OpenHolo Algorithm Guide

(Hologram Core Processing ::

Extraction of distance parameter

using sharpness functions)

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Contents

1. Introduction

We use autofocusing to capture in-focus images. It is based on sharpness of images and various of autofocusing algorithms have been proposed. It represents a peak when the image is in-focus and drops when the image goes out-of-focus. It can relate to holography signal process. Hologram has a depth information of object and is reconstructed at that point. The sharpness of the reconstructed hologram image changes with the change of the depth position.

If the depth of focus is not correct, the reconstructed hologram can not have a clear image. It means the same as in-focus image phenomenon. For this reasons, we will discuss the hologram signal processing using the sharpness functions.

2. Algorithm

2.1. Sharpness functions method

2.1.1. Brenner function

Brenner function [1] : A focus function $f(Z)$ is calculated which is a measure of the average change in gray level between pairs of points separated by n pixels. $f(Z)$ is a maximum when the image is in focus. and is given by

$$f(Z) = \sum_j \sum_i G_i(Z) - G_{i+n}(Z)^2$$

Where the index (i) ranges over all image points, in order along a scan line (j); n is a small integer; Z is the Z-axis, or focus position; and G_i is the transmission gray level for point i. A value of n equal to 2 gives a good signal to noise ratio.

Sharpness functions_Brenner function	
Input	• data.mat : Numerical reconstructed hologram (h_n, h : hologram image, n : depth of focus)
Output	• SF_result_data.mat : Graph of sharpness value (datax: depth of focus, datay : value of Sharpness)

```
load data
for depth = 1:1:10
    exp = ['I = h_',num2str(depth),';];
    eval(exp)
    I = real(I);
    % Brenner function
    Th = 100;
    [Sx,Sy]=size(I);
    Fx=zeros(Sx,Sy);Fy=zeros(Sx,Sy);
    for i=1:Sx;
        for j=1:Sy-2;
            if abs(I(i,j+1)-I(i,j))>=Th;
                Fy(i,j)=abs(I(i,j+2)-I(i,j)).^2;
            else Fy(i,j)=0;
            end
        end
    end
    for i=1:Sx-2;
        for j=1:Sy;
            if abs(I(i+1,j)-I(i,j))>=Th;
                Fx(i,j)=abs(I(i+2,j)-I(i,j)).^2;
            else Fx(i,j)=0;
            end
        end
    end
    Fx_sum=sum(Fx(:));Fy_sum=sum(Fy(:));
    F_3=Fx_sum+Fy_sum;
    F=F_3;
    datax(1,n) = depth;
    datay(1,n) = F;
end
```

```
plot(datax, datay);
save SF_result_data datax datay
```

Code 1. Algorithm 2.1.1. Pseudo Code

3. Implementation S/W

3.1. Extraction of distance parameter using sharpness functions method

Type	Source File	S/W	Description
Matlab	*Sharpness_function.m*		It produces a peak when the image is in-focus and drops when the image is out-focus. It can find an information of depth

4. Reference

[1] J. Brenner et al., "An Automated Microscope for Cytologic Research - A Preliminary Evaluation", Journal of Histochemistry and Cytochemistry, vol. 24, no. 1, pp. 100-111, 1976