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Thermal image Enhancement and Analysis Techniques of Image Processing using Wavelet Transformation

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Abstract:

Image enhancement aims primarily to improve the image quality so that the resulting image is better than the original image for a particular application. Improving the image is the task of implementing certain changes to the input image, such as a visually more pleasant image. Improvement of thermal images in quality control, color and gray photo, issue diagnostics, research and development, risk management programs, Infrared electronic thermal imaging in education, law enforcement and defence. Various improvement schemes are used to improve a gray-scale manipulation image, histogram equalization (HE), fast Fourier transformation, image fusion, and denoise. Improving images is the process of making images more useful. Such causes include highlighting fascinating object detail, eliminating noise from images, making images more visually appealing, enhancing the edge and increasing the image contrast.

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

Introduction:

The problem of image enhancement can be formulated as follows, a low quality source image and the performance output for specific applications. It is well known that improved images as an active topic in medical imaging have received considerable attention in recent years. The goal is to enhance the visual appearance of the object or give a good representation of transformation in future automated image processing, for example evaluation, identification, segmentation and recognition. In addition, it helps analyze background information, which is important to understand the behavior of objects without costly visual inspection by people. Improving the understanding of images under poor images is a challenge because of these reasons. We can not clearly distinguish objects from the dark background because of the poor contrast.

Most color-based approaches would fail if the target and background colors are identical. The survey of available techniques is based on existing image enhancement techniques, which are classified as two large categories: spatial domain enhancement and frequency-based domain enhancement. Spatial domain image enhancement works on pixels directly. The main advantage of a spatial domain technique is its conceptual simplicity that favors real-time implementation and the complexity of these techniques is low. Nevertheless, in particular, these techniques lack sufficient robustness and imperceptibility. Frequency based domain image enhancement is a term used to describe mathematical process or signal analysis with regard to the frequency, which works directly on image transforming coefficients, DWTs, and DCTs. The fundamental idea for using this technique is to improve the image by manipulating the coefficients of transformation. The advantages of frequency-based image enhancement include low computational complexity, easy viewing and manipulation of image frequency and easy application of special transformed domain properties. The fundamental limitations include that it can not improve all image parts simultaneously and that it is also difficult to automate the image enhancement procedure. According to this paper, the current image enhancement techniques including spatial domain methods can again be categorized in two broad categories if the enhanced image contains high quality background information: point processing operations and spatial filter operations.

Image Enhancement and Analysis Techniques of Image Processing

The improvement in image is in fact the class of image processing operations whose aim is to produce a digital image that is more visually adapted for a human observer's visual examination.

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:**

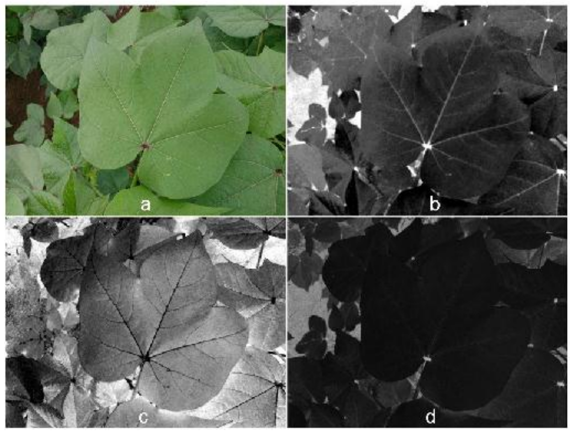
  Input = digital image (grey scale or color)

  Output = digital image (grey scale or color)

Conversion of RGB image into grayscale image:

Every pixel has a specific color in RGB images, which is represented as red, green, and blue. If each of these components has a range of 0–255, the total number of possible colors is

256 ^ 3. Such an image is a "block" of three matrices; the red, green and blue values for each pixel are represented. This means that 3 values correspond to each pixel. While in gray the pixel is a gray color, usually from 0 (black) to 255 (white). This range means that eight bits or one byte can represent that pixel. Other gray scale ranges are used, but they are generally 2.So, we can say that gray images take less memory space compared to RGB images.



a) Example of cotton leaf image. b) Grayscale image of channel a from L*a*b*.
c) Grayscale image of channel C from CMYK. d) Grayscale image of channel M from CMYK.

Two specific methods are available to transform RGB image to a gray image:

i. Average method:

The simplest average method. We just have to take three colors on average. Since it's a RGB image, we must ass its values r, g and b and then split it into 3 to obtain the desired gray scale. We can do that as follows:

Grayscale = (R + G + B / 3)

Original image Grayscale image

ii. Weighted method or method of brightness:

As the red color has more wavelengths than all three colours, and the green color has not only less wavelength than red but also the green colour. This method reduces the red color contribution and increases the green color contribution and puts the blue color contribution between the two colours.

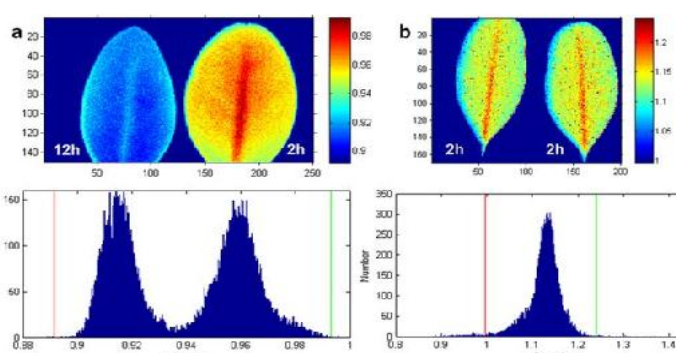
The formula is formed as:

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

Original Image   Grayscale image

Histogram, histographic equalization and improvement of contrast:

Histogram is the calculation of the distribution of likelihood of a given data form. An image histogram is a type of histogram that gives the tonal distribution of the gray values in a digital image graphic representation. Image histograms are an important tool to inspect images. The histogram form of an image provides us with useful information on the possibility to improve contrast. A narrow-form histogram shows a small dynamic range and corresponds to a low-contrast image. Histogram equalization is used to increase the image contrast which spreads the intensity values across the entire range. Equalization of histograms is used to improve contrast. Contrast is not always necessary in this. Many situations may be worse when histogram equalization occurs. The contrast is decreased in this case. Adjusting the contrast, changing overall lightness or darkness of the image. Contrast changes increase the perceptibility of objects in the scene by increasing the light difference between objects and their surroundings An expansion of the contrast enhances the light differences equally across the dynamic range of the image.



Linear image filtering:

A technique for the modification or enhancement of an image is filtering. You can, for instance, filter an image to highlight certain features and delete certain features. The sorting processing of images involves smoothing, sharpening and edge enhancement. Linear filtering is filtering where the value of an output pixel is a linear combination of the pixel values in the area around the input pixel. The noise is eliminated by adaptive filtering, often yielding better results than linear filtering. This adaptive filter is more selective, preserving edges and other high frequency parts of an image than a linear filter.

Analysis of thermal image:

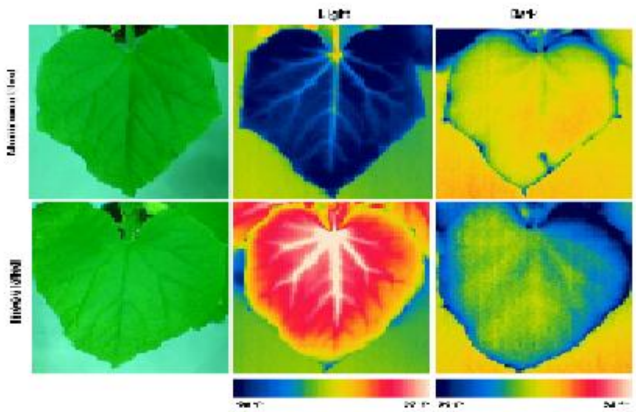
Thermal imaging is a method of enhancing object visibility in a dark environment by detecting the infrared radiation of the objects and creating an image based on that information.

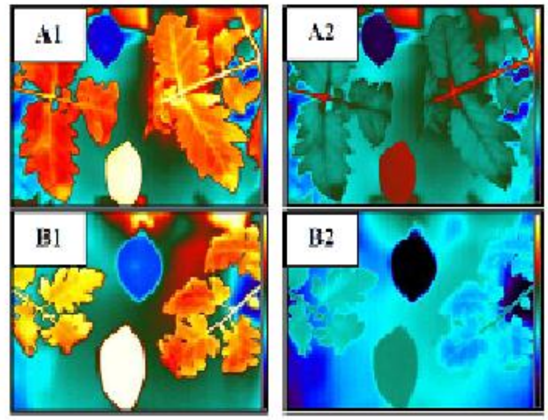
How thermal imaging is working:

Infrared energy (heat) is produced by all objects according to their temperature. The heat signature of the Infrared energy emitted by an object is known. The warmer an object is in general, the more radiation it emits. A thermal imager (also referred to as a thermal camera) is simply a thermal sensor that can detect minor temperature differences. The device collects Infrared radiation from objects in the scene and generates an electronic image based on temperature differences information. Because objects are never at exactly the same temperature as other objects around them, they can be detected by a thermal camera and are shown in a thermal picture.

Techniques of Wavelet

Wavelet analysis can reveal data aspects that other techniques of signal analysis miss aspects such as trends, breakdown points, discontinuities in higher derivatives, and self-similarity. In addition, as it provides a different view of data than traditional techniques, wavelet analysis can often compress or de-noise a signal without significant degradation. There are so many methods I have used to improve an image in this. I have applied enhancement methods to two thermal images:





Source:https://www.wur.nl/en/article/A-thermal-imaging-approach-for-dynamic-stomatal-response-and-phenotyping-of-three-tomato-genotypes.htm

Image fusion:

Image fusion is the process by which relevant information from two or more images can be merged into one single image. The resulting image is more informative than any image. The goal of image fusion is to combine information from several images of the same scene. The result of image fusion is a new image that is better suited to human and machine perception and to further image processing tasks like segmentation, extraction and object recognition. The main use of image fusion is the combination of the high-resolution panchromatic image in gray and the colorful multi-spectral image in low resolution.

For the following reasons, the wavelet-based approach is appropriate to perform fusion tasks:

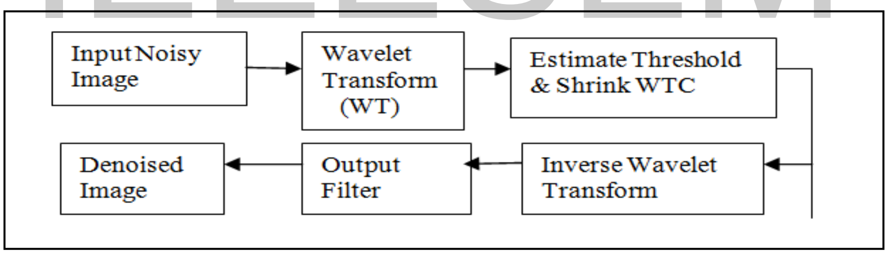
1. It is a multi-scale approach that is well adapted for the administration of the different object resolutions.
2. For years, several researchers have studied the representation of a signal in a multiscal (pyramid decomposition)
3. Have established that multiscale information can be helpful in a number of applications for image processing, including image fusion.
4. These coefficients from various images can be properly combined in order to obtain new coefficients to better collect the information in the original images.
5. Once the coefficients are fused, the final fused image is obtained by the inversely discreet transforming wavelets (IDWT). This preserves the information in the fused coefficients.

6. The fused image has a better quality than any other original image.

Denoising image:

Usually noise is not easily removed during image processing. According to the actual image characteristics, noise statistical property, and frequency spectrum distribution rules, many methods for eliminating noises have been developed, which are approximately divided into space and transformation domains. The space field is data operations carried out by the original image. The area of transformation is image transformation management and coefficients are measured after transformation. Then the aim of eliminating noise is to achieve reverse transformation, such as transformation of the wavelet. Successful use of wavelet transformation can minimize or even fully eliminate the noise effect.

- Apply wavelet transformation to the noisy signal to generate the noisy wavelet coefficients at the rate that can be separated properly for the PD case.
- To better minimize noise, select the right threshold limit at each threshold level and process (hard or soft thresholding).
- Inverse wavelet changes the threshold wavelet coefficients to obtain a denoted signal Block image denotation diagram with wavelet transform.



Compressed Images:

Images require a lot of storage space, wide bandwidth and long transmission time. The only way to improve these resource requirements is to compress images so that they can be transmitted more efficiently and decompressed by the processor. The intensity level (scales) of image processing is 256 gray. 0 is black, 255 is white. Each level has an 8-bit binary number which is 00000000 black and 111111111 white. An image may therefore be viewed as a pixel grid where each pixel can be interpreted as an 8-bit gray scale binary value."Image compression algorithms aims at removing redundancies in data in such a way as to allow image reconstruction. "Which basically means which image compression algorithms attempt to exploit redundancies in data; they measure that information should be preserved in order to By removing redundant data, the image can be represented in smaller numbers and therefore compressed. The redundancy and irrelevance reduction are two key components of the compression.

- Redundancy reduction is intended to remove duplicates (image / video) from the signal source.
- The elimination of irrelevance omits parts of the signal not detected by the signal receiver, namely the Human Visual System (HVS).

The results obtained from wavelet techniques are higher than image processing techniques. Comparative results The image is improved with wavelet techniques compared to image processing. Improving an image is simple by wavelet compared to image processing. The denoted image is also better and compressed image can be easily achieved by using a graphical user interface through a wavelet.

Conclusion

This paper highlights the successful use of wavelet-based thermal image analysis methods. While global thresholding can be successfully used in wavelet to compress images, it is difficult to find a global threshold that will produce nearly optimal results due to the difference between the different information sub-signals. Global thresholding results in unnecessary losses of energy in order to achieve a certain rate of compression.

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