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Resoluting multispectral image using image fusion and CNN model

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***Abstract*---**This paper mainly focus on multispectral image for Entertainment purpose, with such application the quality of the image is an important factor that affects the accuracy of the recognition. Due to hardware limitation, multispectral imaging device may fails to generate high resolution (HR) image. In order to overcome the issue, here we proposes multispectral image super-resolution algorithm (MISR), by fusing low-resolution (LR) multispectral images. In this algorithm the computed response function is used to fuse the multiple images into a single high dynamic range radiance image. It deals with the radiance of the images by mapping. The referred algorithm solves the pre-processing and registration. It uses CNN model to fuse the multiple images into a single high dynamic range image. This fusing technique establishes the common points in the image. Experimental results validate that the MISR algorithm outperforms the state-of-the-arts in terms of both reconstruction accuracy and computational efficiency.

***Keywords*---**Multispectral image, LR image, RGB image, Normalization, Resizing, Registration, Corner and edge detection, Fusion.

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Introduction

Multispectral image is one that captures image data within specific wavelength ranges across the electromagnetic spectrum for applications in remote sensing, biomedicine, agriculture, medical imaging, spectral imaging, detect and track military targets etc. It contains band of spectral images. The multiple images of the same scene are captured with different layers, the images that are captured will be of low resolution in which, there will be some loss of information in each image. The main objective of this project is to get a high resolution multispectral image by fusing low resolution multispectral images.

Figure 1 depicts a hybrid imaging system. The multispectral imaging system includes lens, monochrome camera and tunable filter module. Monochrome photography is photography where each position on an image can record and show a different amount of light, but not a different hue. It includes all forms of black and white photography. Tunable filter is an optical fibre that uses liquid crystal elements to transmit a selected wavelengths of light and exclude others.

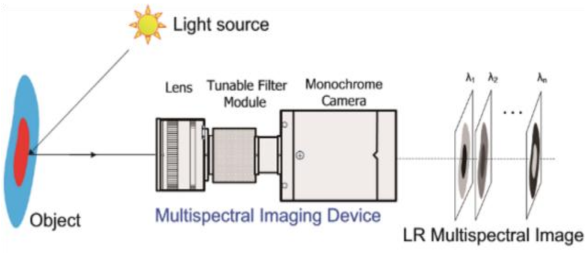

Figure 1. Schematic diagram of the hybrid imaging system

The LR image is spatially degraded by gaussian blur and down sampling operations, provided that the monochrome camera has the linear response function. The gaussian blur models the point spread function of image sensor in high spatial resolution. The RGB image is spectrally degraded with the effect of spectral sensitivity function. This paper proposes a multispectral image resolution to reconstruct the target HR multispectral data with unknown SSF via fusing of multispectral images. In the algorithm first helps to reduce the noise by using gaussian filter under the constraints of monotonicity and smoothening. The linear relationship will remain in the two multispectral images.

Multispectral image is of low resolution and contain less information. To overcome this issue, we use MISR algorithm where, it contains edge detection process which identify points in a digital image at which image brightness changes more formally. In order to extract certain kinds of features and infer the contents of an image corner detection is used. It finds the strongest corner in the image by harries corner detection. Then the registration process is done to align the two or more images of the same scene. The process is followed by image fusion where this process is to combine relevant information from two or more images into a single image. A weighted matrix defines the edge structure by a statistical model and doesn't allow manual setting parameter. It demonstrates the effect of edge structure presentation by fusing MISR algorithm with the wTV.

Super resolution algorithm with wTV recovers the edge well when using a bright and dark RGB image. The main contribution of this paper includes:

(1) A MISR algorithm is proposed to increase the resolution of multispectral image by fusing LR images.
(2) This algorithm helps to remove the noise from the image so that we can get a better quality of the image.
(3) The edges of the HR multispectral images are well preserved while LR images are corrupted by noise.
(4) It introduces a registration framework which is applicable for both unimodal and multimodal images.
(5) It helps to improve the computational efficiency.

Related work

Non negative spare promoting framework to integrate the hyper spectral and RGB data a high-resolution hyper spectral set of data [1]. But the problem is in the form of spare non-negative matrix factorization with knowledge on the spectral and spatial transform responses. Acquiring high-resolution hyper spectral images by jointly using a high resolution RGB camera with a low-resolution hyperspectral camera [2]. Here only eight examples are used in the database and their simulated RGB images. A MSDA algorithm is proposed to train the relationship between HR and LR image patterns, which can be represented by DNN [3]. The HR/LR image patches only sample from HR/LR PAN images respectively without requiring other training images. Recovering camera spectral sensitivities using regular reflective colour targets from a single image with and without knowing the illumination [4]. Camera spectral sensitivity method is applicable only in a laboratory setting with a time-consuming scanning over the wavelength range of interest. This measure is based on the key assumption that the gradient of difference between two aligned band images [5]. Sparser than that between two misaligned ones. But it fails in periodic pattern images and the proposed method only it work for affine transformation. This paper focuses on hyper spectral image (HSI) with low spatial resolution but high spatial resolution (HR) is fused with a multispectral image with high spatial resolution but low spatial resolution to obtain HR HIS [6]. This work is only supported in part by NASA NNX12CB05C and NNX16CP38P. Here they proposed a fast multiband image fusion method based on an explicit solution of a Sylvester equation [7]. But it should incorporate learning of the subspace transform matrix into the function scheme. Due to space limitation only the gaussian prior is considered in this experiment. A paper proposes a deep network architecture for the pan sharpening problem called Pan Net [8]. They incorporate domain-specific knowledge to design the pan Net architecture by focussing on the two aims of the sharpening. Here they have used two sharpening which are spectral and spatial presentation. For these two they introduce a technique called spectral mapping and sampling. Disadvantage of this paper is that they got only a better image reconstruction not an image result. Hyperspectral image sharpening which aims at fusing an observation low spatial resolution image with a high resolution multispectral image of the same scene [9]. This paper proposes a deep HIS sharpening method for the fusion. The main disadvantages of this paper is that they have used CNN to learn general priors whereas, it is necessary to discover CNN with different architectures which improves performance. The paper deep hyperspectral image sharpening is based on two multispectral images which are high and low spatial resolution of same scene [10]. Which are usually sensitive to the parameters selection and time consuming and it has a fusion problem. To provide detailed maps of urban land cover, high resolution hyperspectral data is used [11]. In order to provide such maps, both accurate and precise classification of need, they are improving a mapping accuracy in urban areas by spatial analysis. They used a DAIS system with analysing reference parameters. Disadvantage in this paper is that they have used less principal component to improve the data. Fusing a low spatial resolution hyper spectral data with a high spatial resolution multispectral data has been recognized as an economical approach for obtaining HSR hyperspectral data [12]. The coupled nonnegative matrix factorization has been reported that can yield high quality fused data. The main drawback of this paper is CNMF fused data have little spectral distortion. Filtering images of more than one channel is challenging in terms of both efficiency and effectiveness [13]. Transform domain methods have been widely used in colour and multispectral image (MSI) denoising. Removing a noise from image is to reconstruct the original image and pressure useful information. Non local similarities and linear representation do not change after block circulant operation. Fusing a low spatial resolution hyper spectral image with high spatial resolution multispectral image to obtain a high spatial resolution hyperspectral image has attracted increasing interest years [14]. Here they proposed a coupled spares tensor factorization based approach for fusing such images. But this method still outer performs the other methods in noisy case. The aim of this research is to infer all the spectral bands, of multi resolution sensors, in the highest available resolution of the sensor [15]. They formulated this problem as a minimization of a convex objective function with an adaptive regularize. In a series of experiments with simulated data, we obtain results that outperform state-of-the-art, while showing competitive qualitative results on real Sentinel-2 data. It is dependent on the object size in the input image, so its performance may change across with different object scales. Founded super resolution mapping is an effective technique in mapping flood inundation for multispectral remote sensing image [16]. However, the traditional super resolution flood inundation mapping (SRFIM) is unable to fully utilize the spectral information from multispectral remote sensing image band. In order to resolve this problem, a novel SRFIM by supplying more spectral information (SRFIM-MSI) is proposed to improve mapping accuracy. The disadvantage in this paper is sometimes the spatial resolution of multispectral image is coarse in pursuit of high temporal resolution. Moreover, severe weather during flooding brings great difficulty in collecting multispectral images, resulting in coarse spatial resolution in multispectral images. These problems usually result in the mixed pixels. Super-resolution (SR) produces a high resolution (HR) image using either a single or multiple low resolution (LR) input image(s) of the same scene [17]. Sparse representation techniques are effectively applied for image SR because of their high reconstruction accuracy this paper demonstrates a sparse representation based coupled over complete dictionary training and SR procedure for LR multispectral images. This technique is applicable only for minor region of the image. It gives the importance and accuracy only for the sparse region not for the whole image. Image fusion combines data from different heterogeneous sources to obtain more precise information about an underlying scene. Hyperspectral-multispectral (HSMS) image fusion is currently attracting great interest in remote sensing since it allows the generation of high spatial resolution

HS images, circumventing the main limitation of this imaging modality. Existing HS-MS fusion algorithms, however, neglect the spectral variability often existing between images acquired at different time instants. This time difference causes variations in spectral signatures of the underlying constituent materials due to different acquisition and seasonal conditions. This paper introduces a novel HS-MS image fusion strategy. This method is only useful in a remote sensing areas then it will become fail in the circumstances of the areas.

Proposed Methodology

By referring the papers mentioned in chapter [2], we found some drawbacks in the algorithms used so far. To overcome those issues we are going for MISR algorithm.

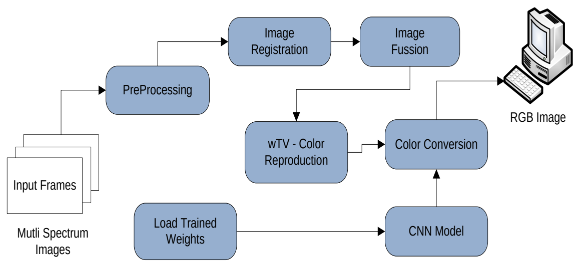

Figure 2. Architecture of proposed methodology

Multi spectral image super resolution (MISR) algorithm, which is used to construct the HR images from observed LR images. This algorithm is used in surveillance, forensics, medical and satellite imaging. This methodology is used to overcome the drawback of all literature survey papers.

Pre-processing
Pre-processing consists of normalization and image resizing.

Normalization
The RGB image is spectrally degraded with the effect of spectral sensitivity function (SSF). The SSF integrates spectral reflectance into RGB triplets. In the algorithm, SSF are solved alternately by keeping the relationship between the acquired multispectral and RGB image. The SSF are computed under the constraints of monotonicity and smoothness respectively. A normalization is the process of changing the range of pixel intensity values. The purpose of using this to bring the image or other type of signal into a range that is normal to the scene.

Resizing
Changing the size of the image without changing the amount of data in that image is called resizing. Edge detection and Corner detection are done here, Edge

detection
Identifying points in a digital image at which image brightness changes sharply or more formally, has discontinuities. The points at which image brightness changes sharply are typically organised into a set of curved line segments termed edges.

Corner detection

Corner detection is an approach used computer vision systems to extract certain kinds of features and infer the contents of an image. It finds the strongest corner in the image by Harris corner detection. A combined corner and edge detector it is called a Harris corner detection.

Image registration

It is the process of aligning two or more images of the same scene is called image registration. It is a process of transforming different sets of data into one coordinate system. Registration is necessary in order to be able to compare or integrate the data obtained from different measurements. Mapping is nothing but a transformation in which the image coordinates are transformed and it helps to overcome issues such as image rotation, scale, and skew that are common when overlapping the image. It helps in remote sensing areas like process of transforming different sets of data into one coordinate system. Data may be multiple photographs, data from different sensors, times, depths, or viewpoints and also used in computer visions, military automatic target recognition, and compiling and analysing images and data from satellites

Image Fusion

Image fusion is the process of combining relevant information from two or more images into single image. The resulting images will be more informative than the input image. Image fusion is necessary because multi sensor data fusion has become a discipline which demands more general formal solutions to a number of application cases.in several situations in image processing require both high spatial and high spectral information in a single image.

wTV - color reproduction the weights definition describes the edge structure by a statistical model and doesn't allow manual setting parameter.
Demonstrates the effect of edge structure preservation by fusing algorithm and the SRIF algorithm with the wTV. MISR algorithm with the wTV recovers the edge well when using a bright and dark RGB image.

Color conversion

The process of converting color image into grayscale image is called color conversion. Where 24 bit of RGB is converted into 8 bit of grayscale values.

CNN model

One of the most popular deep neural network is a Convolutional neural network It is a class of deep feed forward artificial neural network that are applied to analysing visual imagery. Neural network with a convolution operation instead of matrix multiplication. Convolution is easy because of its sparse connectivity parameter sharing and equivalent representations. CNN are usually composed by a set of layers that can be grouped by their functionalities. CNN has multiple layers including convolution layer, non-linearity layer, pooling layer and fully connected layer. The convolution and fully connected layers have parameters but pooling and non-linearity layers don’t have parameters. It’s a deep learning convolution neural networks if the intensity range of the image is 50 to 180 and the desired range is 0 to 255. The process id done by subtractin50 from each of pixel intensity by making the range 0 to 150. Then each pixel intensity is

multiplied by 255/130, making the range 0 to 255.the this CNN is used to make a final fused image to an enhanced image. This CNN output image makes the image to get a clear scene of full informative. Then the output of CNN PSNR is higher than the other methodology of in the paper.
PSNR: Peak signal to noise is the ratio between the maximum possible power of signal and the power of corrupting noise that effects the fidelity of its representation

Algorithm Implementation

In the above flowchart mentioned in Figure 3, initially we took the multispectral images of two different wavelength from CAVE dataset, which is undergone normalization by applying spectral sensitivity function, which are then processed for finding corners in the image.

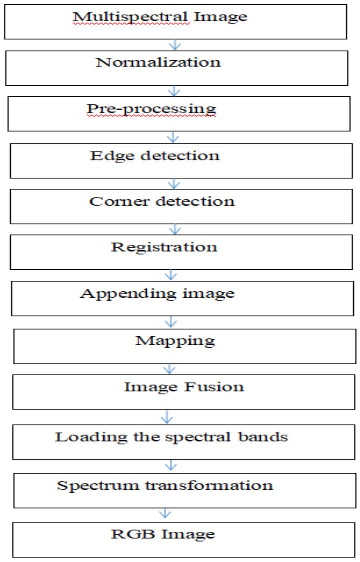

Figure 3. Algorithm Implementation

These images are read separately and key points are found by using SIFT function. Later we appended these two images by using apped keyword in Matlab. Now after appending, mapping is performed between these two images. Then the second image is transformed by applying affline transform. Now by registering first and transformed second image we will get the final registered image.

The input images are taken from the CAVE dataset. The dataset consists of 32 scenes. Each scene has an associated zip file. These zip files include full spectral resolution reflectance data 400nm to 700 nm at 10nm steps (31 band total). Each band is stored as a 16 bit greyscale PNG image. Each scene also consists a single representative color image.

Figure 4. CAVE dataset

A multispectral image is one that captures the image data within specific wavelength ranges across the electromagnetic spectrum. It consists of a band of images which are of LR gray scale image. Multispectral imaging measures light in a small number of spectral band and radiation that’s inherent to an object, regardless of the presence of any external light source. Cave dataset consists of 32 images, from those images one is chosen which consists of 31 different spectral band images which are of grey scale of size 512*512 in .png format.

The particular file content is read through Load HSI( ). In this function images are read mentioning the directory and image folder name. This image folder consists of 31 different band files. Each band represents particular colour spectrum representation. These images are read through imread( ). All the images read are stored in particular array.

The RGB image is spectrally degraded with the effect of spectral sensitivity function (SSF). The SSF integrates spectral reflectance into RGB triplets. In the algorithm, SSF are solved alternately by keeping the relationship between the acquired multispectral and RGB image. The SSF are computed under the constraints of monotonicity and smoothness respectively. Spectral sensitivity is the relative efficiency of detection of light or the signal, as a function of the frequency or wavelength of the signal. spectral sensitivity is the relative efficiency of detection of light or other single, as a function of the frequency or wavelength of the single, in a photography, film and sensors are often described in terms of their spectral sensitivity, to supplement their characteristic curves that describe their responsivity. Load HSI ( ) returns max value, normalized value and total size.

Pre-processing is done using pre-process( ). As a built in pre-requisite for feature detection , the input image is sharpened by Laplace filter which is of 3*3 filter. This is done by applying filter to image and subtracted with original image. In sharpened images the edges and other features of the images are going to be enhanced.

Identifying points in a digital image at which image brightness changes sharply or more formally, has discontinuities. The point at which image brightness changes sharply or typically organised into a set of curved line segments termed edges. To get minor edges canny method differ from the other ends detection methods in that it uses two different thresholds to detect strong and weak edges and includes the week edges in the output only. If they are connected to strong edges, this method is less likely affected by noise and more likely to detect true week edges. In order to implement the canny edge detector algorithm, a series of steps must be followed. Firstly smooth the image with a Gaussian filters. Then compute the gradient magnitude and orientation using finite-difference approximations for the partial derivatives. After that apply non maxima suppression to the gradient magnitude. Then use the double threshold algorithm to detect and link edges.

Corner detection is an approach used within computer vision systems to extract certain kinds of features and infer the contents of an image. It finds the strongest corner in the image by Harris corner detection. A combined corner and edge detector it is called a Harris corner detection. It basically finds the difference in intensity for a displacement of (u,v) in all directions. Corners can be interpreted as a junction of 2 edges , where edge is a sudden change in image brightness.Canny edge detection: In order to implement the canny edge detector algorithm, a series of steps must be followed. The Canny Edge Detection Algorithm has the following steps [8]. Firstly smooth the image with a Gaussian filters. Then compute the gradient magnitude and orientation using finite-difference approximations for the partial derivatives. After that apply non maxima suppression to the gradient magnitude. Immosaic( ) function is used for image registration . The process of aligning two or more images of the same scene is called image registration. It is a process of transforming different sets of data into one coordinate system. Registration is necessary in order to be able to compare or integrate the data obtained from different measurements. Mapping is nothing but a transformation in which the image coordinates are transformed. SIFT( ) is used for finding corresponding points based on invariant features. Sorting the key points is done by taking the inverse cosine( ) . New image is created using append( ).Mapping is also known as a transformation. In spatial transformation, the image co-ordinates are transformed. Which makes the pixels to move in different locations. In intensity transformation, the image intensity values are being transformed. Histogram equalization is one of the example for this type of transformation. The Euclidean distance is the straight line distance between two pixels and is evaluating using the Euclidean norm. RANSAC ( ) is used to find the homography matrix. The process of combining relevant information from two or more images in to a single image. The resulting image will be more information than the input image. It is designed to combine many input images into a fused image wherein, the expected output should contain more information for human or machine perception when compared to any of the input images. The output image contains all the necessary information. The purpose of image fusion is not only for reducing the amount of data but also can construct images that are more appropriate and understandable. Image fusion is done to get an image with high spatial and spectral resolution. Images of same scene are taken at different time. The original image can be divided into regions such that every region is in focus in at least one channel. Identify the regions and combine them together. Each image consists of true part and degradation part, which can be removed by fusion. CNN is a neural network with a convolution operation instead of matrix multiplication in at least on of the layers.CNN is a class of deep feed forward ANN that are applied to analysing visual imagery. The advantage of CNN compare to its predecessors is that it automatically detects the important features of without any human supervision. Spectrum transform( ) is used for loading the RGB color bands. By considering normal grey image and RGB color bands are read and by using SRCNN model base colour image is generated.

Discussion

It uses CNN model to fuse the multiple images into a single high dynamic range image. This fusing technique establishes the common points in the image. Experimental results validate that the MISR algorithm outperforms the state-of-the-arts in terms of both reconstruction accuracy and computational efficiency.

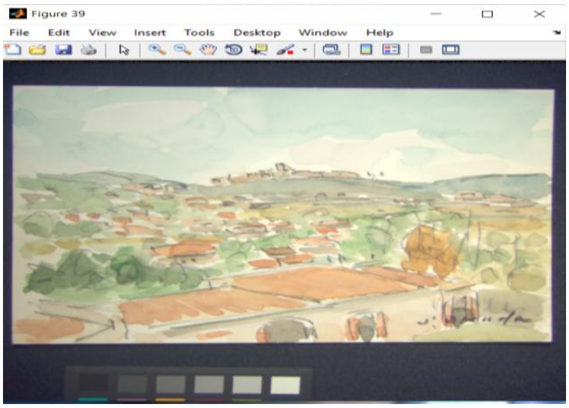

Figure 5. RGB Image Generated

Conclusion

This paper proposes a multispectral image super resolution algorithm, known as SRIF, in order to improve the spatial resolution of multispectral image. The multispectral LR images are fused and got a HR multispectral image. Then the wTV operator is used to keep recovered edge structure. Experimental results validate that MISR algorithm performs better than the state-of-the-arts in terms of both reconstruction accuracy and computational efficiency. The obtained results systematically outperform the competitors, providing experimental evidence of the effectiveness of the proposed MISR method.

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