Synthesis, Coding, and Evaluation of 3D Images Based on Integral Imaging

Roger Olsson
Institutionen för Informationsteknologi och Medier
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Roger Olsson
Department of Information Technology and Media
Mid Sweden University
SE-851 70 Sundsvall, SWEDEN.

Abstract

In recent years camera prototypes based on Integral Imaging (II) have emerged that are capable of capturing three-dimensional (3D) images. When being viewed on a 3D display, these II-pictures convey depth and content that realistically change perspective as the viewer changes the viewing position.

The dissertation concentrates on three restraining factors concerning II-picture progress. Firstly, there is a lack of digital II-pictures available for inter alia comparative research and coding scheme development. Secondly, there is an absence of objective quality metrics that explicitly measure distortion with respect to the II-picture properties: depth and view-angle dependency. Thirdly, low coding efficiencies are achieved when present image coding standards are applied to II-pictures.

A computer synthesis method has been developed, which enables the production of different II-picture types. An II-camera model forms a basis and is combined with a scene description language that allows for the describing of arbitrary complex virtual scenes. The light transport within the scene and into the II-camera is simulated using ray-tracing and geometrical optics. A number of II-camera models, scene descriptions, and II-pictures are produced using the presented method.

Two quality evaluation metrics have been constructed to objectively quantify the distortion contained in an II-picture with respect to its specific properties. The first metric models how the distortion is perceived by a viewer watching an II-display from different viewing-angles. The second metric estimates the depth-distribution of the distortion. New aspects of coding-induced artifacts within the II-picture are revealed using the proposed metrics.

Finally, a coding scheme for II-pictures has been developed that inter alia utilizes the video coding standard H.264/AVC by firstly transforming the II-picture into a pseudo video sequence. The properties of the coding scheme have been studied in detail and compared with other coding schemes using the proposed evaluation metrics. The proposed coding scheme achieves the same quality as JPEG2000 at approximately 1/60th of the storage- or distribution requirements.

Keywords

Integral Imaging, 3D images, coding, quality evaluation, H.264/AVC, JP3D