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HUMAN FACTOR RESEARCH ON NEAR-INFRARED 3D OPHTHALMIC MICROSCOPE

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***Abstract*— Human factor research is needed to verify the performance of near-infrared 3D ophthalmic microscope. Near-infrared 3D ophthalmic microscope was recently developed for an eye surgery and it is superior to existed surgery microscope. Eye surgeon feel more convenient, because it could use 3D monitor. Near-infrared ray could deliver a more clear image of an eye to surgery. Performing a surgery without a visible light could reduce the side effect to a patient and expect to reduce the recovery time. As a result of an experiment, several merit of near-infrared 3D ophthalmic microscope has been proved.**

Keywords—3D Image, Near-infrared, Ophthalmic surgery, Operating microscope.

I. Introduction

Most of the eye operation has been performed in the normal operation room with fluorescent light. Recently, there are several approaches has been introduced for an eye surgery. Using 3D images is one of the ways that has been applied to an eye surgery and it helps to perform an eye surgery more accurate. Last four years, our research team has been working together to develop a new near-infrared 3D ophthalmic microscope.

Developed near-infrared 3D ophthalmic microscope has many advantages for an eye surgeon and patients. First, with the help of 3D images, doctor could see the depth of an eye and it makes possible to perform a more accurate surgery. Second, for a patient, eye surgery in the dark room could reduce the recovery time remarkably. It is reported that exposing to a visible light could harm to an eye. Third, near-infrared 3D ophthalmic microscope could use not only near-infrared, but also use several mixed rays.

Human factor experiment showed that mixed ray has better quality image. 80 adult of men and woman participated in this human factor experiment to prove the efficiency of near-infrared 3D ophthalmic microscope and it is statistically significant number.

II. Literature Review

Junki Kwon *et al.* (2012) compared ocular fatigue, non-ocular symptoms and surface changes after watching 2D and 3D images. Hyung-Chul O. Li (2010) analyzing visual fatigue and developed the method of measure. Hyung-Chul O. Li *et al.* (2008) showed characteristics of subjective 3D visual fatigue and proposed five-factor model. Sungchul Mun *et al.* (2011) analyzed behavioral performance before and after watching a multi-view 3D content. Jongjin Park *et al.* (2014) measured and modeled crosstalk and proved that 3D visual fatigue induced by mobile glassless 3D display. Youngsoo Park *et al.* (2011) measured the quality of left and right image with 2D image quality measurement method.

III. Experimental Process

Two subjective three dimensional fatigue evaluation methods are widely used. First one is DSCQS(Double Stimulus Continuous Quality Scale), the other one is ACR(Absolute Category Rating). ACR method will be applied in this experiment, because it guaranteed more accurate quality evaluation.

This experiment trying to find a transparency of the eye lens and vitreous body of an eye. Human factor research of near-infrared 3D ophthalmic microscope could verify that which light is suitable for eye surgery. Doctor could see clearer image of eye lens and vitreous body of an eye with near-infrared 3D ophthalmic microscope. Experiment includes 8 display images and 3 different images. ACR method slightly modified for this experiment like Figure 1.

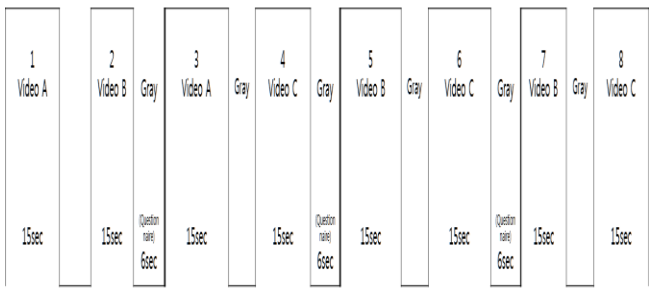

Figure 1. Presentation of display sequence for the ACR Method

Image A is the image when using visual light, image B is obtained when use only near-infrared and the image C is acquired when both of the light visual ray and near–infrared used.

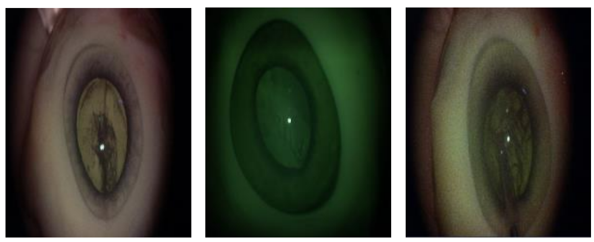

Figure 2. Image A Image B Image C

TABLE 1. QUALITY SCORE SHEET OF THE ACR METHOD

	1 Image A	2 Image B	3 Image C
Excellent			
Very Good			
Good			
Bad			

Very Bad			

4 Experiments will be processed, first one is comparing image A and image B, second one is comparing image A and image C, third one is comparing image B and image C and the last one is comparing B and image C of vitreous body.

IV. Analysis and Results of Experiment

A. *Image A vs. Image B*

The range of score of an image A and image B is shown in Table 2 and the boxplot is drawn in Figure 3.

TABLE 2. AVERAGE OF IMAGE A AND B

Image A	Image B	p-value
3.075±0.897	3.825±0.854	0.000

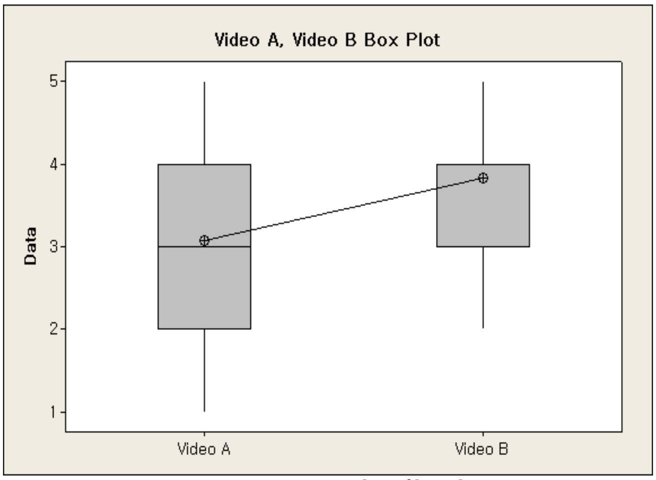

Figure 3. Image A and B of boxplot

Average of image B is higher than image A and the p-value showed that these two images are statistically different.

B. *Image A vs. Image C*

The range of score of an image A and image C is shown in Table 3 and the boxplot is drawn in Figure 4.

TABLE 3. AVERAGE OF IMAGE A AND C

Image A	Image C	p-value
2.963±0.737	4.100±0.773854	0.000

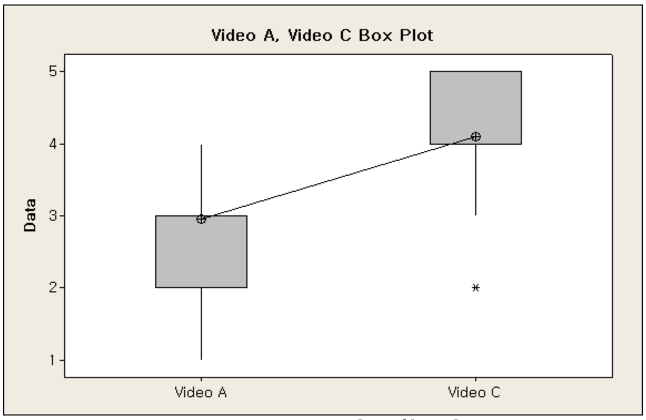

Figure 4. Image A and B of boxplot

Average of image C is higher than image A and the p-value showed that these two images are statistically different.

C. *Image B vs. Image C*

The range of score of an image B and image C is shown in Table 4 and the boxplot is drawn in Figure 5.

TABLE 4. AVERAGE OF IMAGE B AND C

Image B	Image C	p-value
3.713±0.917	3.65±1.02	0.0684

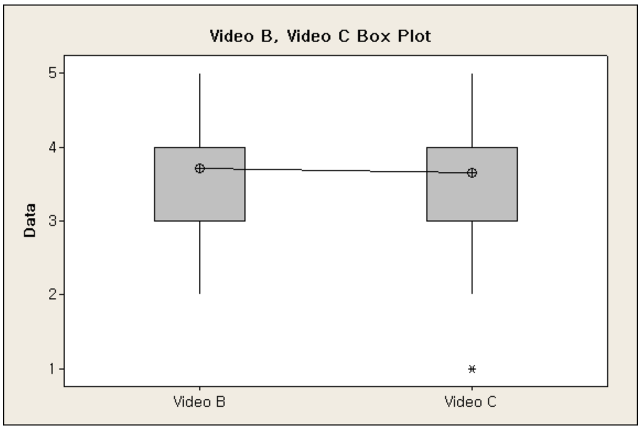

Figure 5. Image B and C of boxplot

Average of image C is higher than image B and the p-value showed that these two images are statistically different.

D. *Image B vs. Image C(Vitreous body)*

The range of score of an image B and image C(Vitreous body) is shown in Table 5 and the boxplot is drawn in Figure 6.

TABLE 5. AVERAGE OF IMAGE B AND C

Image B	Image C	p-value
3.350±0.731	4.613±0.771	0.000

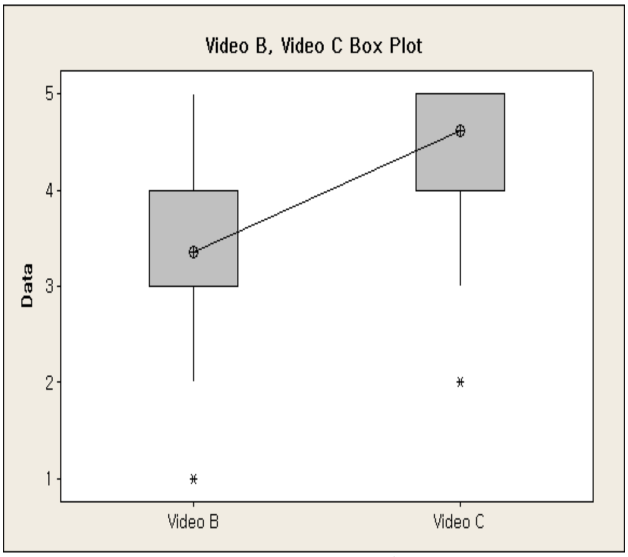

Figure 6. Image B and C of boxplot

Image C has higher range than image B and the p-value is 0.000. The result showed statistical difference between two images. It means that mixed ray has more clear and transparent image of vitreous body of an eye than near-infrared.

V. Conclusion

The performance near-infrared 3D ophthalmic microscope proved by human factor experiments. The images that used for the experiment were obtained from clinical trial with pig eyes before applying to a human eye surgery.

First experiment showed that statistical difference between image A and image B. It means that near-infrared ray image is more transparent and clear image of an eye. Second analysis proved that mixed rays with light visual ray and near-infrared is much better than visual ray. Third attempt implied that there is no statistical difference between near-infrared and mixed rays. Both of them are eligible for eye surgery. And the last test showed mixed rays is more suitable for the vitreous body of an eye. When eye surgeon need to have a surgery with the part of vitreous body of an eye, mixed ray could show more fine image of an eye.

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