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Enhanced the Infrared Image Using Wavelet Transform

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Abstract: - To Enhanced Infrared Image using Wavelet Transform, two enhancement algorithms namely spatial and spatiotemporal homomorphic filtering (SHF and STHF) have been given for enhancement of the far infrared images based upon a far infrared imaging model. The enhanced results with SHF are in general smoother than those with STHF, although STHF may reduce processing time greatly in comparison to SHF.In this paper an additive wavelet transform will be proposed for enhancement and filtration of homomorphic infrared images.

Key Words: - Infrared Images, Additive Wavelet transform, Homomorphic Image Enhancement.

I. INTRODUCTION

Infrared (IR) light is electromagnetic radiation with a wavelength longer than that of visible light, measured from the nominal edge of visible red light at 0.74 micrometers, and extending conventionally to 300 micromeres. These wavelengths correspond to a frequency range of approximately 1 to 400 THz, and include most of the thermal radiation emitted by objects near room temperature. Microscopically, IR light is typically emitted or absorbed by molecules when they change their rotational-vibrational movements. Sunlight at zenith provides an irradiance of just over 1 kilowatt per square meter at sea level. Of this energy, 527 watts is infrared radiation, 445 watts is visible light, and 32 watts is ultraviolet radiation.

A. CIE division scheme:

The International Commission on Illumination (CIE) recommended the division of infrared radiation into the following three bands:

IR-A: 700 nm–1400 nm (0.7 µm – 1.4 µm, 215 THz - 430 THz)

IR-B: 1400 nm–3000 nm (1.4 µm – 3 µm, 100 THz - 215 THz)

IR-C: 3000 nm–1 mm (3 µm – 1000 µm, 300 GHz - 100 THz)

B. Sub-division scheme

A commonly used sub-division scheme is:

a. Near-infrared:

0.75-1.4 µm in wavelength, defined by the water absorption, and commonly used in fiber optic telecommunication because of low attenuation losses in the SiO_2 glass (silica) medium. Image intensifiers are sensitive to this area of the spectrum. Examples include night vision devices such as night vision goggles.

b. Short-wavelength infrared

1.4-3 µm, water absorption increases significantly at 1,450 nm. The 1,530 to 1,560 nm range is the dominant spectral region for long-distance telecommunications.

c. Mid-wavelength infrared:

Also called intermediate infrared: 3-8 µm. In guided missile technology the 3-5 µm portion of this band is the atmospheric window in which the homing heads of passive IR 'heat seeking' missiles are designed to work, homing on to the Infrared signature of the target aircraft, typically the jet engine exhaust plume.

d. Long-wavelength infrared:

8–15 µm. This is the "thermal imaging" region, in which sensors can obtain a completely passive picture of the outside world based on thermal emissions only and requiring no external light or thermal source such as the sun, moon or infrared illuminator. Forward-looking infrared (FLIR) systems use this area of the spectrum. Sometimes also called the "far infrared."

e. Far infrared:

15 - 1,000 µm NIR and SWIR is sometimes called "reflected infrared" while MWIR and LWIR is sometimes referred to as "thermal infrared." Due to the nature of the blackbody radiation curves, typical 'hot' objects, such as exhaust pipes, often appear brighter in the MW compared to the same object viewed in the LW.

Images received through various infrared (IR) devices in many applications are distorted due to the atmospheric aberration mainly because of atmospheric variations and aerosol turbulence [1], [2]. In the dissertation work, new algorithmic strategies have been presented to enhance the visual quality of IR images. The idea is to model the IR image pixels as an input output system with IR image as the input and a "similar" optical image as the output. The image modeling is carried out using the usual system identification strategies. The system identification problem is to estimate a model of a system based on observed input-output data.

Several ways to describe a system and to estimate such descriptions exist and are being used in various applications. The identification process amounts to repeatedly selecting a model structure, computing the best model in the structure, and evaluating this model's properties to see if they are satisfactory. The cycle can be itemized as follows [3], [4].

Design the experiment to collect input-output data from the system to be identified.

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Select and define a model structure (a set of candidate system descriptions) within which a model is to be found.This would mean the order and number of unknown coefficients be identified and tuned to fit the data.

Compute the best model in the model structure according to the input-output data and a given criterion of fit. In other words, fine tuning the coefficient values to get the most optimal values under a given optimality criterion.

If the model is good enough, then stop; otherwise, go back to Step 3 to try another model set. Possibly also try other estimation methods.

The enhancement of infrared images is slightly different from traditional image enhancement in dealing with the large black areas and the small details. So, our suggested approach aims at separating the details in different subbands and processing each subband, separately. We have found that the additive wavelet transform is a powerful tool in image decomposition. If the infrared image is decomposed using the additive wavelet transform, the details can be separated into the higher frequency subbands. Also, we use the homomorphic enhancement algorithm for transforming these details to illumination and reflectance components. Then, the reflectance components are amplified showing the details, clearly. Finally a wavelet reconstruction process is performed to get an enhanced infrared image with much more details.

II. LITERATURE REVIEW & RELATED WORK

Dim target detection is particularly challenging because standard techniques such as spatial thresholding, CFAR detection, and edge detection can fail due to the lack of contrast between target and background. To detect targets in clutter, there must be a set of characteristics that can be exploited to separate targets from clutter. Separation can be based on characteristics such as scale, shape, texture, pixel value dynamic range, pixel value statistical distribution, spatial frequency, brightness, and contrast differences.

Qi, H. and J. F. Head [1] suggested that Wavelets have demonstrated some effectiveness for target detection. Traditionally, there are four primary applications of wavelet-based methods to target detection: These are Wavelets as edge detectors;

Using wavelets to separate targets from clutter based on scale differences;

Using wavelets as approximate matched filters;

Capturing target dynamic range differences using wavelet filters.

A prior knowledge of target or clutter characteristic scales may be exploited. Wavelet coefficients containing significant energy at clutter scales (or non-target scales) may be filtered out. Andreone, L., P. C. Antonello and M. Bertozzi [5] stated that wavelets can be also designed to function as approximate matched filters. For such usage, wavelet filters are designed to produce a large response when matched against a target region. Lastly, the low and high pass filters from the wavelet decomposition can be used to detect target regions of low or high pixel value dynamic range. Dim targets occur in low dynamic range regions; regions of high dynamic range can be rejected. Image enhancement is a very popular field in image processing. Enhancement aims at improving the visual quality of an image by reinforcing edges and smoothing flat areas. Several researchers have evaded this field using different approaches such as simple filtering, adaptive filtering, wavelet denoising, homomorphic enhancement etc. All these approaches concentrate on reinforcing the details of the image to be enhanced.

Infrared image processing is a new field emerging for the evolution of night vision cameras. It also has applications in thermal medical imaging. This evolution of night vision cameras has encouraged the research in infrared image enhancement for information extraction from these images. These images have a special nature of large black areas and small details due to the absence of the appropriate amount of light required for imaging. So, the main objective is to reinforce the details to get as more image information as possible.

III. ANALYSIS OF PROBLEM

Images received through various infrared (IR) devices in many applications are distorted due to the atmospheric aberration mainly because of atmospheric variations and aerosol turbulence [1].

The night vision cameras have encouraged the research in infrared image enhancement for information extraction from these images. These images have a special nature of large black areas and small details due to the absence of the appropriate amount of light required for imaging. So, the main objective is to reinforce the details to get as much details as possible. The system identification problem is to estimate a model of a system based on observed input-output data. Several ways to describe a system and to estimate such descriptions exist and are being used in various applications. Here we are going to Enhance the images generated by various Infrared Devices those Images are having very less information by enhancing these images we will get more and more information, for enhancement we will use Additive Wavelet Transform Algorithm and Homomorphic Enhancement algorithm by using these algorithm we can enhance the images .

A. *Additive Wavelet Transform Algorithm:*

The additive wavelet transform decomposes an image into subbands using the “a’ trous” filtering approach [6–8] in several consecutive stages. The low pass filter used in this process has the following mask for all stages :

$$H = 1/256 \begin{bmatrix} 1 & 4 & 6 & 4 & 1 \\ 4 & 16 & 24 & 16 & 4 \\ 6 & 24 & 36 & 24 & 6 \\ 4 & 16 & 24 & 16 & 4 \\ 1 & 4 & 6 & 4 & 1 \end{bmatrix} \quad ....(1)$$

Each difference between filter outputs of two consecutive stages is a subband of the original image. We can use these subbands for further processing using homomorphic enhancement.

B. *Homomorphic Enhancement Algorithm:*

An image can be used represented as a product of tow components as in the following equation

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$f(n1,n2)=i(n1,n2)r(n1,n2)$ …(2)

Where $f(n1, n2)$ is the obtained image pixel value, $i(n1, n2)$ is the light illumination incident on the object to be imaged and $r(n1, n2)$ is the reflectance of that object. It is known that illumination is approximately constant since the light falling on all objects is approximately the same.

The only change between object images is in the reflectance component. If we apply a logarithmic process on Eq. (2), we can change the multiplication process into an addition process as follows:

$\log(f(n1, n2)) = \log(i((n1, n2)) + \log(r(n1, n2))$ …(3)

The first term in the above equation has small variations but the second term has large variations as it corresponds to the reflectivity of the object to imaged. By attenuating the first term and reinforcing the second term of Eq. (3), we can reinforce the image details.

IV. PROPOSED WORK AND OBJECTIVES.

A. *Proposed Work:*

In the proposed dissertation work infrared image enhancement using additive wavelet transform will be implemented. The dissertation work will be carried out in following steps.

a. *Analysis of available infrared image enhancement algorithms:*

In this Step we will analyse the input Infrared images which we have to enhance and after analysis we have to follow next step that is step 2

b. *Decomposing the infrared image into various bands using additive wavelet transform:*

In this step we will decompose the infrared image into four subbands $p3$, $w1$, $w2$ and $w3$ using the additive wavelet transform and the low pass mask of Eq. (1).

c. *Extracting illumination and reflectance components of each subband:*

In this step we will Extract Illumination and Reflectance component of each subbands generated in the step 2 by doing Additive Wavelet Transposition, We will call this process as Homomorphic Enhancement Processing.

d. *A Reinforcement operation:*

In step 4 we will do the reinforcement of the components, obtained after homomorphic processing, the reflectance component in each subband and attenuation operation of the illumination component from the Homomorphic processing.

e. *Reconstruction of separated bands*

In step 4 we will do the Reconstruction of separated bands from its illumination and reflectance using addition and exponentiation processes. As shown in equation 3 where all the sub bands, w'_1, w'_2,w'_3 and p_3 are added which will give $f'(n_1,n_2)$.

f. *Inverse wavelet Transform:*

Finally, by applying inverse additive wavelet transform on the obtained subbands by adding components after Homomorphic Processingwe will get the new enhance image having more generative information.

V. CONCLUSION

I will give the new approach for infrared image enhancement. This approach will combine both of the Homomorphic Enhancement and the wavelet transforming algorithm's features.

The homomorphic processing is applied to the infrared image subbands, separately. Then, these subbands are merged again to reconstruct an enhanced image. The results obtained using this algorithm reveal its ability to enhance infrared images.

The newly generated image will be having an efficient information which is essential to the user.

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