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Image Haze Removal using Dark Channel Prior

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Abstract- Haze (or fog, mist, and other atmospheric phenomena) is a main degradation of outdoor images, weakening both colors and contrasts. The main aim of this project is to remove the haze from a single input image using Dark Channel Prior. Using this dark channel prior with the haze imaging model, we can recover a high quality haze-free image. At last, we'll use Histogram Equalisation for Image enhancement and Image Sharpening to highlight the finite details in an image. The proposed technique is designed and implemented in MATLAB.

Keywords – Single image dehazing, Image degradation, Dark channel prior.

I. INTRODUCTION

Images plays an important role in the real world, images are used for describing the changes in the environment. Images are captured in open environment due to the bad weather or atmosphere images are not a clear. Images acquired in bad weather, such as the fog and haze, are extremely degraded by scattering of an atmosphere, and decreases contrast. Images captured during adverse weather conditions frequently feature degraded visibility and undesirable color cast effects. The presence of suspended particles like haze, fog and mist in the atmosphere deteriorates quality of captured images. In this paper, we obtain a haze free image.

The rest of the paper is organized as follows. Literature survey in section II. Proposed algorithm is explained in section III. Experimental results are presented in section IV. Concluding remarks are given in section V.

II. LITERATURE SURVEY

A. Existing system

By applying a single per pixel operation on the original image, we produce a 'semi-inverse' of the image. Based on the hue disparity between the original image and its semi-inverse, we are then able to identify hazy regions on a per pixel basis. This enables for a simple estimation of the air light constant and the transmission map. Our approach is based on an extensive study on a large data set of images, and validated based on a metric that measures the contrast but also the structural changes. Time complexity of this process is more when compared with the proposed system.

B. Proposed System

In the existing system, we propose a simple but effective image prior-dark channel prior to remove haze from a single input image. The dark channel prior is a kind of statistics of outdoor haze-free images. It is based on a key observation-most local patches in outdoor haze-free images contain some pixels whose intensity is very low in at least one color channel. Using this prior with the haze imaging model, we can recover a high-quality haze-free image. Results on a variety of hazy images demonstrate the power of the proposed prior. Moreover, a high-quality depth map can also be obtained as a byproduct of haze removal.

III. PROPOSED ALGORITHM

Background:

The most widely used model to describe the formation of a haze image is:

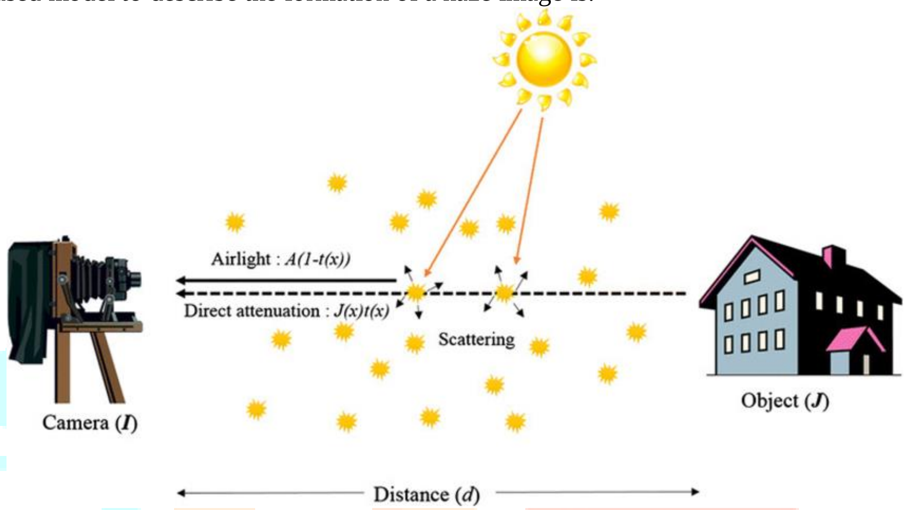


Figure 1: Haze formation image

$$I(x) = J(x)t(x) + A(1 - t(x)) \quad \text{.................. 3.1}$$

where
I is the observed image intensity,
J is the scene radiance,
A is the global atmospheric light,
t is the medium transmission

Working flow of this project is shown by this flow diagram.

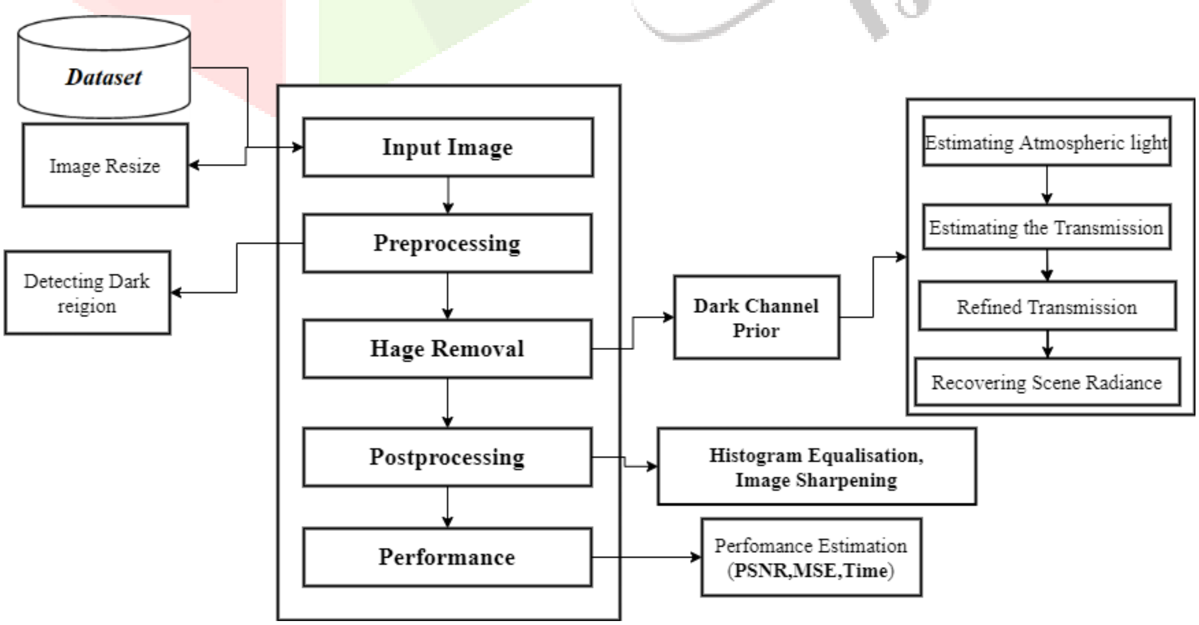


Figure 2: Flow diagram

MODULES:

Module-1: Input image

The first stage of any vision system is the image acquisition stage. Image acquisition is the digitization and storage of an image. First Capture the Input Image from source file by using uigetfile and imread function. However, if the image has not been acquired satisfactorily then the intended tasks may not be achievable.

Module-2: Preprocessing

The prior says, that in most of the local regions that aren't sky, very often some pixels have a very low intensity in at least one of its color channels (RGB). In the hazy image then, these dark pixels can be used to determine the true airlight, since the airlight is apparent on a dark object (as stated in the preceding chapter). The dark channel *Jdark* of *J* (the haze-free image) is defined as

$$J^{dark}(x) = \min_{c\in\{r,g,b\}}\left(\min_{y\in\Omega(x)}\left(J^c(y)\right)\right) \qquad \text{......................... 3.2}$$

where *Jc* is a color channel of *J* and (*x*) is a local patch centered at *x*. This statistical observation is called the *Dark Channel Prior*.

Module-3: Haze Removal

Haze Removal using Dark Channel Prior:

- Estimating the Atmospheric Light
- Estimating the Transmission
- Refined Transmission/Soft matting
- Recovering the Scene Radiance

Since *Jdark* tends to be zero and as *Ac*, the corresponding channel of the atmospheric light is always positive, it may be written:

$$J^{dark}(x) = \min_{c\in\{r,g,b\}}\left(\min_{y\in\Omega(x)}\frac{J^c(y)}{A^c}\right) = 0. \qquad \text{..................... 3.3}$$

This can be used to estimate the transmission for that patch (*x*) by putting this into the haze formation model 3.1, however now in combination with the min operator:

$$\min_c\left(\min_{y\in\Omega(x)} I^c(y)\right) = \tilde{t}(x)\min_c\left(\min_{y\in\Omega(x)} J^c(y)\right) + (1-\tilde{t}(x))\cdot A^c. \qquad \text{..................... 3.4}$$

with *t*(*x*) denoting the transmission in a local patch, then putting 3.3 into 3.4 leads to:

$$\tilde{t}(x) = 1 - \min_c\left(\min_{y\in\Omega(x)}\frac{I^c(y)}{A^c}\right) \qquad \text{.......................... 3.5}$$

which is a direct estimation of the transmission for each local patch. They then apply a soft matting algorithm on the depth map, this leads to a much smoother and detailed depth map. Having the transmission or depth map, the scene radiance according to 3.1 can now be recovered. However, since the direct attenuation term *J*(*x*)*t*(*x*) can be very close to zero, the transmission is restricted to a lower bound *t*0 for example *t*0 = 0.1, since the scene radiance is typically not as bright as the atmospheric light *A*. The final scene radiance *J*(*x*) may then be recovered by:

$$J(x) = \frac{I(x) - A}{\max(t(x), t_0)} + A.$$

..............................3.6

In the above calculations, the atmospheric light *A* was considered to be known, which is of course not the case, at least initially. Pick the top 0.1% brightest pixels in the dark channel(min*c*(*Ic*)), since these must be the most haze-opaque. Among these pixels, the pixel with the highest intensity in the input *I* is picked as the atmospheric light *A*. This may not be the brightest pixel in the image, but is more robust than the "brightest pixel" method. This method seems very elegant and shows very good results.

Module-4: Postprocessing

Histogram Equalisation:

Histogram Equalisation is used for Image Enhancement. Histogram is the graphical representation of any data. Histogram in case of Image processing is used to represent the data related to digital images. Histogram is the representation of relative frequency of occurance of the various grey levels. Histogram is used for various image processing applications like manipulating the contrast value and also brightness of the digital image. The histogram can control the quality of an image by normalizing the histogram values to a flat profile.

Image Sharpening:

The principle objective of sharpening is to highlight the finite details in an image or to enhance the detail that has been blurred either in error or as a natural effect of particular method of image acquisition. It has wide variety of applications including electronic printing, medical imaging, industrial inspections and autonomous guidance in military systems. Sharpening can be accomplished by special differentiation. Hence image differentiation enhances edges and noise and deemphasizes the areas with slowly varying grey level values.

Module-5: Performance

Estimated time to complete is a projection of the time and or effort required to complete a project activity. Estimated time to complete is a value that is expressed in hours of work required to complete a task or project. You can use the work breakdown structure to facilitate estimation.

PSNR and MSE:

The mean-square error (MSE) and the peak signal-to-noise ratio (PSNR) are used to compare image compression quality. The MSE represents the cumulative squared error between the compressed and the original image, whereas PSNR represents a measure of the peak error.

$$MSE = \frac{1}{m\,n}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

The PSNR is defined as:

$$PSNR = 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right) = 20 \cdot \log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right)$$

III. Experiment and Result

The project is implemented in MATLAB version R2015b. The PC for experiment is equipped with an Intel i3 2.2GHz Personal laptop and 4GB RAM. The dataset contains few hazy images with different scenes. The stages of implementation are Pre-Processing, Haze detection, Haze removal, Post processing and Performance. This project successfully gives the Haze removal image for the given Hazy input image.

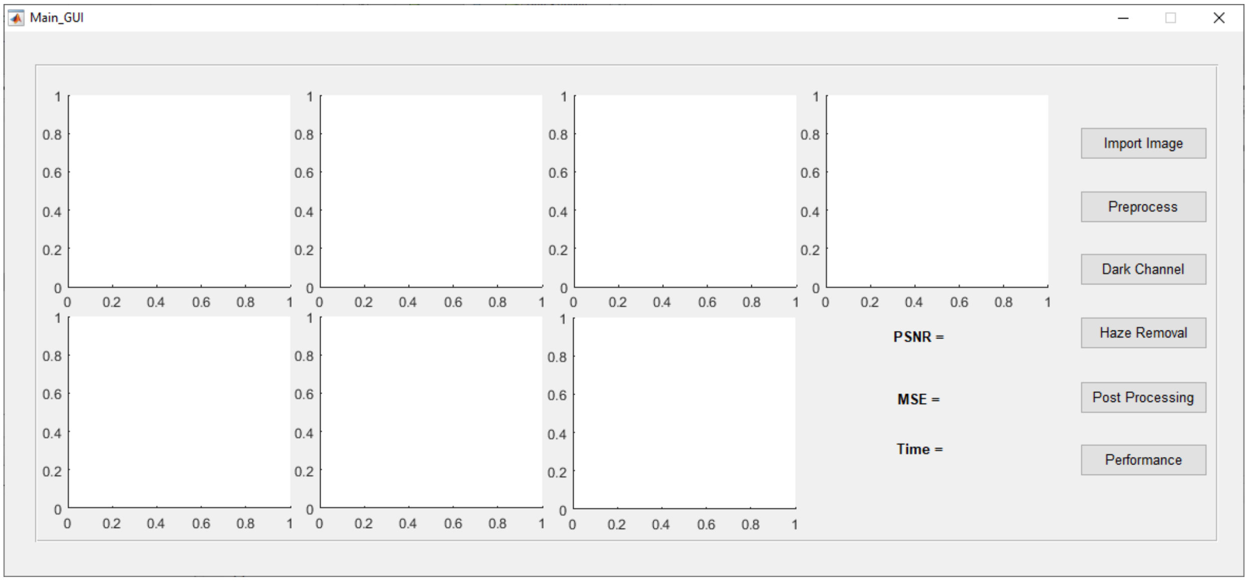


Figure-3: Interface(Screen 1)

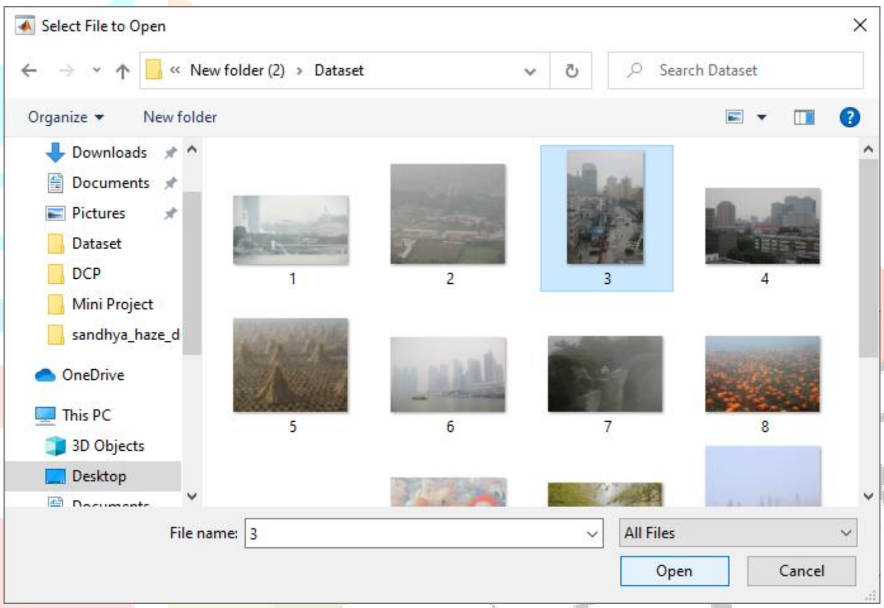
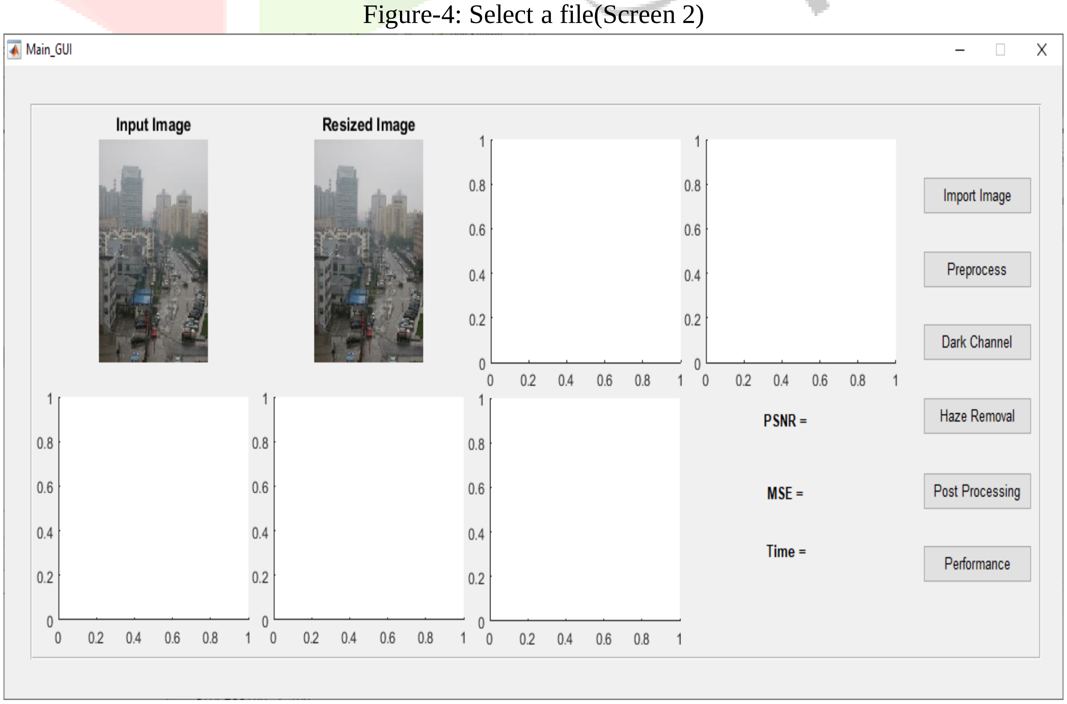
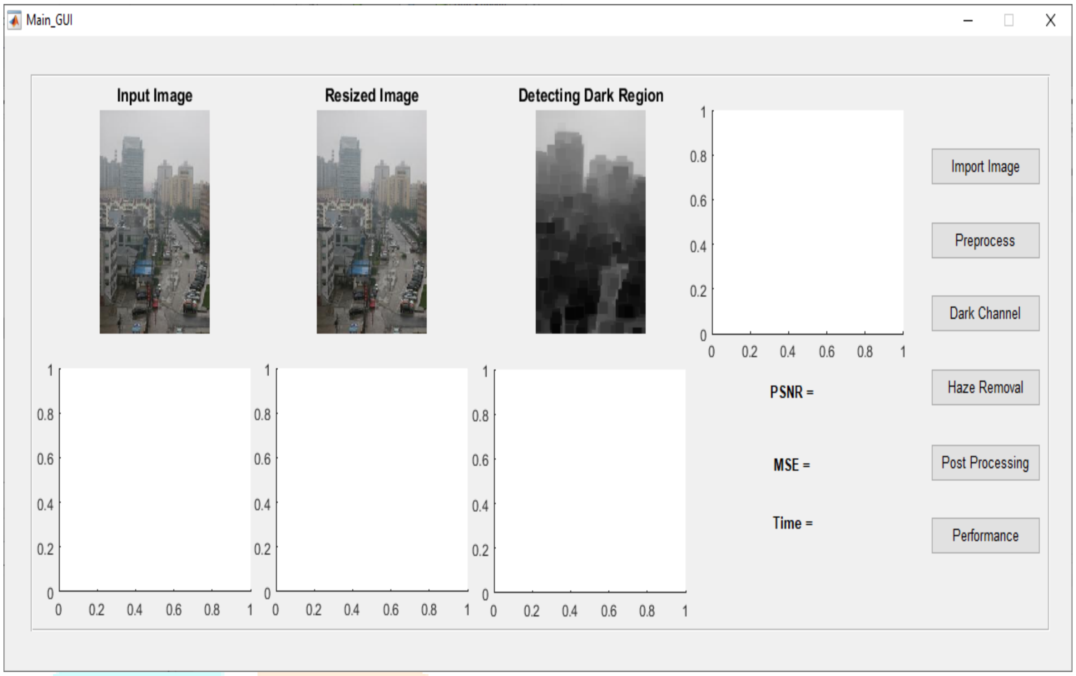


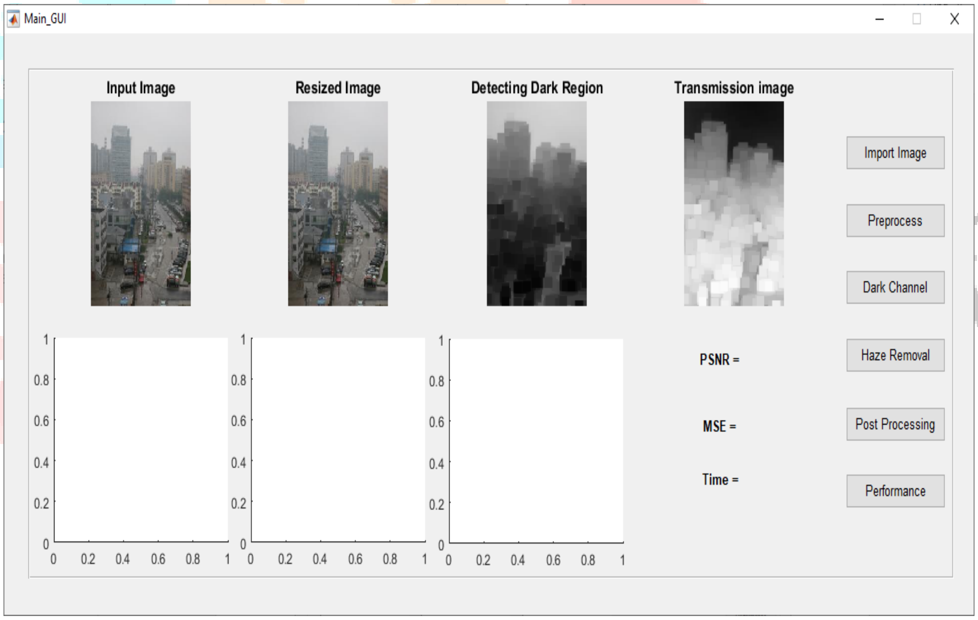
Figure-4: Select a file(Screen 2)



Figue-5: Screen 3



Figue-6: Screen 4



Figue-7: Screen 5

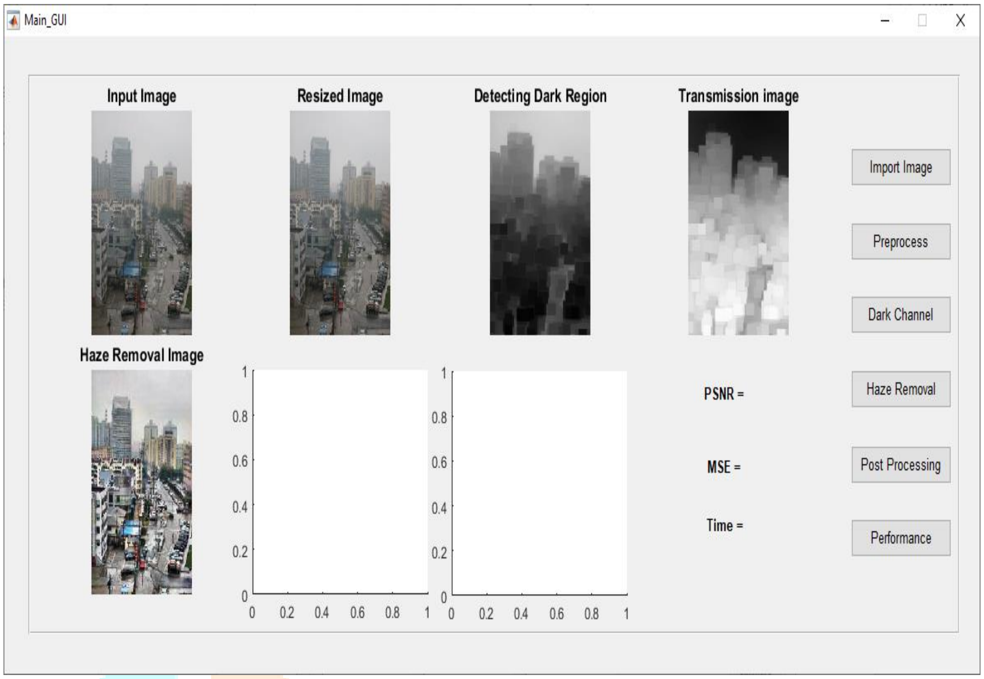
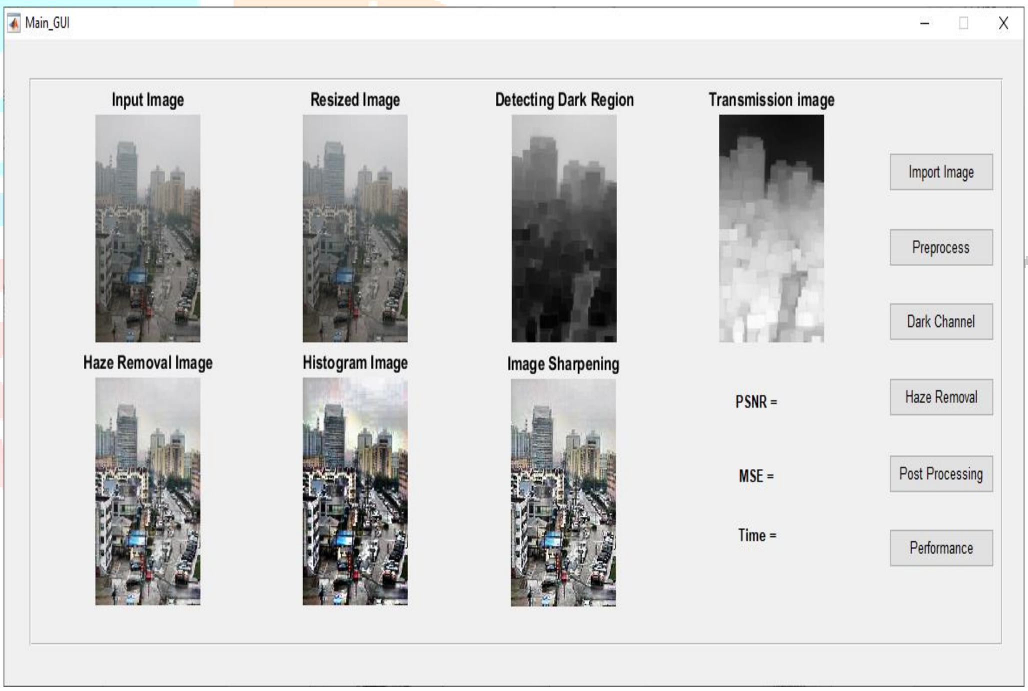
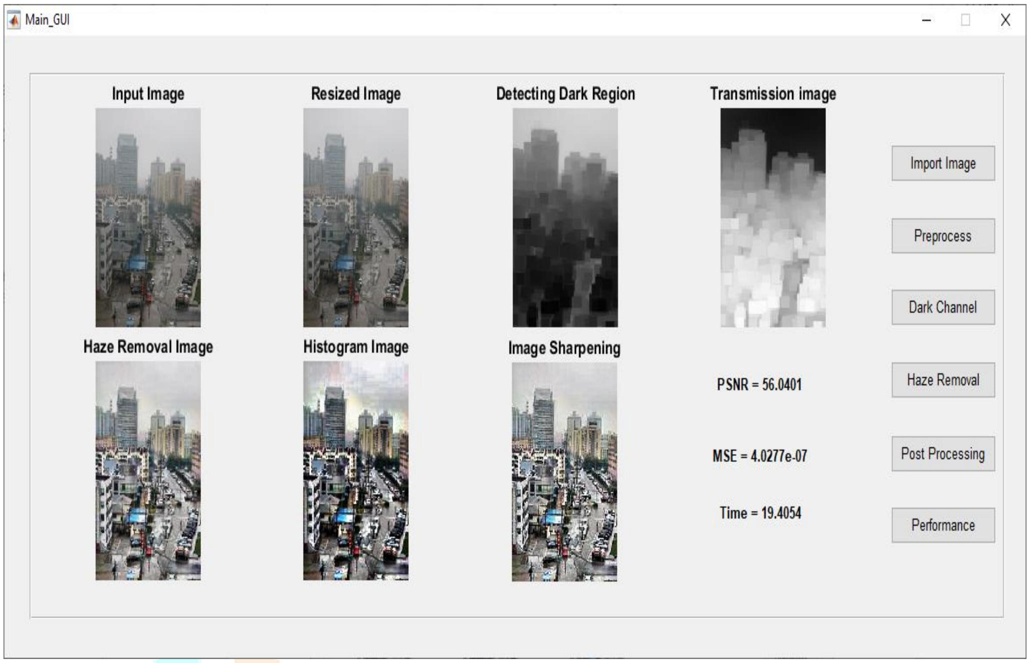


Figure-8: Screen 6



Figue-9: Screen 7



Figue-10: Screen 8

IV.CONCLUSION

In this, we have studied the haze & blur problems and related issues. We propose the dark channel prior algorithm as a single image haze removal algorithm. The dark channel prior comes from an intuitive observation on outdoor haze-free images. Unlike the heuristic assumptions in previous methods, this prior is based on the image statistics, which is the result of inherent physical properties (illumination, colors, and geometry). This algorithm provides a robust estimation for each pixel, and thus solves the ambiguity of the problem. Despite of its simplicity, our haze removal algorithm based on this prior is very effective in various situations. Experiments show that our method outperforms most of the previous works. The challenge is that we need to combine the pixel-wise constraints with spatial continuities, which is usually time-consuming. Hence the given input image is de-Hazed, using dark channel prior algorithm. Finally, the parameters of the resultant image are analysed and ensured with appropriate quality.

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