

A newly developed 3D endoscope composed of a conventional 2D endoscope and a 2D/3D converter using law of light attenuation

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Abstract

A newly developed 3D endoscope composed of a conventional 2D endoscope and a 2D/3D converter using law of light attenuation was described in this paper. The 3D resultant images had 12 parallaxes. Therefore the images were applicable to non-glasses 3D display using multi-parallaxes. Hence, non-glasses 3D endoscope system was possible employing a conventional 2D endoscope and a 2D/3D converter using law of light attenuation.

An experimental new stereo endoscope was presented as above and also the resultant images suggested the usefulness for practical use of the new endoscope in this paper.

Keywords: 3D endoscope, 2D/3D converter, non-glasses 3D display, multi-parallaxes

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Introduction

Stereo endoscope for medical use has been developed. The endoscope cannot be shortened the diameter because of the geometrical limit that needs two different angle aspects it is said parallax images while the stereo image taking. The 3D endoscope requires a plurality of lenses.

Therefore the diameter size is relatively bigger than the 2D endoscope and the resultant images have 2 parallaxes only.

One of author of this paper is patent¹⁾ holder of a 2D/3D converter²⁾ using law of light attenuation. The patent abstract is described below. A stereoscopic image generating apparatus and a stereoscopic image generating method for providing a stereoscopic image generating apparatus and a stereoscopic image generating method capable of using an existing camera without requiring a plurality of lenses are provided. By taking an imaging operation, it is photographed in the natural light state (first shooting). Immediately after the first shooting, the light emitting section is made to emit light and the subject is imaged with light shining (second shooting). The ratio between the luminance value in the first image data and the luminance value in the second image data is calculated for each pixel. Thereafter, the shift amount is calculated based on the calculated ratio data of the luminance value. A parallax image is created according to the calculated shift amount. Instead of natural light, a second light emitting part that emits bounce light

can be provided.

Then a new 3D endoscope composed of a conventional 2D endoscope and the 2D/3D converter described above were newly developed and also resultant multi parallax images were presented and also the resultant images suggested the usefulness for practical use of the new endoscope in this paper.

Materials and Methods

Input a rectangular wave of 0~5V of 30 Hz to the light source power supply of an endoscope having an LED light source. As a result, at a certain timing the image is taken in the natural light state (first shooting), the LED light source emits light immediately after the first shooting, and the object is shot with shining light (second shooting). A ratio between the luminance value in the first image data and the luminance value in the second image data is calculated for each pixel and the shift amount is calculated based on the calculated ratio data on the luminance value. A parallax image is generated according to the calculated shift amount. “USB Digital Microscope Oscope” model MS100 is employed as the endoscope. The spec is that the resolution is 1280×720 pixels, focus range is 10mm to 500mm and LED light brightness is adjustable.

When the luminance value ratio $F(x, y)$ of each pixel (x, y) in the two images of the flash light and the flash non-emission which are taken almost at the same time changes, the positions of the pixel

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luminance of the original image are moved in x direction. The moving distances are as the value $p \times c \times \sqrt{F(x,y) - 1}$ when arbitrary c is constant for user's utility such as the size of 3D display and p is 12 different proportional coefficients¹⁾. As the result, twelve parallax images are obtained. The proportional coefficient used for each 12 parallax images is 6, 5, 4, 3, 2, 1, 0, -1, -2, -3, -4, -5 in the order from the 1st image to 12-th image. If variations of p were 2, the resultant images are composed of stereo pair only

and the images are for glasses 3D display. In this paper, the variations of p were employed as 12 because of preventing image flipping for viewers using autostereoscopic display.

Results

Geometrical position of the image taking was shown in Fig.1. Original images of the flash light and the flash non-emission were shown in Fig.2. Resultant 12 parallax images were shown in Fig3.



Fig.1 Geometrical position of the image taking

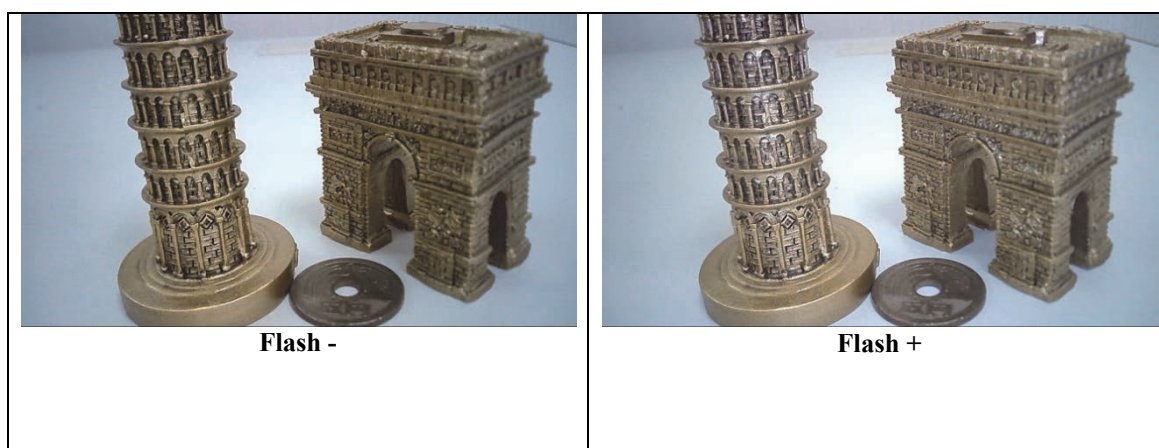
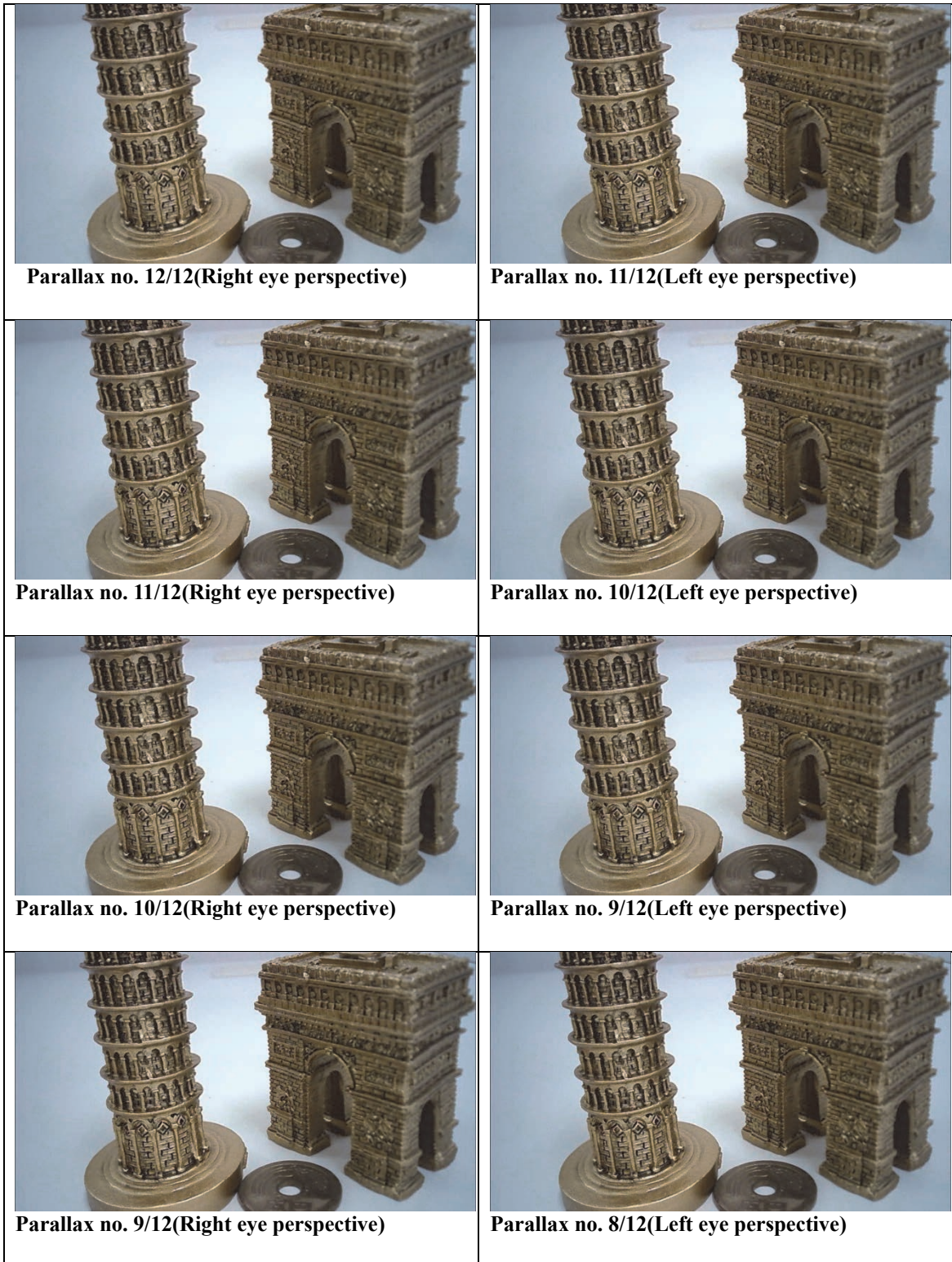


Fig.2 Original images of the flash light and the flash non-emission



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Parallax no. 8/12(Right eye perspective)



Parallax no. 7/12(Left eye perspective)



Parallax no. 7/12(Right eye perspective)



Parallax no. 6/12(Left eye perspective)



Parallax no. 6/12(Right eye perspective)



Parallax no. 5/12(Left eye perspective)



Parallax no. 5/12(Right eye perspective)



Parallax no. 4/12(Left eye perspective)

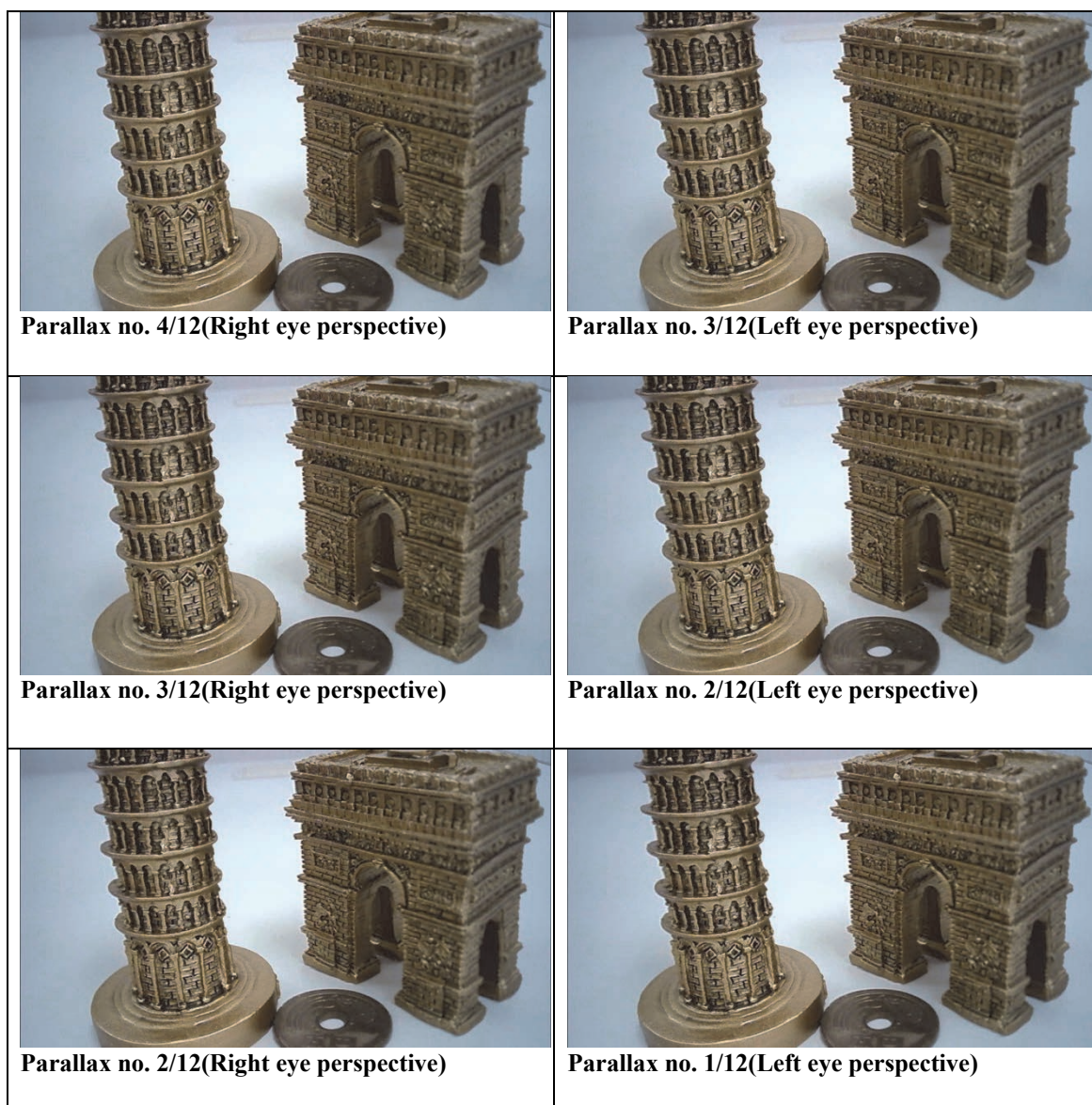


Fig.3 Resultant 12 parallaxes (See above images as cross viewing)

Discussion

2D/3D conversion³⁾ stereo images were superior with respect to depth perception than conventional stereo images under condition of endoscopic examination and/or surgery⁴⁾ as former research.

Many stereo endoscopes for medical use have been developed. The type of endoscope cannot be shortened the diameter because of the geometrical limit that needs two different angle aspects it is said parallax images while the stereo image taking. The 3D endoscope requires a plurality of lenses. Therefore the diameter size is relatively bigger than the 2D endoscope and the resultant images have 2 parallaxes only. Then the conventional 3D endoscope is very hard to apply to non-glasses 3D

display. But the endoscope with the 2D/3D converter presented in this paper is very suited non-glasses 3D display because of the easily producing multi-parallaxes.

Conclusion

A newly developed 3D endoscope composed of a conventional 2D endoscope and a 2D/3D converter using law of light attenuation was described in this paper. The 3D resultant images had 12 parallaxes. Therefore the images were applicable to non-glasses 3D display using multi-parallaxes. Hence, non-glasses 3D endoscope system was possible employing a conventional 2D endoscope and a 2D/3D converter using law of light attenuation.

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従来方式の2次元内視鏡と光の減弱法則を用いた2D/3D変換とで構

成された新型の立体内視鏡

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要 約

本稿では、従来の2D内視鏡と光減衰の法則を用いた2D / 3D変換器を用いた新開発の3D内視鏡について述べた。結果として得られた3D画像は12の視差を有していた。そのため、画像はマルチ視差を用いた非眼鏡方式の3Dディスプレイに適用可能であった。したがって、従来の2D内視鏡および光減衰の法則を使用する2D / 3D変換器を使用することで非眼鏡3D内視鏡システムの実現が可能であった。

以上のように、新しいステレオ内視鏡を試作し、その結果得られた画像から本内視鏡の実用性が示された。

キーワード: 3D endoscope, 2D/3D converter, non-glasses 3D display, multi-parallaxes

