Response to Reviewer 3 Comments

Point 1: The description is not quite clear, which makes the manuscript difficult to read. For example, line 132-136 describes the deficiency of traditional method, which is the important part to highlight the contribution of the proposed method. But the statement does not clearly describe what is exactly missing in the traditional method.

Response 1:

When the conventional model-based methods directly perform prior analysis on the input images, certain problems will appear during image dehazing. These problems include but are not limited to:

(1) The values of A tend to be underestimated due to the reflection that occurs when light from the light source passes through atmospheric particles such as fog.

(2) t(x) refers to the part of the light reflected by the target pixel that is not scattered during the process of projecting the light from the target pixel to the camera through the medium. The influence of the surrounding pixels on the target pixel causes the part received by the camera to change, resulting in an inaccurate estimated t(x).

In Page 4-5, Lines 163-170, the manuscript has been modified as following:.

The atmospheric scattering model in Section 2.1 suggests that estimation of the atmospheric illumination and transmittance is two crucial steps to recover a haze-free image. In order to obtain more accurate atmospheric illumination value and transmittance, we propose GIC, an image dehazing algorithm based on atmospheric scattering model and considering image background interference. A few intermediate outputs in our procedure to obtain J from I using GIC method are shown in Figure 2.

Point 2: The shading partition enhancement is the key contribution from the manuscript. The rest part of algorithm such as DCP already exists. How shading partition enhancement is related to resolving the issues from traditional method as described from 132-136 is not clearly described.

Response 2:

By analyzing the pixels around the atmospheric illumination observation point obtained by DCP, the pixel value of the observation point tends to increase suddenly compared with the surrounding pixel value. Therefore, we believe that this phenomenon is due to the fact that the pixel value of the observation point is affected by the surrounding pixels.

In Page 4, Lines 185-189, the manuscript has been modified as following:

"We found that the brightness standard deviation of surrounding pixels tends to fluctuate within a small range. After adding the brightness value of the center pixel, the standard deviation increases significantly. Combined with the experimental results, we believe that the sudden increase in the brightness value of the center pixel is affected by the surrounding pixels."

In Page 9, Lines 274-282, the manuscript has been modified as following:

The shading partition enhancement mechanism is essentially an image enhancement algorithm, which can effectively compensate for the light intensity reflected by the light of the light source when it passes through atmospheric particles such as fog. It can be seen from Figure 3 and Eq (6) that the calculation method of this mechanism simulates the influence of surrounding pixels on the target pixel, so that the image is restored to the state without background interference, so as to prepare for the subsequent DCP calculation processing.

The experimental results show that the surrounding pixel values of the atmospheric observation points obtained by analyzing the GIC algorithm are close to or even equal to the pixel values of the observation point. In a certain area centered on this point, its pixel value is the maximum value. Therefore, the observation point of atmospheric illumination can be found more accurately after processing by this mechanism.

Point 3: The meaning of weighting factor in eq(10) is not clear, and how the value is determined in the test picture is not described either.

Response 3:

In Page 7, Lines 253-255. In-depth descriptions about Eq(10) have been added.

The global illumination compensation factor is used after the optimization of the initial transmittance through guided filtering, so that the transmittance image can have a clearer outline. It is calculated by taking the average value of pixels in a small range centered on x as the weight of x in the dark channel of the enhanced image I^*.

$$w(x) = \underset{y \in \Omega(x)}{mean}\left(\min_{y \in \Omega(x)}\left(\min_{c} I^{*c}\right)\right)$$

Point 4: As the proposed algorithm take the influence of background into consideration, it is reasonable to speculate that the final performance could be background dependent. It could perform better for some specific pictures, but worse for the others. Could a rigorous argument be provided to show that the performance will always be better than that of traditional methods.

Response 4:

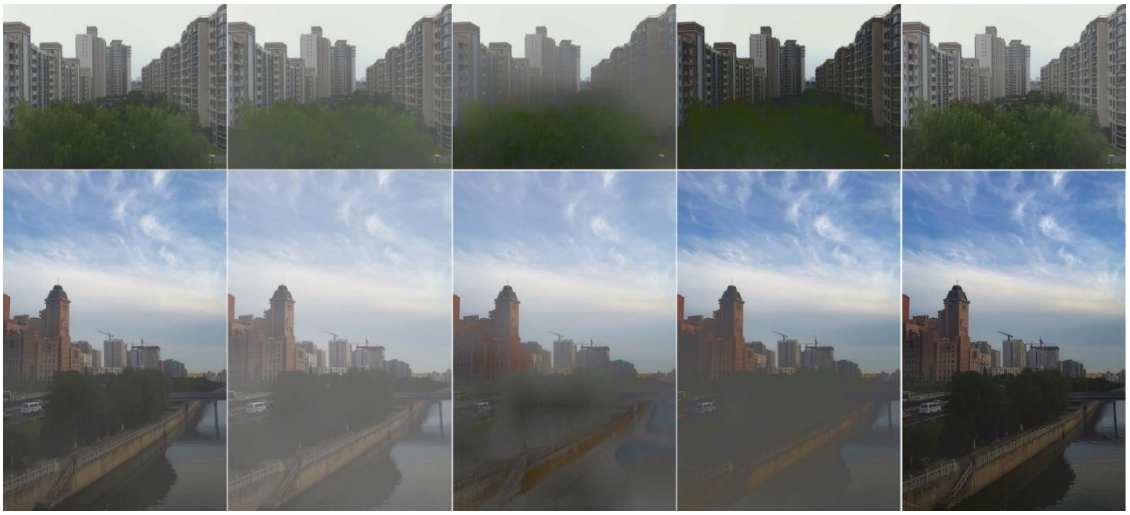
For synthetic indoor images, we process and analyze the foggy images with various fog concentration ranging from 1 to 10. The GIC algorithm has an satisfactory dehazing effect at low concentration fog, i.e. 1 to 3, but the effect will gradually decrease as the fog concentration increases. For outdoor real images, the GIC algorithm has an improved dehazing personsefor the SOTS data set alone, due to the lack of image data of different concentration levels.

In response to the questions raised by the reviewers, we analyzed the indicator data. Only a few images outperform the candidate methods on all four metrics. So we are temporarily missing a rigorous argument to show that the performance will always outperform traditional methods. This will be an optimization direction for us in the future.

The shading partition enhancement mechanism is a critical mechanism of the GIC dehazing algorithm. In order to better highlight its role in image dehazing, we added two image enhancement algorithms i.e. B3 and B4 that were proposed in recent years, to illustrate the pros-and-cons of these

dehazing approaches. the method B3 denotes Contrast Limited Adaptive Histogram Equalization (CLAHE) processing, and method B4 adapts the Retinex processing. The following are qualitative and quantitative comparisons, both of which demonstrate the feasibility of the shading partition enhancement mechanism in image dehazing.

In Page 9, Lines 302-308, additional experiments have been accomplished to illustrate the characteristics of the proposed GIC method. Relevant experimental analysis are given as following:



(a) (b) (c) (d) (e)

Figure 1. Comparison of outdoor image dehazing for the five methods. (a)B1 method processing results, (b) B2 method processing results, (c) B3 method processing results, (d) B4 method processing results, (e) GIC method processing results.

Original Table 1. Comparison of indexes of the three methods.

Methods	PSNR		SSIM		SSEQ		NIQE	
	AVG	SD	AVG	SD	AVG	SD	AVG	SD
B1	18.67	3.61	0.88	0.05	18.20	6.36	**2.61**	0.60
B2	18.48	3.25	0.79	0.09	18.01	6.30	3.39	0.81
GIC	**22.07**	**3.02**	**0.90**	**0.05**	**15.49**	**5.60**	2.76	**0.59**

has been modified to

Table 1. Comparison of indexes of the five methods.

Methods	PSNR		SSIM		SSEQ		NIQE	
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B2	18.48	3.25	0.79	0.09	18.01	6.30	3.39	0.81
B3	19.54	2.39	0.71	0.09	16.25	5.87	4.14	0.81
B4	13.75	4.10	0.51	0.24	24.65	15.10	4.09	1.72
GIC	**22.07**	**3.02**	**0.90**	**0.05**	**15.49**	**5.60**	2.76	**0.59**

Method B1 does not perform image enhancement, method B2 uses histogram equalization processing, method B3 denotes Contrast Limited Adaptive Histogram Equalization (CLAHE) processing, and method B4 adapts Retinex processing. Except for the different image enhancement methods, the other processes of these methods are the same as the GIC algorithm.

From both qualitative and quantitative perspectives, the shading partition enhancement mechanism has better dehazing effect and stability than other image enhancement methods, proving the effectiveness of this mechanism in image dehazing.

Point 5: The “refracted” in line 123 and Fig. 1 should be “reflected” ?

Response 5:

In Page 4, Lines 156.

“refracted” has been modified as “reflected”.

Other grammatical errors were also modified as well.