Monochrome Image Hologram (MIH)

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Abstract:

A new computer-generated optical element called a monochrome image hologram (MIH) is described. A real nonnegative function to represent the transmittance of a synthesized hologram is used. This technique uses the positions of the samples in the synthesized hologram to record the phase information of a complex wavefront. Synthesized hologram is displayed on laser printer and is recorded on a film. Finally the reconstruction process is done using computerized .

Introduction:

From the fact that the photograpic plate on which the hologram is recorded contains only variation in blacking(1-3), it ought to be possible to create such variations artificially, and consequently to synthesize a hologram(4-9). The previous papers defined a general object by giving the coordinates and intensities of its points but in this paper we can take any monochrome image to do hologram (MIH). The monochrome image hologram (MIH) is a new computer-generator hologram wavefront reconstruction device which, like the hologram, provides the display of a two dimensional image. Computationally, monochrome image hologram constriction is faster than conventional hologram construction because we do not need lines to draw the image(10). In this paper we describe a new method of generating real and nonnegative function H(u,v) related to the two-dimensional Fourier transform F(u,v) of an image f(x,y). The function H(u,v) will produce a good approximate under Fourier transformation to the image f(x,y). The synthesized hologram produced by using this real nonnegative function are different from the holograms is made by lines method.

Procedure in synthesized the Hologram:

The procedures in synthesizing a hologram on a computer consist of the following steps. First, the information about the monochrome image of a scene or object are stored in a form that can be conveniently introduced to the computer. In most of our experiments we save the data on file by using matlab software. The second step computes the wavefront of the scene or object. The wavefront is the Fourier transform of the two-dimensional monochrome image. Before calculating Fourier transform we will choice best function to satisfy the conditions specified for synthesizing hologram and this function is Fk(u,v) where this function is real and nonnegative so, the transmittance of hologram given by:

$$H(u,v) = \sum_{m=-\infty}^{\infty} \sum_{n=-\infty}^{\infty} \sum_{k=1}^{4} F_k(u,v) \times \delta[u-(4n-k+1)/4w, v-m/w] \quad (1)$$

$\delta(u,v)$ is the two dimensional that Dirac Delta function, the constant w is a parameter that allows the reconstructed monochrome image of f(x,y) to appear shifted along the x-axis. The choice of this parameter depends on the width of the monochrome image f (x,y) along the x-axis. It can be noted in Eq. (1) that the

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sampling rate along the u-axis for H(u,v) is four times that along the v-axis. Now to calculate the proper Fourier transform for synthesizing hologram we carry out the computation as follows:

$$F(k\Delta u/4,\ k'\Delta v) = \sum_{m=(N/2)}^{(N/2)-1} \sum_{n=(N/2)}^{(N/2)-1} f(m\Delta x, n\Delta y) \times \exp[-i2\pi(\frac{mk}{4} + nk')/N]. \qquad (2)$$

Where $\Delta x \times \Delta u = \Delta y \times \Delta v = 1/N$ and

$k = -2N, -2N+1, ..., 2N-1.$

$k' = -N/2, -N/2+1, ..., N/2-1.$

The discrete values [f(mΔx, nΔy)] are samples of the two-dimensional monochrome image f(x,y). The Fourier transform samples $[F(k\Delta u/4,\ k'\Delta v]$ are computed with the Fast Fourier transform algorithm(11). In Eq. (2) we assume that the two-dimensional monochrome image consists of NxN samples. The number of samples in the Fourier transform is equal to N×4N. After we have computed the Fourier transform, we can use Eq(1) to calculate the values of the amplitude transmission H(u,v) of hologram. The values of the function H(u,v) at the sampling locations are given by:

$$H\{(4m+k-1-2N)(\Delta u/4),[n-(N/2)]\Delta v\} = \begin{cases} \mathrm{Re}((-i)^{k-1}F\{(4m+k-1-2N)(\Delta u/4),[n-(N/2)]\Delta v\}) \\ \text{if } H\{(4m+k-1-2N)(\Delta u/4),[n-(N/2)]\Delta v\} > 0 \\ 0 \text{ Otherwise} \end{cases} \qquad (3)$$

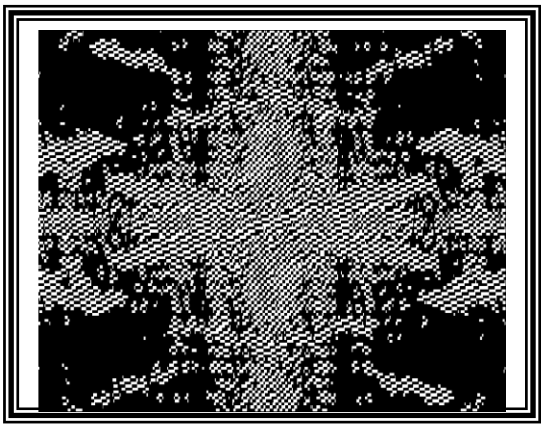
Where n, m= 0, 1, 2, …………, N-1 and k=1, 2, 3, 4. The symbol (Re) denotes the real part of the enclosed complex number. In our production process the amplitude transmission of the hologram is obtained by laser printer, after that we photoreduced it to approximately 3×3mm2. This reduced Photography is the synthesized hologram.

Experimental:

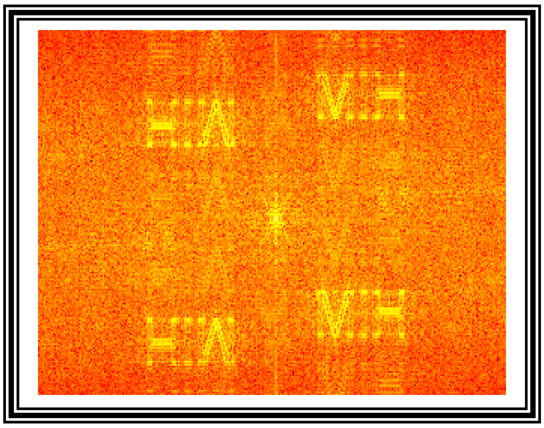
In this experiment we shall demonstrate the effect of use a real and nonnegative function so, the transmittance of hologram for two-dimensional monochrome image is shown in fig(1).

Fig(1): Original two-dimensional monochrome image.

The image has 128× 128 samples. The number of samples of the corresponding Fourier transform needed to make the synthesized hologram is new equal to 128×512 therefore, the Fourier transform of the image is computed by using Eq(1) and after that we calculate the values of amplitude transmission H(u,v) of hologram by using (2). The next step is printing this hologram on 3×3 mm^2 area by using laser printer and finally photoreduced this hologram on film. Images constructed from the monochrome image hologram is shown in Fig. 2. Image reconstruction from the synthesized hologram by use this technique is shown in Fig(3).



Fig(2): Computer generated hologram of the synthesized two-dimensional monochrome image



Fig(3): Digital reconstruction image of a hologram

In this Figure we can see that there are many pictures in reconstruction process this thing belong on the Fourier transform process and those pictures were opposite directions this is also belong to the attributed to the interference pattern to the Fourier transform .

Conclusion:

There are many conclusions we can concluded from this research:

1- This technique was faster than the conventional hologram.

2- The reconstruction images were more clear than the conventional hologram.

3- We can deal with any monochrome image without any problem in draw.

4- Fourier transform do on alteration the image in reconstruction process and also change the directions of these images in oppositely.

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الهولوغرامات المولدة للصور الاحادية اللون

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الخلاصة:

في هذا البحث تم توليد عنصر بصري جديد باستخدام تقنية الهولوغرامات المولدة حاسوبياً تسمى الهولوغرامات الصور احادية اللون. وتم استخدام دالة حقيقية موجبة لتمثيل شكل هذا الهولوغرام. معلومة الطور لجبهة الموجة لهذه الصورة سوف تسجل على فلم لصناعة العنصر البصري.