OpenHolo Algorithm Guide

(Generation :: Triangular Mesh based CGH)

Yeon-Gyeong Ju, Jae-Hyeung Park

OpenHolo Commission

Contents

1. Introduction

: Generation::Triangular Mesh Based CGH generates complex optical field of 3D objects represented in triangular meshes. Triangular mesh based CGH can be classified into non-analytic method and the analytic method according to the way the local angular spectrum is obtained. In current release, only the analytic method is implemented.

2. Algorithm

2.1. Triangular mesh based CGH generation Method

2.1.1. Introduction

: Triangular mesh based CGH generates the complex field of 3D objects represented as a collection of the triangular meshes. The algorithm aggregates the angular spectrums of individual triangular meshes and then performs a Fourier transform to obtain the complex field for entire objects. The angular spectrum of the individual triangular mesh is obtained using the analytic formula of the Fourier transform of the reference triangular aperture, considering the geometrical relation between the hologram plane and the local mesh plane, and also between the local mesh and the reference triangular aperture. The phase distribution on the mesh is determined by the carrier wave is assumed to be a plane wave of a specfic direction in the code. The amplitude inside each mesh is determined by the surface shading model and it can be either linearly varying for the continuous shading or uniform for the flat shading.

2.1.2. Method

:

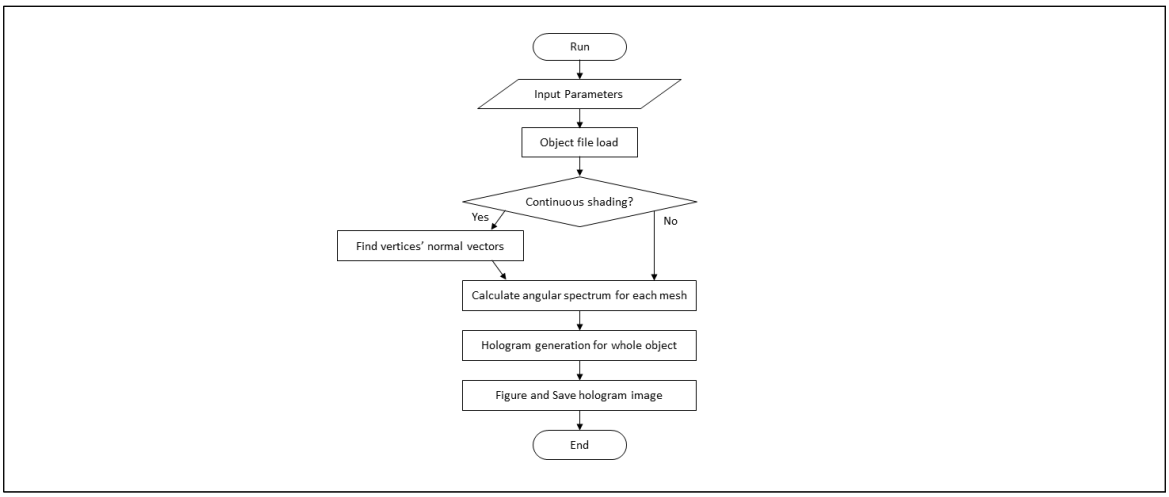

Fig 1. Algorithm 2.1.1. Flow Chart

Algorithm Name: Generation::Triangular Mesh based CGH	
Input	obj : 3d object represented in meshes (N*9 matrix) holoParam : wavelength, SLM parameters shadingParam gpuAvailable
Output	hologram : hologram complexfield

```
1  %% Input
2
3
4  % 01 Hologram parameters
5  % 02 Shading parameters
```

```
% 03 Load object & adjust size
% 04 Output file name

%% 01 Hologram parameters
holoParam.wavelength=532e-9;     %%%%% LASER wavelength in meter
holoParam.Nx=1920;       %%%%% SLM resolution ( holo.Nx * holo.Ny )
holoParam.Ny=1080;
holoParam.dx=8e-6;    %%%%% SLM pixel pitch in meter
holoParam.dy=8e-6;
holoParam.sizeX = holoParam.Nx*holoParam.dx;
holoParam.sizeY = holoParam.Ny*holoParam.dy;
%%%%% SLM physical length in meter

%% 02 Shading Effect
% Illumination position / [0 0 0] (if you don't want to put illumination effect)
shadingParam.illu=[1 1 1];
% Continuous Shading
shadingParam.con = 1;     % put or not

%% 03 Load object and adjust size
meshDataFileName = './teapot/mesh_teapot.txt';
% Object shift from center
shiftX=0;    shiftY=0;   shiftZ=0.1;
objectSize = holoParam.sizeX/3;

%% 04 Output File Name - Save File
hologramFileName='hologram.jpg';
recFileName='recon.jpg';

%% %%%%%%%%%%%%%%%%%% Setting done %%%%%%%%%%%%%%%%%%

%% Object File Load
obj=load(meshDataFileName);
obj = fn_normalizeCenteringObj(obj);
obj = fn_scaleShiftObj(obj, [objectSize, objectSize, objectSize], [shiftX, shiftY, shiftZ]);

%% Hologram generation
hologram = fn_genH(obj, holoParam, shadingParam, gpuAvailable);

%% Numerical reconstruction
[rec,du,dv] = fn_FresnelPropagation_as(hologram, holoParam.dx, holoParam.dy, shiftZ,
holoParam. wavelength, gpuAvailable);
```

Code 1. Algorithm 2.1.1. Pseudo Code

3. Implementation S/W

3.1. Triangular mesh based CGH generation Method

3.1.1. Implementation

:

3.1.2. Interface

:

Type	Source File	S/W	Description
Matlab	*main_TriMesh*	*해당 구현 함수, 클래스 등*	*example S/W to generate triangular mesh based CGH*
Matlab	*fn_genH.m*		*function to generate hologram complex field*
Matlab	*fn_FindVertexNormalVector.m*		*function to find vertices' normal vertors to implement 'continuous shading effect'*
Matlab	*fn_AS_continuous.m*		*function to calculate angular spectrum with 'continuous shading effect'*
Matlab	*fn_AS_shading.m*		*function to calculate angular spectrum with 'flat shading effect'*
Matlab	*fn_normalizeCenteringObj.m*		*function to normalize the size and to shift the object to the coordinate origin*
Matlab	*fn_scaleShiftObj.m*		*function to scale and shift the object*
Matlab	*fn_FresnelPropagation.m*		*function to propagate complex field numerically (Angular spectrum method)*

4. Reference

[1] J.-H. Park, "*Recent progresses in computer generated holography for three-dimensional scene*," Journal of Information Display, DOI:10.1080/15980316.2016.1255672 Aug 2016. (Published online. http://dx.doi.org/10.1080/15980316.2016.1255672)

[2] Y.-M. Ji, H.-J. Yeom, and J.-H. Park, "*Efficient texture mapping by adaptive mesh division in mesh-based computer generated hologram*," Optics Express, vol. 24, no. 24, pp. 28154-28169, (2016).

[3] H.-J. Yeom, and J.-H. Park, "*Calculation of reflectance distribution using angular spectrum convolution in mesh-based computer generated hologram,*" Optics Express, vol. 24, no. 17, pp. 19801-19813 (2016).

[4] J.-H. Park, S.-B. Kim, H.-J. Yeom, H.-J. Kim, H. Zhang, B. Li, Y.-M. Ji, S.-H. Kim, and S.-B. Ko, "*Continuous shading and its fast update in fully analytic triangular-mesh-based computer generated hologram*," Optics Express, vol. 23, no. 26, pp. 33893-33901 (2015) (Selected as Optics Express Cover Image and OSA Image of the Week).

[5] J.-H. Park, H.-J. Yeom, H.-J. Kim, H. Zhang, B. Li, Y.-M. Ji, and S.-H. Kim, "*Removal of line artifacts on mesh boundary in computer generated hologram by mesh phase matching*," Optics Express, vol. 23, issue 6, pp. 8006-8013 (2015)