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Betterment of Infrared Image Resolution Using Infrared RGB Filter and Common RGB Filter

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Abstract

The present study proposed a method of reducing chromatic aberration to enhance the resolution of digital infrared images. To effectively lower the chromatic aberration of infrared images, three sections of high resolution and low chromatic aberration were determined within the infrared range. The three sections hardly hadoverlaps, making it possible to capture the entire infrared range that commercial consumer digital still cameras cover.As each range reacts to light uniquely, image information is lost if the exposure is kept to a same level, leaving a certain range less exposed. Thus, the present study proposed a method of using the common RGB filterin tandem with the infrared RGB filter for a simultaneouscapture. As a result, the brightness of images was comparable across therange,with the resolution bearing a close parallel to that of visual rays.

Keywords:**C**onsumer digital still camera, Near infrared, Diffraction, Resolution, RGB filter, Chromatic aberration

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1 Introduction

Analogue near-infrared(NIR) photography has already been used a lot in both scientific and medical photography, in which cases near-infrared radiation was mostly captured by Infrared sensitive plates or film emulsions. However, this situation could be changed completely, as the image sensors used in consumer digital still cameras (CDSC) are very sensitive to NIR wavelengths [1]. The spectral sensitivity range of an image sensor in CDSC is approximately between 380nm~1200nm and the figure includes some of the near ultraviolet wavelengths & NIR wavelengths [2][3]. Infrared is used for a diagnosis and care in the areas of dermatology, hemorrheology, ophthalmology, and surgical care. Also, it is used for judging the disease of plants in the fields of microscope scans, agriculture, and forestry. In the field of archaeology and art, infrared is used for determining the fake [4][5].However, the infrared image taken by CDSC is limited because of the decrease in resolution. In the study of the medical profession and conservation, research on resolution is now in its infant stage because of insufficient technical knowledge of camera. Therefore, it is essential for photography experts to research infrared image resolution. Using Adobe Photoshop(PS), a universal image program, the present study proposeda method of reducing the chromatic aberration for improving the resolution of infrared images, and keeping the exposure of each wavelength range to a similar level for practical applicability.

2 Related Researches

2.1 Existing technologies

Previous studies investigated how to improve the resolution of photographic images capturedin visible rays, focusing on diffraction and chromatic aberration.“The sensor size also causes diffraction problems at low apertures. To calculate from which f-stop these problems begin, we have to look at the Rayleigh Resolution Criterion (circa 1879). If we combine this with the discrete positioning of a sensor, it appears that the pixel pitch has to be at least the required distance of the two Airy circles, namely the radius of the circle”[6].Also, the research suggested the development of a lens for correcting chromatic aberration and how to control an aperture to minimize chromatic aberration [7]. On photographing in visible light, diffraction and chromatic aberration determines the resolution. Infrared is also similar electromagnetic wave with visible light and diffraction and chromatic aberration determines the resolution. Also, Willams Robin & Williams Gigi(2002) mention that the change of refraction is greater than visible light because infrared is longer wavelength than visible light and also has wider wavelength band[8].

2.2 Advanced technologies

In visible rays, as the RGB channels with low chromatic aberration form an image,it is possible to improve its resolution by adjusting the size and position of the image and thus lowering its chromatic aberration [Fig. 2]. Yet, in infrared rays, adjusting the size and position will not lead to any betterment of resolution because the infrared image hasRGBchannels of broad wavelengths and thus sufficient chromatic

aberration. Hence, a narrow band-pass filter is used here to remove the chromatic aberration. If we use a Narrowband-pass filter, chromatic aberration does not occur and the resolution increased. However, the actual use is limited due to the lack of light. Therefore, JongwooJoo(2014) gained the recordable exposure, and set the broadband section which has less chromatic aberration and high resolution. Using a Hi-pass filter and Low-pass filter, he set the spectral region which chromatic aberration similar to visible light occurred and then he got the image of resolution which is similar to visible light. Through this research, he could resolve the exposure time of the disadvantage of a Narrowband-pass filter [9].

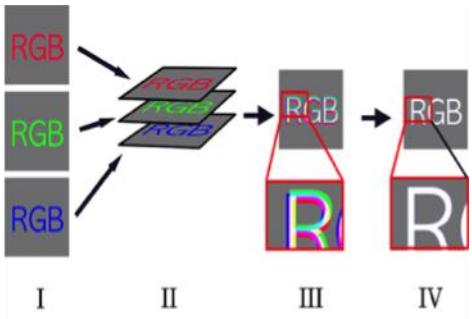


Fig1.The correction method of chromatic aberration

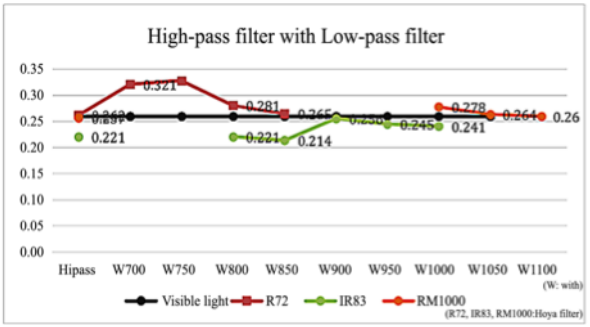


Fig 2. Results of using a Hi-pass filter and Low-pass filter (black:visible light)

By using CDSC, an infrared photograph has lower resolution. However, if a photographer controls the wavelength region photographed, the chromatic aberration is lower and the photograph can obtain the similar level of resolution with visible light. Also, because the wavelength range is narrowed, areas that have excellent resolutions are more than one [Fig. 2].

3 System Configuration

The present study aimed to improve the resolution and sharpness of digital infrared images, and ultimately to promote the usability of infrared photographs. According to

related research, the resolution of infrared photographic images is contingent upon such variables as diffraction and chromatic aberration. Accordingly, the present study intends to enhance the resolution by eliminating the chromatic aberration. The proposed infrared RGB filter subdivides infrared rays intothree (RGB) channels. The section on mixing the infraredRGB(iRGB)filter withthe common RGB(cRGB) filter describes using the iRGB filter in combination with the cRGB filter for practicality. In the experiment, the images of iRGB channelswerecapturedrespectively and used to form an image withPS [Fig 3].

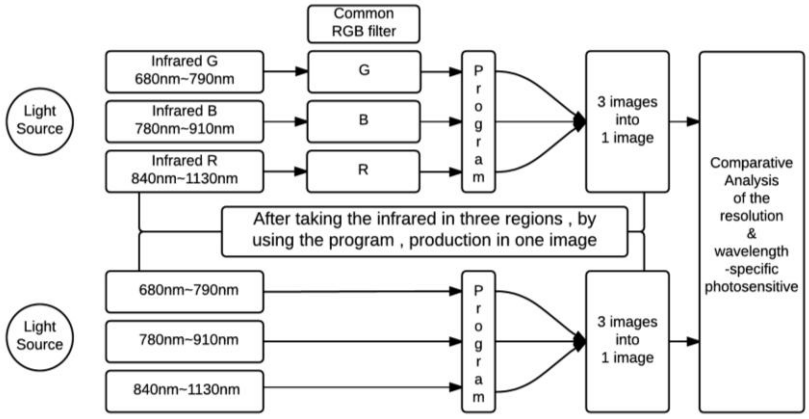


Fig 3. Diagram of the experiment

3.1 Proposed infrared RGB filter

This study makes improving the resolution by decreasing the chromatic aberration of an infrared image. In that way, we suggest using PS. In the image taken by visible light, the chromatic aberration can be adjustable by using PS, but the adjustment of chromatic aberration is impossible by using PS in the image taken by infrared [9][10]. As such, to apply PS to infrared images, it is necessary to define three new channels with low chromatic aberration in the infrared range. The three channels are based on the advanced technologies section. The selected three wavelength channels hadan excellent resolution and embraced all infrared channels that a CDSE can take. These three channels are named infrared RGB. Each channel is described as follows.With PS, an image is generated from each infrared channel.The procedure is as follows:1. The image of three wavelengths that has less chromatic aberration should be created 2. By controlling the size and adjust the position of the image 3. Finally a piece of high resolution image is produced [Fig 1, 3].

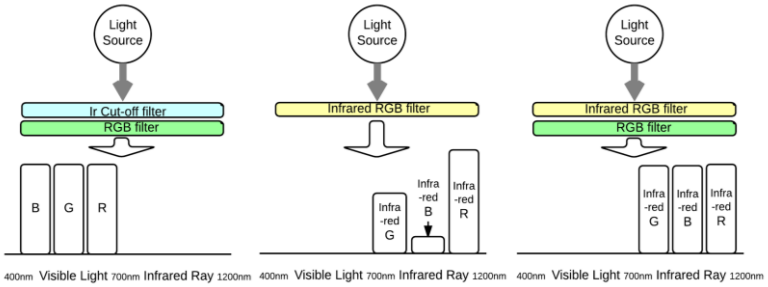
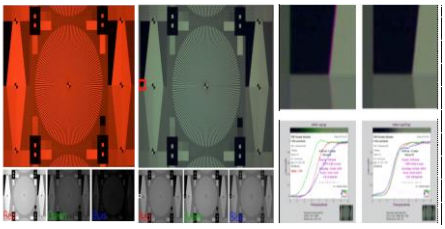


Fig 4.iRGB filter &cRGB filter

3.2 Mixing iRGB with cRGB filters

In practice, when only the iRGB filter is used, longer wavelength channels become less exposed. Therefore, information of long wavelength channels is lost. To capture the information of all infrared channels, the present study proposed a method of using the iRGB filter in combination with the cRGB filter[Fig 4]. As cRGB has different spectral characteristics of infrared light, each channel of the cRGBfilter is set toa similar exposure value, i.e.Infrared G(680nm-790nm), Infrared B(780nm-910nm), Infrared R(840nm-1130nm)[Fig 3].



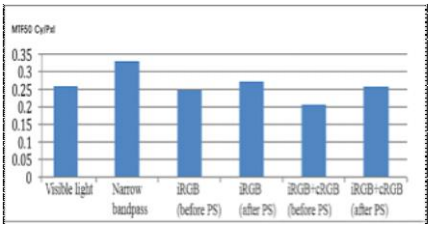


Fig 5.iRGB, IRGB+cRGB **Fig 6. The resolution of each case**

4 Conclusion

As a way to minimize or eliminate the chromatic aberration, the present study proposed sub-dividingthe infrared light into three channels of lower chromatic aberrationusing PS. Also, as a way to captureinfrared images at a time in practice, this study proposed usingthe iRGB filter in combination withthe cRGB filter. As the result of this study, we got infrared images of high-resolution, and whole range of wavelength(approximately 680nm-1150nm) in infrared to which a general camera respond, could be displayed. Each range had three independent wavelength channels with little chromatic aberration. A single piece of high-resolution image with lower chromatic aberration was obtained by adjusting the exposure and using PS withthe images from these three channels.However, as different wavelength channels of image sensors reacted to light at different speeds, it was not possible to record the entire infrared range simultaneously.By using the iRGB filter in tandem with the

cRGB filter, and setting channels considering the iRGB filter's transmissivity, comparable brightness of images was yielded across RGB channels[Fig 5]. For cRGB, color gamut was considered in separating the wavelength channels. By contrast, as iRGB had no color present, only chromatic aberration and resolution were considered in setting the wavelength channels.Hence, wavelength channels of higher resolution than that of visible rayswere determined. As a result, it was possible to capture broader wavelength channelsthan visible rays, whilst the resolution was comparable to that of visible rays[Fig 6].The present paper used a relatively inexpensiveCDSC to obtain high-resolution infrared images. In that infrared wavelength channels were separated, the present findings will be conducive significantly to conservation science for cultural heritages and crime scene images, where wavelength channels are separated for analysis. In addition, the present study will lay the foundation for research on infrared using CDSC in many disciplines.

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