Real Time Visibility Enhancement for Single Image Haze Removal

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In this paper, we propose an efficient method to remove haze from a single input image. Here, we presented an approach which is based on Fast Fourier Transform. Transmission map is refined by the dark channel prior method and Fast Fourier Transform. Finally the scene radiance is corrected using the visibility restoration model. Qualitative and quantitative results demonstrated that this method can effectively remove the bad weather condition and enhance the contrast of the input images and performs well in comparison with bilateral filtering. Moreover, the proposed method can significantly reduce the computational complexity. The use of Fast Fourier Transform in these images makes our approach faster by 88% in comparison to the bilateral filtering method. The main advantage of the proposed approach is suitable for images with too much of the sky background. Proposed method, due to its speed and ability to improve visibility, may be used in many systems such as surveillance, consumer electronics and remote sensing.

Keywords: Bad Weather Condition, Bilateral Filtering, Dark Channel Prior, Fast Fourier Transform, Transmission Map.

1. INTRODUCTION

Images and videos captured from optical devices are usually degraded by turbid media such as haze, fog, rain and snow. Haze is the most common problem in outdoor scenes because of the atmosphere conditions. The effect of outdoor surveillance systems is limited by bad weather conditions. Under hazy weather conditions, the color and contrast of the images are drastically degraded. As the degradation is spatial-variant, it is a challenge to recover the color and details of a scene from the foggy images and videos. So, imaging in poor weather is often severely degraded by scattering due to suspended particles in the atmosphere such as haze and fog [1-3]. Based on the type of the visual effects, bad weather conditions are broadly classified into two categories: Steady and dynamic. In steady bad weather, constituent droplets are very small (1-10 µm) steadily float in the air. Fog, mist, and haze are examples of steady weather. The intensity produced at a pixel is due to the aggregate effect of the large numbers of the droplets within the pixel’s solid angle. In dynamic bad weather, constituent droplets are 1000 times larger (0.1-10 mm) than those of the steady weather. Rain and snow represent dynamic weather conditions.

This degradation level increased with the distance from the camera to the object. In the haze and fog degradation, invisibility is caused by two fundamental phenomena attenuation and airlight. Light beam coming from a scene point, gets attenuated because of scattering by atmospheric particles. This phenomenon is termed as attenuation, which reduces contrast in the scene. Light coming from the source is scattered towards camera and adds whiteness in the scene. This phenomenon is termed as airlight. Haze and fog effect can be mathematically realized as an exponential function of the distance from the scene to the camera. Hence the removal of haze and fog requires the estimation of scene depth. If scene depth is known, then the problem of removing fog becomes much easier. But, this is trivial and requires prior knowledge such as depth cues from
Table 3

Processing Time Comparison (in sec) with Bilateral Filtering for Different Image Sizes

<table>
<thead>
<tr>
<th>Image</th>
<th>Size</th>
<th>Bilateral filtering</th>
<th>Proposed Method</th>
<th>% improvement w.r.t bilateral filtering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>190x265(s)</td>
<td>2.573</td>
<td>0.528</td>
<td>79.47</td>
</tr>
<tr>
<td>Sample 2</td>
<td>400x600(s)</td>
<td>9.949</td>
<td>0.561</td>
<td>94.36</td>
</tr>
<tr>
<td>Sample 3</td>
<td>384x465(s)</td>
<td>7.508</td>
<td>0.498</td>
<td>93.36</td>
</tr>
<tr>
<td>Sample 4</td>
<td>1080x1620(s)</td>
<td>78.944</td>
<td>3.334</td>
<td>95.52</td>
</tr>
<tr>
<td>Sample 5</td>
<td>327x1000(s)</td>
<td>13.634</td>
<td>2.218</td>
<td>83.73</td>
</tr>
<tr>
<td>Sample 6</td>
<td>460x512(s)</td>
<td>8.400</td>
<td>1.506</td>
<td>82.07</td>
</tr>
</tbody>
</table>

Figure 4. Comparison Chart of Indicator Vs. Processing Time

observe in Sample 4. Figure 3 shows the output results by using bilateral filtering method. The main contribution of our method is less processing time along with enhanced results as compared with the bilateral filtering method. For a quantitative comparison, the speed improvement over bilateral filter obtained and summarized in the last columns of Table 3. It is found that the proposed approach takes very less time in execution as compared with the bilateral filter. It can be seen from Table 1, Table 2 and Table 3, the processing speed of the proposed algorithm has been increased and also an objective indicator have been improved for too much of the sky background. This approach is giving a better result with speed improvement up to 88% as compared with the bilateral filtering method. The result obtained by proposed approach and bilateral filter method is also compared and analyzed with the help of the comparison chart as shown in Figure 4.

7. CONCLUSIONS

In this paper, we proposed a faster and simple image restoration method. The proposed method uses Fast Fourier Transform method which gives good result. Our method takes less processing time as compared with the bi-
lateral filtering method. Experimental results show that the proposed approach achieves high efficiency and dehazing effect as well. Our approach is giving a better result with speed improvement up to 88% of the time as compared with the bilateral filter. The proposed approach with less processing time can be useful for many systems ranging from surveillance, intelligent vehicles, for remote sensing, etc. Next, we will focus on the hardware realization of the proposed algorithm is worth studying further.

REFERENCES