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科学研究費助成事業　　研究成果報告書

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研究課題名（和文） インタラクティブマルチビュービデオ通信システム

研究課題名（英文） Interactive Multiview Video Communication System

研究代表者
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交付決定額（研究期間全体）：（直接経費）　　3,600,000円

研究成果の概要（和文）：画像技術の進歩により、カラー画像と奥行き画像を同時に複数の角度から撮影することが可能になった。撮影した画像を用い、本研究の目的は、インタラクティブな３次元画像システムが実現できるように、基礎技術を開発すること。三つのテーマで研究を進めた。一つ目は、３次元画像の圧縮。二つ目は、３次元データーのネットワーク転送。三つ目は、３次元データーの復元。画像圧縮に関しては、グラフフーリエ変換を用い、マルチ解像度、輪郭の対応性ある画像圧縮アルゴリズムを開発した。データー転送に関しては、データー冗長度を利用するリカバリー手法を提案した。画像データー復元に関しては、グラフラプラシアンを用いた復元手法を開発した。

研究成果の概要（英文）：Today's imaging technologies can now capture texture maps (e.g., color images) and depth maps (per-pixel distance between objects in the 3D scene and camera) from multiple viewpoints simultaneously. Given this rich set of input images, the objective is to develop key technologies that enable a range of interactive 3D imaging applications. In particular, we focus on three aspects of an end-to-end visual communication system: i) coding of 3D images, ii) transmission of 3D data over data networks, and iii) restoration of virtual views given transmitted 3D data. For coding of 3D data, we have developed is a multi-resolution edge-adaptive image codec based on graph Fourier transform (GFT). For transmission of 3D data, we have developed a strategy to exploit the data redundancy inherent in the representation of multiview texture-plus-depth format for loss recovery. For restoration of 3D images, we have studied the use of graph Laplacian regularizer as signal prior for regularization.

研究分野： 信号処理

キーワード： 画像処理　グラフ信号処理

１．研究開始当初の背景

The advance of image sensing technologies means that one can now readily capture texture maps (e.g., color images) and depth maps (per-pixel distance between objects in the 3D scene and camera) from multiple viewpoints simultaneously. Unlike conventional single-view video capture where the decoder can only play back video exactly as it was recorded at the encoder with no interactivity, having this rich set of multi-view input images enables a wide range of interactive 3D imaging applications at the decoder; e.g., free viewpoint TV (where observation viewpoints of an interested 3D scene can be freely selected), immersive visual communication (where a user’s head movements would induce corresponding change in the rendered viewpoint), etc. The objective of this research is thus to explore signal processing technologies that can help bring these 3D imaging applications to reality.

２．研究の目的

The technical goal of this research is to develop key technologies that enable interactive 3D imaging applications. In particular, we focus on three important aspects of an end-to-end visual communication system: 1) representation and coding of 3D images, 2) robust transmission of 3D data over heterogeneous networks, and 3) signal restoration and rendering of virtual views given transmitted 3D data.

３．研究の方法

(1) For representation and coding of 3D data, we have focused on the compression of depth images. The main technique we have developed is a multi-resolution edge-adaptive image codec based on graph Fourier transform (GFT). The basic idea is to first encode detected edges in a depth map in high resolution using arithmetic edge coding (AEC), then perform edge-adaptive low-pass filtering and down-sampling, and encode the low-resolution block using GFT.

(2) For transmission of 3D data over networks, we have developed a strategy to exploit the data redundancy inherent in the representation of multiview texture-plus-depth format for loss recovery, resulting in a higher synthesized view quality at the decoder.

(3) For restoration of 3D images (e.g., image interpolation, disocclusion hole filling, etc), we have studied the use of graph Laplacian regularizer as signal prior for regularization. Together with a signal fidelity term in L2-norm, we have shown that this problem can be solved efficiently via iterative reweighted least square (IRLS), where each iteration is an unconstrained quadratic programming problem with a closed form solution.

４．研究成果

(1) For coding of depth images, we have shown that our multi-resolution edge-adaptive image codec can outperform H.264 intra coding by up to 6.8dB in average PSNR. An example of our coding results is shown in the following PSNR versus bitrate plot for Teddy sequence.

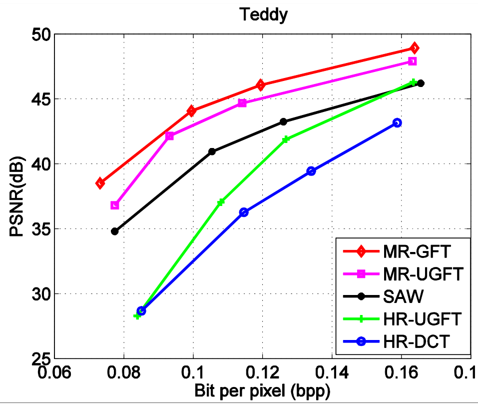

Fig.1: PSNR versus encoding bitrate for the Teddy sequence.

(2) For robust transmission of multiview texture-plus depth video over lossy wireless links, we have shown that our proposed unequal forward error correction (FEC) protection scheme, together with decoder loss recovery that exploits inter-view redundancy for effective concealment (marked “patch-based” in the figure), can outperform other robust streaming proposals by up to 6.2dB.

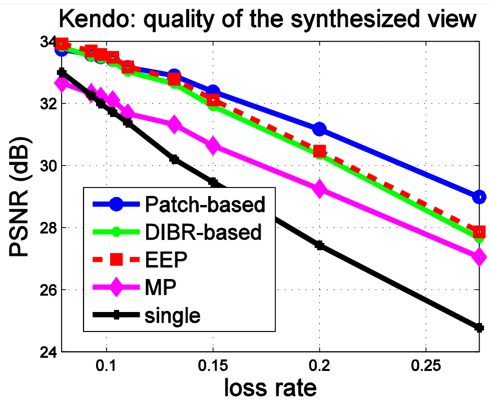

Fig.2: PSNR versus packet loss rate for

different transmission / loss recovery scheme.

(3) For image interpolation of DIBR-synthesized view, our devised local graph-based interpolation method using a graph Laplacian regularizer has shown remarkably natural image quality compared to naïve methods such as linear and bi-cubic interpolation. See Fig.3 for an example of actual DIBR-synthesized image and corresponding interpolated image.

Fig.3: (left) DIBR-synthesized image for virtual viewpoint closer to the 3D scene, (right) interpolated image using our proposed graph-based algorithm

５．主な発表論文等

（研究代表者、研究分担者及び連携研究者には下線）

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〔図書〕（計　0　件）

〔産業財産権〕
○出願状況（計　1　件）

名称：　濃淡画像符号化装置及び復号装置
発明者：　チョン ジーン、フー ウェイ
権利者：大学共同利用機関法人情報・システ

ム研究機構
種類： 特許
番号： 特願 2012-140268
出願年月日： 2012/6/21
国内外の別： 国内

○取得状況（計 0 件）

名称：
発明者：
権利者：
種類：
番号：
出願年月日：
取得年月日：
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