

“Beyond HDTV”

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The television systems have spread worldwide and have come to fulfill the role of “viewing at a distance” that was the original dream. Television systems are not only used for broadcasting, but also they are used in many fields as video systems and are firmly embedded in society’s infrastructure. Television has now been reborn as high-definition television (HDTV), with new developments appearing. Meanwhile, movies were popular long before the invention of television. Through masterpieces and documentaries, they have given people thrills and wisdom. As electronic video has developed, it has been adopted into shooting and editing, making it possible to produce movies efficiently. Recently, even screenings in cinemas have become electronic, and movies have been restructured as the digital cinema, including stereoscopic 3-D systems.

In television, systems that surpass HDTV are being investigated and developed as ultrahigh-definition television (UHDTV), and are coming closer to a level at which they can display large-screen video. As a result, the UHDTV and the digital cinema have a cross relationship, so that the barriers between TV systems and cinemas have been lowered. This Special Issue titled “Beyond HDTV” is timely in that it considers both topics, and is thought to address the demands of today.

It is known that angle of view has a large effect on sensation of reality. It increases as the viewing angle widens, but it is saturated at around 100°. Widening the viewing angle more than that of the HDTV would require ex-

tremely high resolution that is beyond the HDTV systems. For single-screen formats, the resolution of sensors and screens has to be increased accordingly. This method is common to the digital cinema and to UHDTV today.

An alternative is to use multiple sensors and screens, which are linked together and are referred to as tiled display or multiple-screen display. Thinking outside the box, “Beyond HDTV” can be constructed in a completely original manner. But to design an actual working system in the present, the system would relate to current HDTV and follow in the footsteps of television systems that have come before it. This being the case, resolution, frame rate, scanning method, colorimetry, aspect ratio, and other parameters must be targeted for study. As for advanced 3DTV systems, a variety of systems can be considered. Depth information of the 3-D video systems, in general, is converted to 2-D images when recorded and transmitted. Therefore, a drastic improvement of resolution enables the system to carry enough depth information. Given that system, we consider that if we can realize an extremely

The overview papers in this Special Issue cover the key technologies regarding the emergence of UHDTV and the digital cinema, including coverage of stereoscopic 3-D systems.

high resolution in 2-D system, we can also reach a sufficiently compelling 3-D system.

The overview papers in this special issue cover these technologies and are contributed by some of the leaders in the field of “beyond HDTV.” The paper by Sugawara and Masaoka discusses the relationship between image format and visual experience of UHDTV. Its results generally have been applied to large format images. Two papers related to colorimetry are provided. Park *et al.* present a new wide-gamut RGB primary set and an efficient color encoding method for UHDTV. The paper by Wen provides color management for future video systems.

Four papers related to devices and equipments are provided. Travis *et al.* describe wedge optics in flat panel displays that can be applied to 3-D viewing. Takayanagi and Nakamura describe high-resolution CMOS video image sensors. Yamashita and Mitani present 8K extremely-high-resolution camera systems. The

paper by Kanazawa and Kusakabe presents ultrahigh-definition LCOS projectors.

Two papers related to format-free systems composed of plural screens are presented. Schreer *et al.* discuss ultrahigh-resolution panoramic imaging for format-agnostic video production. The introduced system has flexibility applied to many video systems. The paper by Leigh *et al.* shows scalable resolution display walls. It describes approaches and trends in display hardware construction, middleware architecture, and user-interaction design.

Shishikui *et al.* describe high-performance video codec for Super Hi-Vision. The paper by Fujii *et al.* presents digital cinema creation and distribution on optical high-speed networks. Oyamada *et al.* describe progress of transmission technologies for UHDTV.

The paper by Aylsworth *et al.* presents the stereographic digital cinema: production and exhibition techniques in 2012. Son *et al.* show

how 3-D imaging will be able to create real-world-like environments.

The subject of “Beyond HDTV” is very broad and its technologies need R/D for devices, system architectures, transmission, and display systems. “Beyond HDTV,” based on these technologies, will be recognized as “essential” in the future.

We consider that this Special Issue configured by outstanding contributions will be of use not just to video researchers and engineers, but also to all graduate students. Since the application range for video is expected to expand even further, these articles should be suitable in the PROCEEDINGS OF THE IEEE to ensure they will be of service not only to those who are directly concerned with video, but also to all IEEE members.

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ABOUT THE GUEST EDITORS

Fumio Okano (Fellow, IEEE) received the Ph.D. degree from Tohoku University, Sendai, Japan, in 1996.

He joined Japan Broadcasting Corporation (NHK), Tokyo, Japan, in 1978. Since 1981, he has been engaged in research on high-definition television (HDTV) cameras, HDTV systems, television standards converters, 3-D television, and extremely-high-resolution imagery. He supervised the total system of ultrahigh definition television (UHDTV) with 4000 scanning lines “Super Hi-Vision” during 2000–2005. He has applied UHDTV system to his research on 3DTV systems based on integral method. He moved to NHK Engineering Service in 2009, and is currently Operating Officer.

Dr. Okano received the Achievement Award (Institute of Electronics, Information and Communication Engineers Japan, 2006); the Tokyo Metropolitan Achievement Award (Tokyo Metropolitan Government, 2006); and the IBC2003 President Award (International Broadcasting Convention, 2003), which are related to high-resolution imaging. He held the Chair of the IEEE BTS Japan Chapter, and he is a Fellow The Institute of Image Information and Television Engineers in Japan (ITE).



Wendy L. Aylsworth received the B.S. degree in computer sciences from the University of Michigan, Ann Arbor, in 1974 and the M.S./M.B.A. (Beta Gamma Sigma) degree in managerial sciences/strategic planning from the University of Southern California, Los Angeles, in 1981.

She began her career with 15 years in the aerospace industry, designing and developing computing systems for military aircraft at Lockheed Aircraft Co., as well as managing software departments in R&D and military training simulators at Honeywell Inc. She moved to the entertainment industry in 1989 to manage the software department for theme park rides at The Walt Disney Co. She then directed the engineering efforts for the development of the Computer Animation Production System (CAPS) for Disney’s animation division, for which the company received a Scientific and Technical Achievement Award from the Academy of Motion Pictures Arts and Sciences in 1991. She joined Warner Bros., Burbank, CA, in 1994, establishing an all-digital production operation for a newly created Feature Animation division before moving to Technical Operations in 1999. She is currently Senior Vice President of Technology for Warner Bros. Technical Operations. In this role, she



oversees the establishment of new technologies for Warner Bros. production divisions and assesses the impact of emerging technologies on content creation and distribution. Her department participates in public and private standards consortia to promote interoperability and commonality for the benefit of the entertainment sector. She is the President Elect of the Society of Motion Picture and Television Engineers (SMPTE), and has held a number of offices in the organization.

Ms. Aylsworth was honored as a SMPTE Fellow in 2004. From 2004 through 2007, she chaired the SMPTE DC28 Technical Committee, creating the first digital cinema standards in the industry. These standards were subsequently adopted by the International Standards Organization (ISO) Technology Committee 36 on Cinematography, in which she also participates. She was honored with the Digital Cinema Pioneer Award at ShoWest 2006 for her work in this field. From 2008 through 2010, she was elected as the Engineering Vice President of the Society, managing all of the standards development activity and establishing the Society's initial work in broadband standards and in stereoscopic imagery standards for home use. She is a member of both the Academy of Motion Pictures Arts and Sciences and the Academy of Television Arts and Sciences, currently acting as Co-Chair of the Technical Emmy's Committee. Her other selected awards, offices, and publications include: Advanced Television Systems Committee, Board of Directors, (2008–2010); Vice-Chair, International Telecommunications Union, Radiocommunication Sector, Study Group 6 Broadcasting, Working Party 6 M on Multimedia (2003–2007); Featured in *Changing Our World: True Stories of Women Engineers*, S. E. Hatch, SCTE Press, ISBN 0-7844-0841-6, pp. 110–111; President Emeritus, High Point Academy, Board service, including President (1990–2003); Conference Chair, Advanced Television Enhancement Forum Symposium, University of Central Florida, October 2001; "The Need for Asset Management and Digital Archive," SMPTE Annual Technical Conference, October 2000; Chairman, Klimke Endowment Fund (1989–1995); Honeywell Achievement Award for Software Development of GBU-15 Trainer in 1988; "Successful User Involvement in Trainer Designs," National Computer Conference, May 1983; and YWCA, Woman of the Year in Engineering Award in 1978.

Ralf Schäfer received the Dipl.-Ing. and Dr.-Ing. degrees in electrical engineering from the Technical University of Berlin, Berlin, Germany, in 1977 and 1984, respectively.

In October 1977, he joined the Heinrich-Hertz Institute (HHI), Berlin, Germany. Since 1989, he has been the Head of the Image Processing Department, where he is responsible for about 75 researchers and technicians. His R&D interests cover all areas around images and video, from capture to display and from algorithms to silicon.

Dr. Schäfer is a member of the German Society for Information Technology (ITG), where he is Chairman of the experts group "Digital Coding." He is a member of the German Society for Television and Motion Picture Technology (FKTG), where he belongs to the URTEL Award Committee. In 1986, he received the paper award of the ITG and in 2000 the Richard Theile Medal of the FKTG.



Paul J. Hearty received the Ph.D. degree from Queen's University, Kingston, ON, Canada, in 1981.

He has worked for 30 years in fields relating to television and cinema. Currently, he is Vice President, Technology Standards at Sony Electronics, San Diego, CA. From 1987 to 1995, he was a leader in the development and standardization of the digital HDTV system currently deployed in North America and elsewhere, being recognized with one Emmy and for contributions to four others. An active contributor to technology standards, he has served in many national and international standards development organizations, such as the ITU, IEC, ATSC, and CEA. He has chaired the Society of Cable Telecommunications Engineers' Digital Video Subcommittee, responsible for digital cable standards for North America, since its inception in 1996.

Dr. Hearty is a Fellow of the Society of Motion Picture and Television Engineers (SMPTE), and serves in SMPTE as Editorial Vice President, Member of the Board, and Member of the Board's Executive Committee. He was a member of the Federal Communications Commission's (FCC's) Video Programming Access Advisory Committee, and is a member of the Council for the U.S. National Committee for the International Electro-technical Commission and on the Corporate Advisory Group of the IEEE.

