Single Image Dehazing

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***Abstract*—Outdoor images are affected by atmospheric visibility reduction, particularly haze. The hazing effect are influenced by several factors including location, weather, pollution and other geographic and environmental parameters. Visibility degradation is depedent on the distance between the camera and the scene points. Litterature shares various algoritms to dehaze outdoor images. As part of the image processing project, our group will apply an aglorithm preforming a dehazing process requiring one single input developed by scientists from Hebrew University of Jerusalem. By delimiting and exploiting local patches from this single input, the global airlight vector - the atmospheric colour - and the transmission gradient - the hazing reduction coefficient - are extracted. Through this report, we will describe the three steps of the algorithm, validate the dehazing process by showing the after-process results and compare it with the original pictures.**

I. Introduction

Haze, visibility reduction phenomenom, is coming from the presence in the atmosphere of particules scattering the ambiant light, attenuing the contrast for outdoor images and corrupting the true radiance of the scenary by a ambiant colour. To dehaze images, majority of the dehazing algorithm is processing image from on its RGB representation. it operate based on the following pixel colour-based image model [1]. The algorithm presented in this paper will follow the same operating process.

$$I(x) = t(x)J(x) + (1 - t(x))A \tag{1}$$

where $I(x)$ is the pixel colour under hazing condition or in other words, the image input, A is the ambiant light colour, $J(x)$ the true pixel radiance, $t(x)$ is the transmission function is the scattering coefficient ranging from 0 (airlight colour) to 1 (true radiance colour), distance-dependent is defined by the equation [2]:

$$t(x) = e^{-\beta d(x)} \tag{2}$$

where β is the wave phase number and $d(x)$ the scene pixel distance from the camera. From the equation [2] one can observe $t(x)$ is dependent on the wavelength and thus be different for each colour component. Nevertheless, the dehazing method assume a constant matting gradient $t(x)$ for each colour channel. The used algorithm is operating under this assumption. The contrast attenuation and the ambiant colour corruption can be highlited by breaking the equation [1] - $t(x)J(x)$, the attenuation component and $(1 - t(x))A$, the ambiant light effect. $I(x)$ being the input, the dehazing process is reduced to find the transmission and the global airlight parameters to recompose the true radiance scenary. This process can be decomposed in three steps : the airlight vector determination [a], the airlight magnitude determination [b] and the transmission coefficient calculation [c].

Even if the algorithm is indeed based on the equation [1], it uses an mathematical relation steming from [1]:

$$I(x) = l(x)R_i + c_i A \tag{3}$$

Where $l(x)$ expresses the shading coefficient related to the angle between the normal direction of the scene surface and the 3D line from the camera to this specific surface, R_i is the true radiance and c_i, the ambiant light coefficient - $(1-t(x))$. The dehazing method is a local patch-based algorithm meaning the image is decomposed on patches on which information is gleaned after image treatment. The patches should obey to specific conditions : it should be composed of pixels with same true radiance and with constant transmission coefficient. The motivation behind this decomposition lies in the retrieval of the airlight vector. By finding patches composed of pixels fulfilling the previous constraints, we can construct the line $I(x) = l(x)R_i + C$ with C a constant equals to $c_i A$. The funding idea is that the constructed line will intersect the airligth vector in the RGB frame. Reconstructing lines from multiples patches will lead to the determination of the airlight vector which ultimately will result to the dehazing of the image. The steps will be explained in details in the following sections.

II. Airlight vector determination

The importance of the airlight determination has been introduced in the previous section. We will now move to its computation. the first stage will be focused on the determination of the airligth vector.

i Patch decomposition
ii Eigenvalue comparison
iii Distance to origin
iv Eigenvector angles threshold
v Eigenvector intersection after projection
vi Minimal distance for Â determination

III. Airlight magnitude determination

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IV. transmission range determination

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V. Validation

VI. Conclusion