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| Title | **Format of Deep Learning Network Training Dataset and Content Streaming for Hologram Generation and Printing** |
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| Re: |  |
| Abstract | This contribution defined deep learning network training dataset format for standardization of quality and form of training data as a creation of high-definition digital holographic content, holographic printing content streaming format for recording high-definition digital holographic content. |
| Purpose | To start discussion on purpose of the new standard topic. |
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**Format of Deep Learning Network Training Dataset and Content Streaming for Hologram Generation and Printing**

Preface

1 Purpose

The standard proposes the definition of deep learning network training dataset format for high-definition digital holographic content generation and holographic content streaming format for real-time streaming.

2 Summary

The standard defined deep learning network training dataset format for standardization of quality and form of training data as a creation of high-definition digital holographic content, holographic printing content streaming format for recording high-definition digital holographic content.

3 Relationship to Reference Standards

None*)*

Format of Deep Learning Network Training Dataset and Content Streaming for Hologram Generation and Printing

1 Coverage

This standard is for learning datasets and content streaming formats for creating and recording high-resolution digital holographic content. For the development of deep learning networks for the creation of high-resolution digital holographic content, we propose standardization of the quality and shape of training data, and the standardization of content streaming formats for hologram printing for transmission to holographic printers that record high-resolution digital holographic content.

2 Citation Standards

None

3 Defining Terms

3.1 Hologram

Information or media containing amplitude and phase of light to reproduce the distribution of light in space

[Source] TTAK.KO-10.0871

3.2 Hogel

The minimum unit in which all point-of-view information in a 3-D image is stored on a holographic stereogram printer.

3.3 Training Dataset

Image-based input data for deep learning network development for digital holographic content creation.

3.4 Streaming

A technique for sending video files to print holographic content from a holographic stereogram printer and playing it back in real time.

3.5 High-resolution digital holographic content

Define the number of horizontal/vertical viewing angle points within the horizontal/vertical viewing angle of holographic printing results and the product resolution of the point-in-time image to be more than 50K.

4 Abbreviation

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| **R-S** | Rayleigh-Sommerfeld |
| **WRP** | Wavefront Recording Plane |
| **ASM** | Angular Spectrum Method |

5 Deep learning network learning dataset formats for high-resolution digital holographic content creation

5.1 Overview

Describing deep learning network learning dataset formats for high-resolution digital holographic content creation.

5.2 Deep learning network for digital holographic content creation

(Figure 5-1) The existing hologram generation algorithm generates a hologram dataset using a depth map-based RGBD dataset, and shows that the deep learning network model is formed through the back wave as compared to the one that generated the hologram dataset utilizing the deep learning network model.

(Figure 5-1) Existing hologram generation algorithms (using RGBD datasets) and deep learning hologram generation algorithms using deep learning networks

5.3 Training dataset format of input images for depth map based and output holographic images

For standardization of the quality and shape of the training data of the deep learning network for digital holographic content creation, the format of the input image and output holographic image is defined as follows.

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| The input image is composed of RGB and depth information as shown in (Figure 5-2), and individual RGBD data is composed of the following camera parameters.   * Field of View * The pixel size of the camera sensor, the focal length of the camera lens, etc. * Rendering parameters – Near, Far and Depth level (0~256) conversion values, etc. |

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| The parameters for quality evaluation of deep learning network training data can be obtained through the information of the dataset used to create the input RGBD dataset, and are configured in the following format.   * Depth uniformity (0~1 Normalization) * Image similarity * Source of the original computer-synthesized model dataset |

In general, the higher the depth uniformity of the input RGBD dataset, the lower the image similarity, the better the deep learning network training for hologram generation. The dataset information used to create the RGBD dataset (the source of the original computer composite model dataset) determines whether the data set is suitable for the user to train.

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| The output holographic image will have the form of a complex hologram and consists of algorithm-related parameters and related physics used for the complex hologram generation as follows.   * Complex hologram form(Real, Imaginary) * Algorithm Generation: R-S, WRP, ASM etc * Related physics values: Wavelength, pixel size, etc. |

The training dataset format defined in this standard is used for dataset sharing or training quality prediction, and it is possible to increase the efficiency of deep learning network development through the reuse of training data.



(Figure 5-2) Training dataset of input image and output holographic image based on depth map

6 Content streaming format for holographic printing

6.1 Overview

Describing content streaming formats for high-resolution digital holographic content printing.

6.2 Content streaming format for digital holographic content printing

**6.2.1 Overview**

This standard describes a content streaming format that can efficiently handle generated digital holographic content. The existing method of holographic printing is a method of creating plural holographic viewpoint images and storing them individually as shown in (Figure 6-1), and when transferring them to a holographic printing device and recording them. The revision can be done with very complicated process when they were accessed because the number and size of files is large.



(Figure 6-1) Existing viewpoint image format method of holographic content for holographic printing (top) and the proposed viewpoint image format method (bottom)

**6.2.2 Hogel for holographic printing**

Hogel defines the total resolution as the number of horizontal and vertical pixels in a holographic stereogram printer with a meaning similar to the pixel used as a resolution measure in a general 2D flat panel display as the minimum unit in which all viewpoint information of a 3D image is stored. One hogel is optically reduced and recorded as resolutions of 1K, 2K, 4K, etc. depending on the resolution of the spatial light modulator.

**6.2.3 Content streaming format for holographic printing**

Generated hogel data using each viewpoint image for holographic printing has spatio-temporal similarities between adjacent hogels, and is advantageous for compression, editing, and output process because it can be efficiently handled directly within the same memory area. Since services such as real-time streaming services can be used for holographic printing, as shown in (Figure 6-1), it is possible to save one integrated file in the form of a video file using H.264. As shown in (Figure 6-2), assuming that M x N hogel files are transmitted to the printer through streaming for holographic printing, it is possible to transmit one video file having a total of M x N frames (hogels) if the proposed standard method is used, while existing M x N still image files were transmitted, respectively. The format for streaming the hologram content used at this time is (Figure 6-2) and uses the image format defined in H.264 as it is, but records by defining only the aspect and vertical spacing of the hogel size for printing.



(Figure 6-2) Holographic content streaming format for proposed holographic printing

**6.2.4 Holographic printing**

Using a deep learning network, high-resolution digital holographic content is created, and it is converted into a hologram video file (using H.264 format) in the form of (Figure 6-2) using a content streaming format, using a holographic printing device. Through the same process as (Figure 6-3), the holographic printing result is created.



(Figure 6-3) Manufacturing process for holographic printing result