty Research Award; and the 1997 IEEE Philadelphia Section Service Award. He was the Cochair of the Special Sessions of the 2008 IEEE International Conference on Acoustics, Speech, and Signal Processing, Las Vegas, NV; the Technical Chair of the 2nd IEEE International Symposium on Signal Processing and Information Technology, Morocco, 2002; the General and Organization Chair of the IEEE Workshop on Statistical Signal and Array Processing, Pennsylvania, 2000; and the General and Organization Chair of the IEEE International Symposium on Time–Frequency and Time-Scale Analysis, Pennsylvania, 1994. He was an Associate Editor of the IEEE TRANSACTIONS ON SIGNAL PROCESSING during 1996–1998.

**Kamal Sarabandi** (S'87–M'90–SM'92–F'00) received the B.S. degree in electrical engineering from Sharif University of Technology, Tehran, Iran, in 1980, and the M.S. degree in electrical engineering and the M.S. degree in mathematics and the Ph.D. degree in electrical engineering from the University of Michigan, Ann Arbor, in 1986 and 1989, respectively.

He is currently the Director of the Radiation Laboratory and a Professor with the Department of Electrical Engineering and Computer Science, University of Michigan. He has 22 years of experience with wave propagation in random media, communication channel modeling, microwave sensors, and radar systems and is leading a large research group including two research scientists and 12 Ph.D. and 2 M.S. students. He has graduated 30 Ph.D. and supervised numerous postdoctoral students. He has served as the Principal Investigator on many projects sponsored by NASA, JPL, ARO, ONR, ARL, NSF, DARPA, and a larger number of industries. He has published many book chapters and more than 160 papers in refereed journals on miniaturized and on-chip antennas, meta-materials, electromagnetic scattering, wireless channel modeling, random media modeling, microwave measurement techniques, radar calibration, inverse scattering problems, and microwave sensors. He has also had more than 420 papers and invited presentations in many national and international conferences and symposia on similar subjects. His research areas of interest include microwave and millimeter-wave radar remote sensing, meta-materials, electromagnetic wave propagation, and antenna miniaturization.

Dr. Sarabandi is a member of NASA Advisory Council appointed by the NASA Administrator. He also served as a Vice President of the IEEE Geoscience and Remote Sensing Society (GRSS) and a member of the IEEE Technical Activities Board Awards Committee. He is serving on the Editorial Board of the IEEE Proceedings and has served as Associate Editor of the IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION and the IEEE SENSORS JOURNAL. He is a member of Commissions F and D of URSI and is listed in American Men and Women of Science Who's Who in America and Who's Who in Science and Engineering. He was the recipient of the Henry Russel Award from the Regent of the University of Michigan. In 1999, he received a GAAC Distinguished Lecturer Award from the German Federal Ministry for Education, Science, and Technology. He was also a recipient of the 1996 EECS Department Teaching Excellence Award and a 2004 College of Engineering Research Excellence Award. In 2005, he received the IEEE GRSS Distinguished Achievement Award and the University of Michigan Faculty Recognition Award. He also received the Best Paper Award at the 2006 Army Science Conference. In 2008, he was awarded a Humboldt Research Award from the Alexander von Humboldt Foundation of Germany. In the past several years, joint papers presented by his students at a number of international symposia (IEEE APS'95,'97,'00,'01,'03,'05,'06,'07; IEEE IGARSS'99,'02,'07; IEEE IMS'01; USNC URSI'04,'05,'06; AMTA'06; and URSI GA 2008) have received student paper awards.