Effective Global Prediction for Dense Light-Field Compression by Using Synthesized Multi-focus Images

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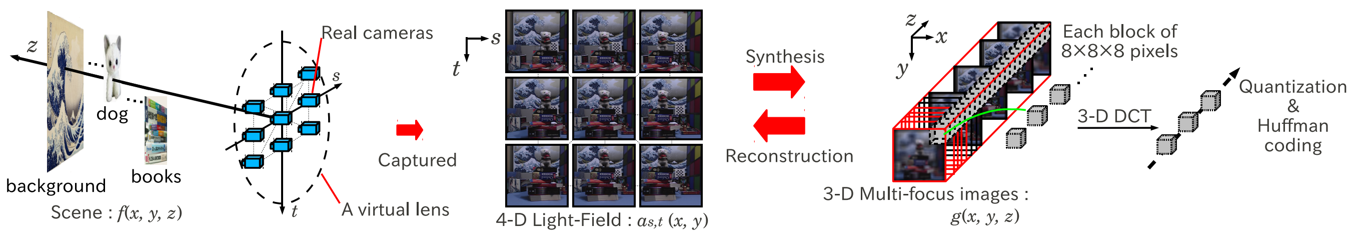


Figure 1: *Light-Field compression using multi-focus images.*

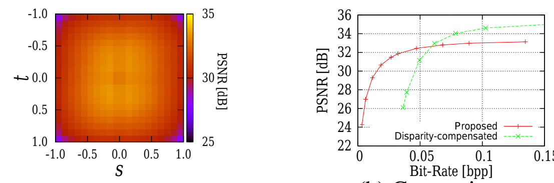
1 Introduction

Light-Field Rendering is a promising technique generating 3-D images from multi-view images captured by dense camera arrays or lens arrays[Isaksen et al. 2000]. However, Light-Field generally consists of 4-D enormous data, that are not suitable for storing or transmitting without effective compression[Magnor and Girod 2000]. We previously derived a method of reconstructing 4-D Light-Field directly from 3-D information composed of multi-focus images without any scene estimation[Kodama et al. 2006]. On the other hand, it is easy to synthesize multi-focus images from Light-Field. Therefore, we can achieve conversion between 4-D Light-Field and 3-D multi-focus images without significant degradation. Recently, researchers in computational photography also study such interesting properties of Light-Field[Levin and Durand 2010]. In this work, based on the conversion, we propose novel global prediction for dense Light-Field compression via synthesized multi-focus images as effective representation of 3-D scenes like Figure 1.

2 Our Approach

We synthesize multi-focus images $g(x, y, z)$ with a virtual lens by merging shifted multi-view images using constant weight function $p(s, t)$ as follows: $g(x, y, z) = \sum_{s,t} p(s, t)a_{s,t}(x+sz, y+tz)$, where a viewpoint is denoted by (s, t) and $a_{s,t}(x, y)$ is the corresponding image. Then, we apply DCT-based coding to synthesized multi-focus images. The compressed 3-D multi-focus images enable us to predict 4-D Light-Field globally. Actually, $g(x, y, z)$ is combined with 3-D scene $f(x, y, z)$ by using a convolution of a 3-D blurring filter $h(x, y, z) = (1/z^2)p(x/z, y/z)$[Kodama et al. 2006]. Based on the relation, Light-Field can be approximately reconstructed by a simple combination of dimension reduction and a 2-D filtering[Ou et al. 2008; Kodama et al. 2010].

We show experimental results using real images [Ota et al. 2009]. 21 × 21 multi-view images are taken from equally-spaced viewpoints, and each image has 512×512 pixels. Disparity between adjacent images is smaller than about 2.0 pixels. Figure 2(a) shows quality of the reconstructed multi-view images from the synthesized 64 multi-focus images compressed at 0.027 bpp. It indicates how the reconstruction quality changes by (s, t), where PSNR is evaluated for 384 × 384 pixels in the center of the image. We obtain 30∼35 dB at almost all the viewpoints. In Figure 2(b), our proposed global prediction using multi-focus images is compared with the conventional local disparity-compensation[Magnor and Girod 2000] by averages of PSNR. Our prediction is robust, especially, at very low bit-rate. Effective Light-Field compression including residuals based on the proposed prediction is expected in future.



(a) Reconstruction quality (b) Comparison

Figure 2: *Evaluation of prediction.*

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