Shadow Removal Based On Gamma Decoding Method for Moving Object Images

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***Abstract*— Shadows are reflections of objects exposed to light. So there is an image pixel that has a darker intensity than the object's pixel. The development of digital technology, the shadow into noise on digital images and digital video. Therefore the information on the image becomes inaccurate. One of the usage of digital image or video digital is intelligent transportastion system using digital video-based CCTV camera. But the use of digital video has several problems, including the presence of a shadow. Therefore, it is necessary to have a method to eliminate shadows. In this paper, we use gamma decoding method to determine object pixels and pixel shadow based on the illumination of the object, so the shadow pixels can be eliminated. The result of this research is images without shadow.**

I. INTRODUCTION

In digital imaging, the shadow is an area affected by a lighting change. In other words when the object is placed between the light source and the background surface, the object will block the light to get to the background surface. Basically shadow consists of two categories, namely umbra and penumbra. Based on the the above conditions, the shadow is one of the noise in a video or digital image that affected to the accuracy of image recognition or object counting. So the special treatment is needed to eliminate the shadow.

Some previous research related to this research was conducted by Chin-Teng Lin in 2010 entitled An Efficient and Robust moving shadow removal and its application in ITS, in this research used gaussian mixture model method as substraction method background and foreground, and this research is done with uniform light distribution [1]. Mohamad Toha et al [2], researches to remove the shadow of moving objects by estimating the image foreground with frame different and applying the gamma decoding method to segment the shaded area and object area. In 2016, Budi Setiyono et al [3] do research on the topic of eliminating shadows with the title a new approach algorithm for counting of vehicle moving based on image processing by updating the parameter values of gaussian mixture model in order to reduce the pixel image. Another study titled An Approach to Shadow Removal in Moving Object is done by Prajapati et al.[4] Tt's combining of averaging method and gaussian mixture model as substraction method background and foreground in HSV color space.

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in this paper we apply gamma decoding method to segment shadow pixels and object pixels from a frame of video digital.

II. THE ALGORITHM OF SHADOW REMOVAL

Gamma Correction or better known as Gamma is a non-linear function used to mark (encode) and read luminance (decode) marks on an image, either video or a single image [5]. Gamma Correction is simply defined as the result of the gamma rank on each image pixel value.

$$V_{out} = A * V_{in}^{\gamma} \tag{1}$$

where the non-negative result of the v_{in} input value will be increased by the γ and multiplied by the constant A. Generally the value A = 1 and the result is within the $[0.1]$ range. The gamma value $(\gamma) < 1$ is called encoding gamma which is often used in the compression process, whereas the gamma value $(\gamma) > 1$ is called a gamma decoding process that applies more to gamma expansion.

Gamma Decoding method is what will be used in the process of identifying shadow pixels on the object. Because based on basic information about the illumination of shadows on the image, the gamma decoding method is able to "darken" the shadow of the object. So the thresholding process using the method of thresholding otsu can be done optimally and the shadow of the object can be identified[2].

Generally, The method of this research can be seen on figure 1. From the diagram, the input data used is a video

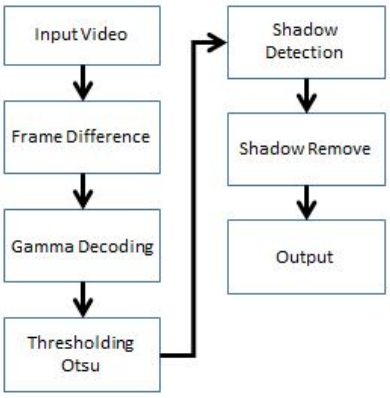

Fig. 1. Diagram For The Shadow Removal Method

which then through frame extraction process. So the video becomes a few frames and we have to generate the RGB Background from these frames by using value mode of

intensity value in each position. After that frames extraction result are then processed in the frame difference method to obtain differences in the k^{th} and the RGB background. Mathematically the frame difference process can be presented in the equation below.

$$D_k = |I_k - B_k|$$

D_k is the result of the frame difference, I_k is the result of k^{th} frame extraction, and B_k is the RGB background. The process is a segmentation process to get the image object from background. So that the image object can be separated from the existing background. It should be noted that the intended image object is including the shadow of the object. The result of this process will facilitate the gamma decoding method to perform splitting of image pixels and image pixels, since almost uniform background pixels can be ignored.

Fig. 2. (a) Frame before any process (b) Frame after Frame Difference Method

Gamma decoding method apply to each pixels of the image, so the intensity value of each pixels becomes changed. After this process, we have to apply Otsu's thresholding.

Otsu thresholding method is a method for segmentation based on image histogram. Otsu method works by maximizing inter-class variance (between-class variance). This inter-class variance is suitable for class statistical discriminant analysis. The Otsu method uses a histogram to group against the pixels in the image. This grouping is based on threshold or threshold values. This threshold value becomes objective or purpose of Otsu method. The basis of the Otsu method is the difference in intensity of the pixels separated in certain classes. So, for each frame will have a threshold which different each other.

The final result of otsu's thresholding is a threshold value to convert the image become a binary image. From this process we can get each pixels that identified as shadow pixels.

III. Shadow Detection And shadow removal

The results of otsu give us the reference to the identified image pixels as shadows and objects. in figure 3, the obtained binary image is the result of the Otsu process performed by satisfying the conditions according to the following equation:

$$I(x) = \begin{cases} 1 & ,if\ I(x) > Threshold \\ 0 & ,other \end{cases}$$

Based on the condition, we have identified the shadow pixels by the pixels intensity value equals to one. After that, the

Fig. 3. The result of Otsu's Thresholding

removal process will be done.

In this study, for the removal method, we just replace the pixel value from the identified shadow pixel with the intensity value of the background. So, the pixel identified as shadow removed.

IV. Experiment and Result

We have designed a testing scenario for this shadow removal method as in figure 4.

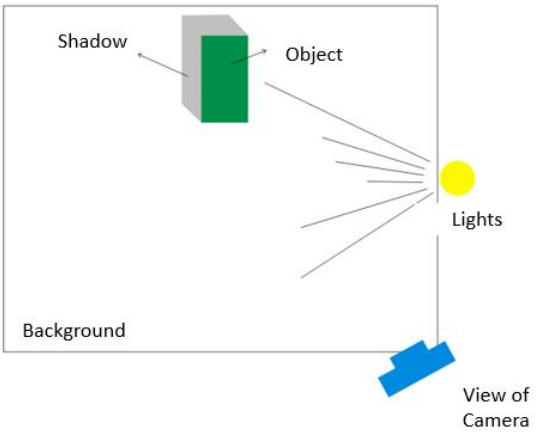

Fig. 4. The Experiment Design

Based on the picture above, the original object without a shadow is given a shadow by giving lighting. Objects with these shadows are used for testing experiments. The experiments performed, we used static image data to obtain PSNR values based on the method. This value is used as a reference image quality obtained. In this test the data used is a simple single static object to obtain the value of PSNR. This test is done with the data in the form of images of objects with shadows and images of objects without shadows which subsequently shaded images are processed in the shadow removal method to obtain images without shadow the results of shadow removal process and calculated PSNR. We also can generate the flow diagram of the experiment as follows figure 5.

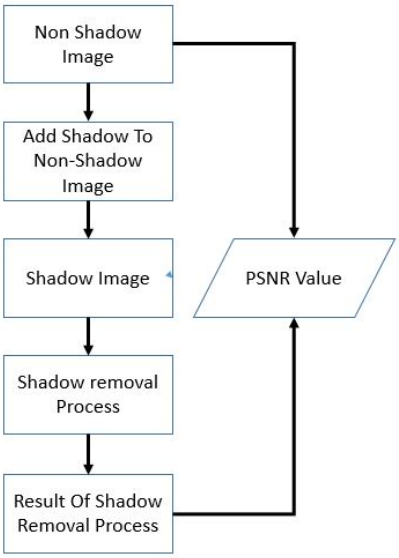

Fig. 5. Simulated scenario of Experiment to obtain PSNR Value

Experiments in this study were devided in two categories of data, namely simulation data and field test data. Test results with simulation data is used to measure the quality value of shadow removal results, while field test data is done to determine the performance of methods visually.

A. Experiment Using Data Simulation

For the experiment by simulation data we have the data as follows :

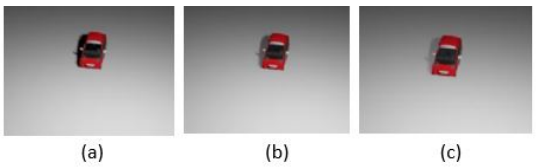

Fig. 6. Video data from intensity difference (a) intensity = 1 (b) intensity = 0.8 (c) intensity = 0.5

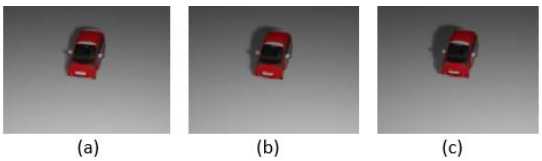

Fig. 7. Video data from wide shadow difference (a) wide shadow 1 (b) wide shadow 2 (c) wide shadow 3

Using the simulation data above, we can get the data of PSNR value in the test frame presented in table 1.

Based on the data in the table 1 and figure 8 can be seen that the intensity of light affects the quality of shadow removal method results. The intensity of light affects the dark level of a shadow formed. So in the shadow removal method used, the best light intensity is 0.8, it means that the intensity of light that is not too dark and not too vague gives good shadow removal results with this method.

TABLE I
TABLE PNSR FOR INTENSITY DIFFERENCE IN EACH CHANNEL

	1	0.8	0.5
R	53.4006	54.643	53.76
G	52.9811	53.7726	52.766
B	53.4997	53.8917	53.1621

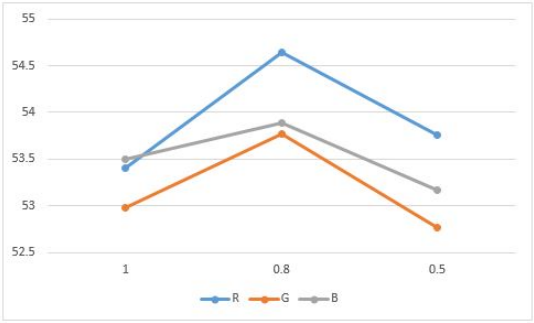

Fig. 8. Graphic PNSR for Intensity Difference in each channel

Based on the data in the table II and figure 9 above can be seen that the width of the shadow affects the results of shadow removal. In the table and graph the best PSNR values are obtained on data with the width of the first category shadow, which is the smallest shadow width category. So with the shadow removal method used in this paper, the smaller shadow width will have a better quality. This is because the pixel image image processed in the method becomes less, so the shadow pixel identification error by method becomes smaller and the level of similarity with the video without the shadow becomes higher.

TABLE II
TABLE PNSR FOR INTENSITY DIFFERENCE IN EACH CHANNEL

	1	2	3
R	53.4434	48.8289	47.0126
G	52.975	48.6613	46.8374
B	52.7481	48.6475	46.864

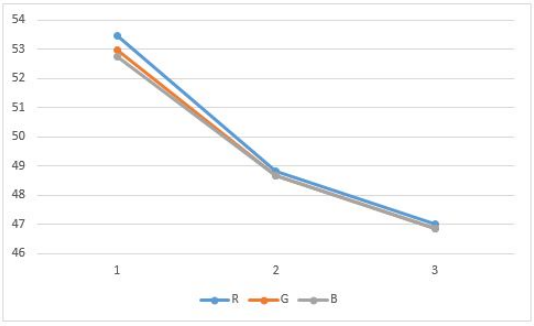

Fig. 9. Graphic PNSR for Wide Shadow Difference in each channel

B. Experiment Using Field Data

Besides to simulated data testing, there are tests with field test data. where this data is used as test data measured visually.

Fig. 10. (a)Shadowed Images (b) Shadow Removal Result (c) Original Image

From the Experiment result in figure 10, we obtain the PSNR value 47.0717 dB at Red channel, 46.9290 dB at Green channel, and 46.3442 dB at Blue channel. Based on this result, we have applied the method for frame video.

Fig. 11. Shadow region in original images

Fig. 12. Shadowless image as the result of the method

V. CONCLUSIONS

In this paper, we have described a system for removing shadows from a single scene image. And we can concluded as follows :

- The intensity of light affects the dark level of a shadow formed. it means that the intensity of light that is not too dark and not too vague gives good shadow removal results with this method. Its proved by the highest PSNR value at intensity equals to 0.8
- The smaller shadow width will have a better quality. This is because the pixel image image processed in the method becomes less, so the shadow pixel identification error by method becomes smaller and the level of similarity with the video without the shadow becomes higher.

For future research, the shadow removal method can be develop into some of colour space, such as HSI, CYMK, etc. And the testing data can be add with some categories, such as the object moving directions.

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