**Modified Slanted-Edge Method and Multidirectional Modulation Transfer Function Estimation**

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Ultra-high definition television (UHDTV) has a high pixel count of 4K (3840 x 2160 pixels) or 8K (7680 x 4320 pixels) and provides a better viewing experience than HDTV. To fully exploit the features and effectiveness of UHDTV, the image resolution characteristics of 4K and 8K cameras are primarily important. The slanted-edge method specified in ISO Standard 12233 measures the modulation transfer function (MTF) of digital image acquisition devices by analyzing the image data of a simple knife-edge target captured by the device. The target is framing free, enabling precise focus by adjusting the shooting distance instead of the rough focus ring. The estimated MTF is, however, a function of the horizontal or vertical spatial frequencies, not multidirectional. In addition, the method is not robust against noise because it takes the derivative of each data line in the edge-angle estimation. We propose a modified method that estimates the edge angle by fitting a two-dimensional function to the image data. The method has a higher accuracy, precision, and robustness against noise than the ISO 12233 method and is applicable to any arbitrary pixel array, enabling a multidirectional MTF estimate in a single measurement of a starburst image.

**Still Images of High Spatial Resolution Enable Short TV Viewing Distances**


Masaki Emoto and Masayuki Sugawara

Preferred viewing distance (PVD), which is the viewing distance favored in the home viewing environment, is important for overall TV broadcasting system assessments to guarantee the image quality of TV programs. Previous studies have suggested that image size and resolution have little effect on the PVD. However, in future TV systems such as ultra-high definition television, which are expected to have a wide field of view and high spatial resolution, program production methods may change depending on the specific values of these parameters, and viewer behaviors may change accordingly. Here we used a program consisting of still images to show that viewer behavior differs between two spatial resolutions. This result suggests that the conditions in previous studies discouraged viewers from finding an optimized PVD for each scene because there was little need and insufficient time to move spontaneously.

**A Novel MOSFET with Vertical Signal-Transfer Capability for 3D-Structured CMOS Image Sensors**


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We have developed a novel metal-oxide-semiconductor field-effect transistor (MOSFET) that can transfer signals vertically without through-silicon vias by using a fully depleted silicon-on-insulator structure with its source region connected to the back electrodes as well as the front ones. A test of a prototype MOSFET fabricated using the backside anisotropic wet etching technique has confirmed that the electrical characteristics measured from the front and the back electrodes are identical. The subthreshold factor S of the prototype was found to be 64.5 mV/decade, suggesting a good switching performance. Since the double-sided MOSFET has vertical signal-transfer capability and excellent operating characteristics, it is expected to contribute to developing a More-than-Moore device of three-dimensional integration such as a pixel-parallel image sensor.

**Optical Compensation For Hologram Distortion Using Wavefront Interpolation In Angle-Multiplexed Holograms**

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Distortion of the hologram may occur when the photopolymer material used in the medium shrinks or expands. We analyzed interference fringe distortion for plane waves and a reference beam with an angular gap between recording and reproducing for the purpose of compensating for the distortion. We found that the wavefronts that could compensate for the distortion could approximately be obtained by linear interpolation of such angle-multiplexed holograms. We recorded 80 data pages with the angle-multiplexing method and obtained an optimized wavefront to compensate for hologram distortion on the first, fortieth, and eightieth data pages using adaptive optics with genetic algorithms and linear interpolated wavefronts at the other data pages. The calculation time for 80 wavefronts to compensate for distortion fell to 3/80th of that of having to calculate optimizations for all pages. The bit error rates were lower than 1.0 × 10⁻² on all data pages reproduced using these wavefronts.