

Study of Image Processing, Enhancement and Restoration

Bhausahab Shinde, Dnyandeo Mhaske, A.R. Dani

Computer Science Department, R.B.N.B. College, Shrirampur Affiliated by Pune University
Maharashtra, India

Principal, R.B.N.B. College, Shrirampur Affiliated by Pune University
Maharashtra, India

Head, International Institute of Information Technology, Hinjwadi, Pune
Maharashtra, India

Abstract

Digital image processing is a means by which the valuable information in observed raw image data can be revealed. A web-based image processing pipeline was created under the ambitious educational program Venus Transit 2004 (VT-2004). The active participants in the VT-2004 can apply the basic processing methods to the images obtained by their amateur telescopes and/or they can process an image observed at any observatory involved in the project. The processed result image is displayed immediately on the display. Above that all participants can follow the distance Sun-Venus centers computation performed at the professional observatory in the real time. There is a possibility to submit an image from their own observation into the database. It will be used for the distance Earth-Sun computation.

Keywords: Educational project, WEB pipeline, image processing

1. Introduction

An image is digitized to convert it to a form which can be stored in a computer's memory or on some form of storage media such as a hard disk or CD-ROM. This digitization procedure can be done by a scanner, or by a video camera connected to a frame grabber board in a computer. Once the image has been digitized, it can be operated upon by various image processing operations.

Image processing operations can be roughly divided into three major categories, Image Compression, Image Enhancement and Restoration, and Measurement Extraction. Image compression is familiar to most people. It involves reducing the amount of memory needed to store a digital image.

Image defects which could be caused by the digitization process or by faults in the imaging set-up (for example, bad lighting) can be corrected using Image Enhancement techniques. Once the image is in good condition, the Measurement Extraction operations can be used to obtain useful information from the image.

Some examples of Image Enhancement and Measurement Extraction are given below. The examples shown all operate on

256 grey-scale images. This means that each pixel in the image is stored as a number between 0 to 255, where 0 represents a black pixel, 255 represents a white pixel and values in-between represent shades of grey. These operations can be extended to operate on color images.

The examples below represent only a few of the many techniques available for operating on images. Details about the inner workings of the operations have not been given, but some references to books containing this information are given at the end for the interested reader.

2. Image Enhancement and Restoration:

The image at the top left of Figure 1 has a corrugated effect due to a fault in the acquisition process. This can be removed by doing a 2-dimensional Fast-Fourier Transform on the image (top right of Figure 1), removing the bright spots (bottom left of Figure 1), and finally doing an inverse Fast Fourier Transform to return to the original image without the corrugated background Bottom right of figure 1.

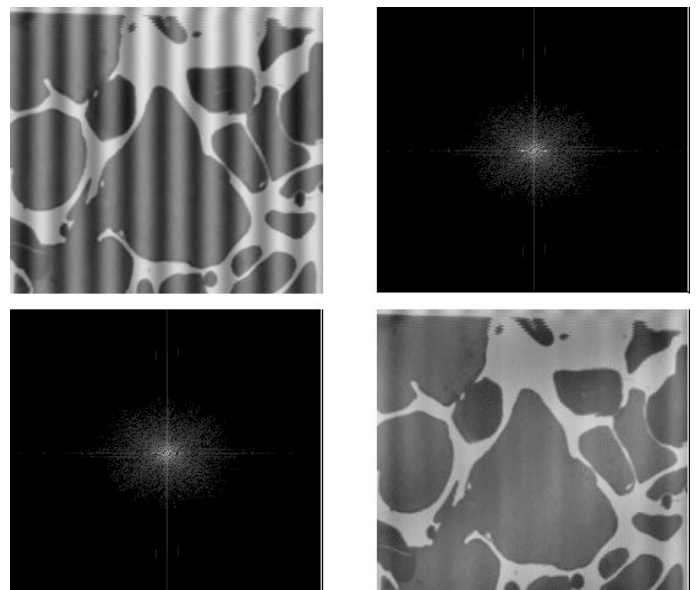


Figure 1. Application of the 2-dimensional Fast Fourier Transform

An image which has been captured in poor lighting conditions, and shows a continuous change in the background brightness across the image (top left of Figure 2) can be corrected using the following procedure. First remove the foreground objects by applying a 25 by 25 grayscale dilation operation (top right of Figure 2). Then subtract the original image from the background image (bottom left of Figure 2). Finally invert the colors and improve the contrast by adjusting the image histogram (bottom right of Figure 2).

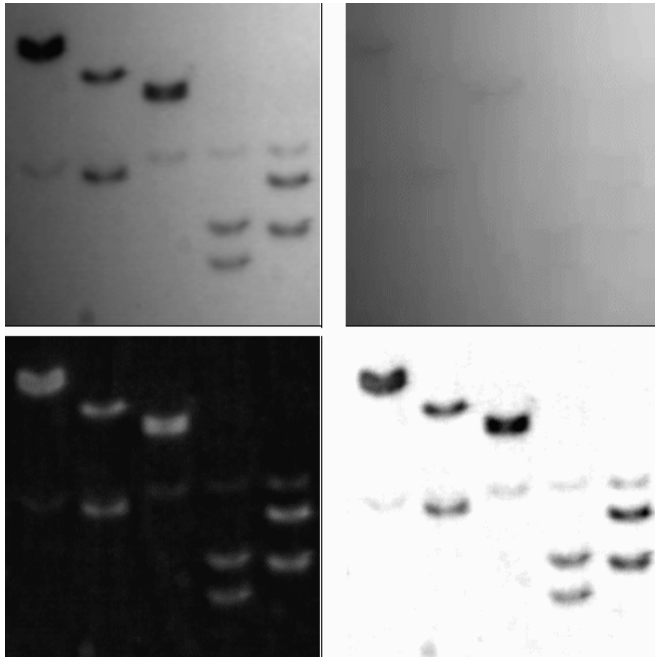


Figure 2. Correcting for a background gradient

3. Image Measurement Extraction: The example below demonstrates how one could go about extracting measurements from an image. The image at the top left of Figure 3 shows some objects. The aim is to extract information about the distribution of the sizes (visible areas) of the objects. The first step involves segmenting the image to separate the objects of interest from the background. This usually involves thresholding the image, which is done by setting the values of pixels above a certain threshold value to white, and all the others to black (top right of Figure 3). Because the objects touch, thresholding at a level which includes the full surface of all the objects does not show separate objects. This problem is solved by performing a watershed separation on the image (lower left of Figure 3). The image at the lower right of Figure 3 shows the result of performing a logical AND of the two images at the left of Figure 3. This shows the effect that the watershed separation has on touching objects in the original image.

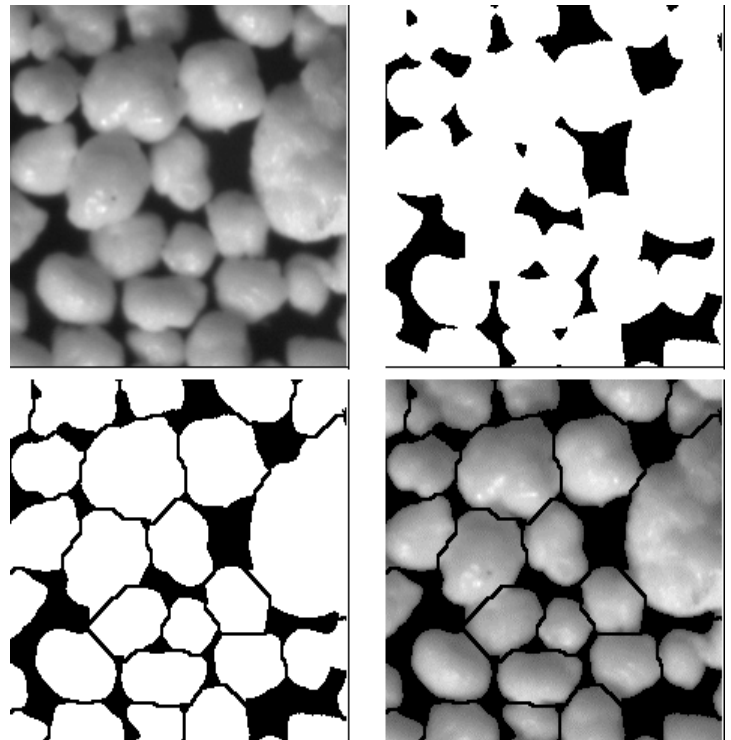


Figure 3. Thresholding an image and applying a Watershed Separation Filter

4. Color Balancing Method for Cameras:

The problem of separating the illumination from the reflectance information in a given image has been extensively researched in the last three decades, following Edwin Land's seminal work on color vision and his development of the Retinex theory [4]. The problem can be described as follows – given an input image S , we would like to decompose it into two different images – the reflectance image R and the illumination image L , such that $S(x, y) = R(x, y) L(x, y)$. There are many benefits to such a decomposition, including the ability to correct for color-shifts due to illumination, correct for uneven illumination, introduce artificial lighting and enhancing dynamic range. It is not hard to see that in general, this problem is ill-posed – for a given input image L , there are infinitely possible solutions of L and R pairs that can explain S . Many works have tried to constraint the problem, by posing assumptions on the type of illumination (e.g. constant-hue illumination over the field-of-view and spatial smoothness). With the growing popularity of digital cameras the importance of fast algorithms for color correction (also known as auto white-balancing, AWB in short) grew as well. Such algorithms are an integral part of the image signal processing (ISP) pipeline that is responsible for converting the RAW image captured by the sensor into the final color JPEG image that is saved on the memory card. AWB algorithms try to estimate the correct three white balance gains (for the red, green and blue channels) that should be applied on an input image in order to correct for color shifts caused by illumination, so that white elements in the scene indeed appear white in the image – similar to the way the human visual system can compensate for different

lighting conditions so that white color always seems white under different illuminations. Figure 1 shows an example of correct vs. incorrect white balancing.

Conclusion: You have seen a few of the features of a good introductory image processing program. There are many more complex modifications you can make to the images. For example, you can apply a variety of filters to the image. The filters use mathematical algorithms to modify the image. Some filters are easy to use, while others require a great deal of technical knowledge. The software also will calculate the RA, Dec, and magnitude of all objects in the field if you have a star catalog such as the Hubble Guide Star Catalog (although this feature requires the purchase of an additional CD-ROM).

The standard tricolor images produced by the SDSS are very good images. If you are looking for something specific, you can frequently make a picture that brings out other details. The "best" picture is a very relative term. A picture that is processed to show faint asteroids may be useless to study the bright core of a galaxy in the same field.

1.1 References:

1. Russ, John C., **The Image Processing Handbook**, 3rd ed., CRC Press
2. Jähne, Bernd, **Digital Image Processing: Concepts, Algorithms, and Scientific Applications**, 3rd ed., Springer-Verlag
3. Pratt, William K, **Digital Image Processing**, 3rd ed., Wiley
4. Gonzalez, Rafael C., Woods, Richard C., **Digital Image Processing**, Addison-Wesley

Shinde Bhausaheb: I have completed my M.C.S.(Master Of Computer Science) from Pune University, M.Phil. Also Register to Ph.D in Sighania University, Rajasthan. Currently I am working in R.B.N.B. College as Head of Computer Science Department having 12 years of expert as well as Lecturer experience.