Image Enhancement and Analysis of Thermal Images Using Image Processing

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Abstract

The Principle objective of Image enhancement is to improve the image quality so that the resultant image is better than the original image for a specific application. Image enhancement is the task of applying certain alterations to an input image like as to obtain a more visually pleasing image. Thermal image enhancement used in Quality Control, colour and gray scale image, Problem Diagnostics, Research and Development, Risk Management Programme, Digital infrared thermal imaging in health care, law enforcement and defence. Various enhancement schemes are used for enhancing an image which includes gray scale manipulation, Histogram Equalization (HE), fast Fourier transform, Image fusion and denoising. Image enhancement is the process of making images more useful. The reasons for doing this include, Highlighting interesting detail in images, removing noise from images, making images more visually appealing, edge enhancement and increase the contrast of the image.

Keywords: Adaptive filtering, DE noising, fast Fourier transform, histogram equalisation, Image enhancement, Image fusion, linear filtering.

Introduction

Image enhancement problem can be formulated as follows: given an input low quality image and the output high quality image for specific applications. It is well-known that image enhancement as an active topic in medical imaging has received much attention in recent years. The aim is to improve the visual appearance of the image, or to provide a “better” transform representation for future automated image processing, such as analysis, detection, segmentation and recognition. Moreover, it helps analyses background information that is essential to understand object behaviour without requiring expensive human visual inspection. Carrying out image enhancement understanding under low quality image is a challenging problem because of these reasons. Due to low contrast, we cannot clearly extract objects from the dark background.

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Most color based methods will fail on this matter if the colour of the objects and that of the background are similar. The survey of available techniques is based on the existing techniques of image enhancement, which can be classified into two broad categories: Spatial based domain image enhancement and Frequency based domain image enhancement. Spatial based domain image enhancement operates directly on pixels. The main advantage of spatial based domain technique is that they conceptually simple to understand and the complexity of these techniques is low which favours real time implementations. But these techniques generally lacks in providing adequate robustness and imperceptibility requirements. Frequency based domain image enhancement is a term used to describe the analysis of mathematical functions or signals with respect to frequency and operate directly on the transform coefficients of the image, discrete wavelet transform (DWT), and discrete cosine transform (DCT). The basic idea in using this technique is to enhance the image by manipulating the transform coefficients. The advantages of frequency based image enhancement includes low complexity of computations, ease of viewing and manipulating the frequency composition of the image and the easy applicability of special transformed domain properties. The basic limitations including are it cannot simultaneously enhance all parts of image very well and it is also difficult to automate the image enhancement procedure. In this paper according to if enhanced image embed high quality background information, the existing techniques of image enhancement like spatial domain methods can again be classified into two broad categories: Point Processing operation and Spatial filter operations.

Image Enhancement and Analysis Techniques of Image Processing

Image enhancement is actually the class of image processing operations whose goal is to produce an output digital image that is visually more suitable as appearance for its visual examination by a human observer

a. The relevant features for the examination task are enhanced

b. The irrelevant features for the examination task are removed/reduced

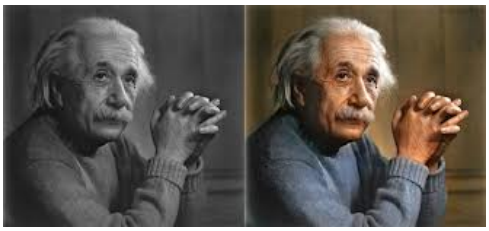
• Specific to image enhancement:

- Input = digital image (grey scale or color)

- Output = digital image (grey scale or color)

Conversion of RGB image into grayscale image

In RGB images each pixel has a particular colour; that colour is described by the amount of red, green and blue in it. If each of these components has a range 0–255, this gives a total of 256^3 different possible colours. Such an image is a "stack" of three matrices; representing the red, green and blue values for each pixel. This means that for every pixel there correspond 3 values. Whereas in greyscale each pixel is a shade of gray, normally from 0 (black) to 255 (white). This range means that each pixel can be represented by eight bits, or exactly one byte. Other grayscale ranges are used, but generally they are a power of 2.so, we can say gray image takes less space in memory in comparison to RGB images



Grayscale image Original image

There are two basic methods to convert RGB image into grayscale image:

i. Average method:

Average method is the simplest one. We just have to take the average of three colours. Since it's an RGB image,so we have to ass its r, g and b value and then divide it by 3 to get the desired grayscale image. We can do this as:

Grayscale = (R + G + B / 3)

Original image Grayscale image

Problem: Since each colour has its own wavelength and its own contribution in the formation of image, so we should take average according to their contribution which is not done in this method.

ii. Weighted method or luminosity method:

Since red colour has more wavelengths of all the three colours, and green is the colour that has not only less wavelength then red colour but also green is the colour that gives more soothing effect to the eyes. So in this method we decrease the contribution of red colour and increase the contribution of green colour and put blue colour contribution between these two colours.

The equation will get form as :

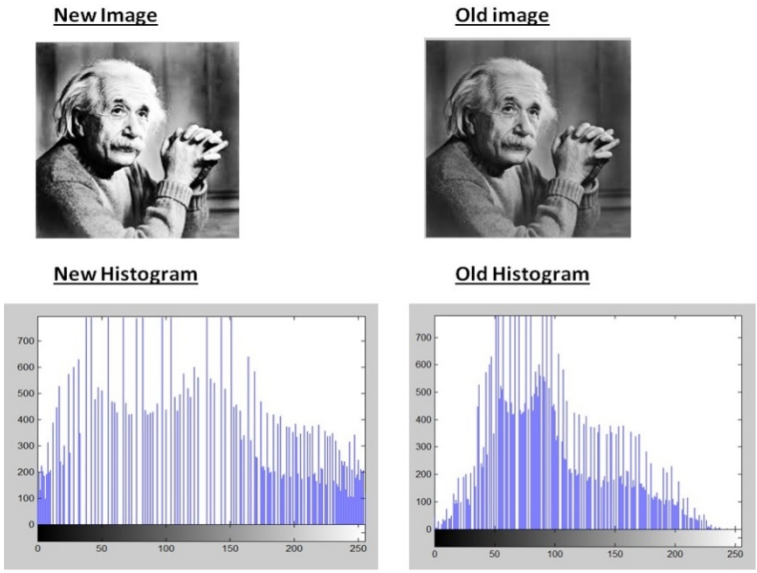
New grayscale image = ((0.3 * R) + (0.59 * G) + (0.11 * B))

Original Image Grayscale image

Histogram, histogram equalization and contrast enhancement

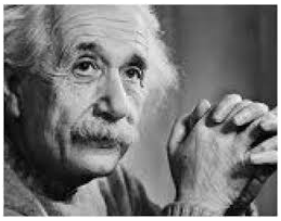
Histogram is the estimation of the probability distribution of a particular type of data. An image histogram is a type of histogram which offers a graphical representation of the tonal distribution of the gray values in a digital image. Image histograms are an important tool for inspecting images.The shape of the histogram of an image gives us useful information about the possibility for contrast enhancement. A histogram of a narrow shape indicates little dynamic

range and thus corresponds to an image having low contrast. Histogram equalization is used to enhance the contrast of the image it spreads the intensity values over full range. Histogram equalization is used to enhance contrast. It is not necessary that contrast will always be increase in this. There may be some cases were histogram equalization can be worse. In that case the contrast is decreased. Contrast adjustment, overall lightness or darkness of the image is changed. Contrast enhancements improve the perceptibility of objects in the scene by enhancing the brightness difference between objects and their backgrounds A contrast stretch improves the brightness differences uniformly across the dynamic range of the image.



Linear filtering of the image

Filtering is a technique for modifying or enhancing an image. For example, you can filter an image to emphasize certain features or remove other features. Image processing operations implemented with filtering include smoothing, sharpening, and edge enhancement. Linear filtering is filtering in which the value of an output pixel is a linear combination of the values of the pixels in the input pixel's neighbourhood. The noise is removed by adaptive filtering approach, often produces better results than linear filtering. The adaptive filter is more selective than a comparable linear filter, preserving edges and other high-frequency parts of an image



Filtered image after the histogram

Analysis of thermal image

Thermal imaging is a method of improving visibility of objects in a dark environment by detecting the objects' infrared radiation and creating an image based on that information.

How thermal imaging works: All objects emit infrared energy (heat) as a function of their temperature. The infrared energy emitted by an object is known as its heat signature. In general, the hotter an object is, the more radiation it emits. A thermal imager (also known as a thermal camera) is essentially a heat sensor that is capable of detecting tiny differences in temperature. The device collects the infrared radiation from objects in the scene and creates an electronic image based on information about the temperature differences. Because objects are rarely precisely the same temperature as other objects around them, a thermal camera can detect them and they will appear as distinct in a thermal image.

Techniques of Wavelet

Wavelet analysis is capable of revealing aspects of data that other signal analysis techniques miss aspects like trends, breakdown points, discontinuities in higher derivatives, and self-similarity. Furthermore, because it affords a different view of data than those presented by traditional techniques, wavelet analysis can often compress or de-noise a signal without appreciable degradation. There are so many techniques to enhance an image that I have used in this to enhancement. There are two thermal images on that I have applied enhancement methods:

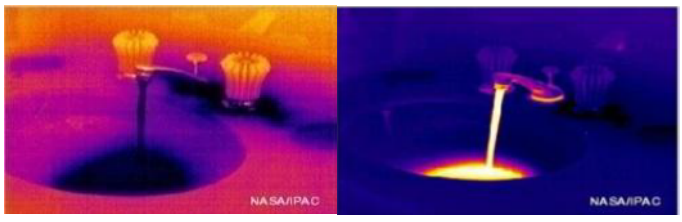


Image fusion:

Image fusion is the process of combining relevant information from two or more images into a single image. The resulting image will be more informative than any of the input images. The objective of image fusion is to combine information from multiple images of the same scene. The result of image fusion is a new image which is more suitable for human and machine perception or further image-processing tasks such as segmentation, feature extraction and object recognition. The main application of image fusion is merging the gray-level high-resolution panchromatic image and the coloured low-resolution multispectral image.

The wavelets-based approach is appropriate for performing fusion tasks for the following reasons:

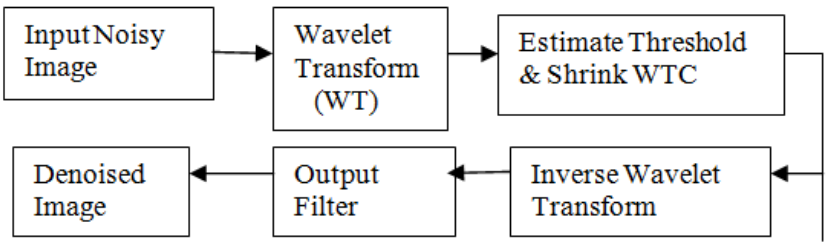
1. It is a multiscale (multiresolution) approach well suited to manage the different image resolutions. In recent
2. Years, some researchers have studied multiscale representation (pyramid decomposition) of a signal and
3. Have established that multiscale information can be useful in a number of image processing applications including the image fusion.
4. Such coefficients coming from different images can be appropriately combined to obtain new coefficients, so that the information in the original images is collected appropriately.
5. Once the coefficients are merged, the final fused image is achieved through the inverse discrete wavelets transform (IDWT), where the information in the merged coefficients is also preserved.
6. Hence, the fused image has better quality than any of the original images

Denoising image

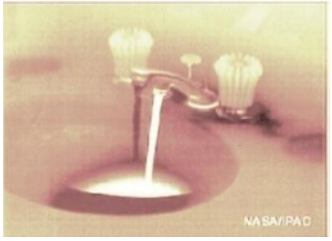
The image usually has noise which is not easily eliminated in image processing. According to actual image characteristic, noise statistical property and frequency spectrum distribution rule, people have developed many methods of eliminating noises, which approximately are divided into space and transformation fields The space field is data operation carried on the original image, and processes the image grey value, like neighbourhood average method, wiener filter, centre value filter and so on. The transformation field is management in the transformation field of images, and the coefficients after transformation are processed. Then the aim of eliminating noise is achieved by inverse transformation, like wavelet transform. Successful exploitation of wavelet transform might lessen the noise effect or even overcome it completely. The general wavelet denoising procedure is as follows:

• Apply wavelet transform to the noisy signal to produce the noisy wavelet coefficients to the level which we can properly distinguish the PD occurrence. • Select appropriate threshold limit at each level and threshold method (hard or soft thresholding) to best remove the noises.

• Inverse wavelet transforms of the threshold wavelet coefficients to obtain a denoised signal Block diagram of Image denoising using wavelet transform



Block diagram of Image denoising using wavelet transform.



Compressed image

Images require much storage space, large transmission bandwidth and long transmission time. The only Way currently to improve on these resource requirements is to compress images, such that they can be transmitted quicker and then decompressed by the receiver.In image processing there are 256 intensity levels (scales) of grey. 0 is black and 255 are white. Each Level is represented by an 8-bit binary number so black is 00000000 and white is 11111111. An image Can therefore be thought of as grid of pixels, where each pixel can be represented by the 8-bit binary Value for grey-scale."Image compression algorithms aim to remove redundancy in data in a way which makes image reconstruction possible." This basically means that image compression algorithms try to exploit redundancies in the data; they calculate which data needs to be kept in order to reconstruct the original image and therefore which data can be 'thrown away'. By removing the redundant data, the image can be represented in a smaller number of bits, and hence can be compressed Two fundamental components of compression are redundancy and irrelevancy reduction.

- Redundancy reduction aims at removing duplication from the signal source (image/video).
- Irrelevancy reduction omits parts of the signal that will not be noticed by the signal receiver, namely the Human Visual System (HVS).

(A) By global Thresh holding method: balance Sparsity norm Retained energy=99.90, No. of zeros=93.64

(B)By global Thresh holding method: remove near zero Retained energy=100

Comparative Results

The result obtained from the wavelet techniques is better than the image processing techniques. The image gets enhanced using wavelet techniques in comparison to image processing. The enhancement of an image is easy through wavelet as in comparison to the image processing. The denoised image and compressed image is also better and is easy to obtain result through wavelet by using graphical user interface.

Conclusion

This work highlights the successful application of wavelet based methods for analysis of thermal images. Although in wavelet, global thresholding can be used successfully to compress images it is difficult to find a global threshold that will give near optimal results because of how the different detail sub signals differ. Global Thresholding leads to unnecessary energy losses in order to obtain a certain compression rate.

References

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