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RGB Image Fusion and Radiometric Calibration: Survey & Discussions

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ABSTRACT

Feature based image fusion is new area of research in the field of image fusion. The image fusion used lower content of image feature. The lower content of image feature such as color texture and dimension. The texture features are very important component of image. the processing and extraction of texture feature used various transform function such as wavelet transform function Gabor transform function and many more signal based transform function. In the process of image fusion involve two and more image for the process of fusion. In this paper we present the survey for the various image fusion techniques and the quality of an image and image restoration.

Keywords: Image Reconstruction, Image Fusion, High Resolution, Red Green Blue, Discrete Wavelet Transform, Feature extraction, Multi-resolution.

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INTRODUCTION

Multispectral imaging acquires spectral information of scenes and has been a promising tool for applications in biomedicine, remote sensing, colour reproduction, and etc. Although multispectral imaging can achieve high spectral resolution, it has the limitation of low spatial resolution when compared with general RGB cameras [1]. the coverage from the High Resolution Stereo Camera(HRSC) on the European Space Agency's Mars Express is sufficient to begin constructing mosaic products on a global scale. HRSC is a multi-sensor push broom instrument comprising nine CCD line sensors to acquire multi- angle and colour images of the Martian surface [2].

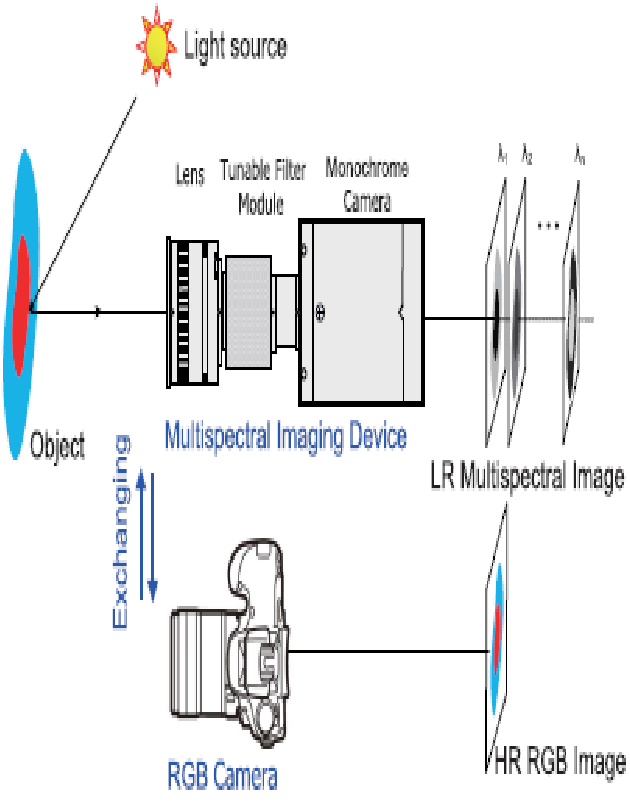
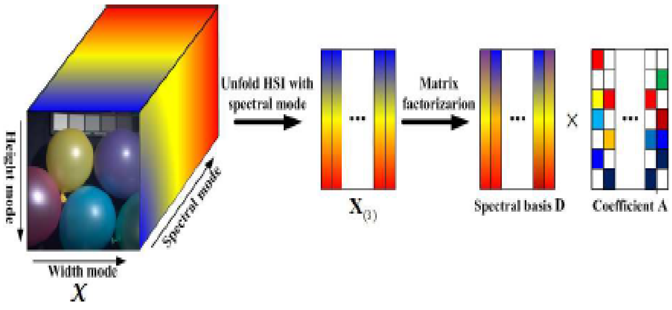


Figure 1: Diagram of the hybrid imaging system.

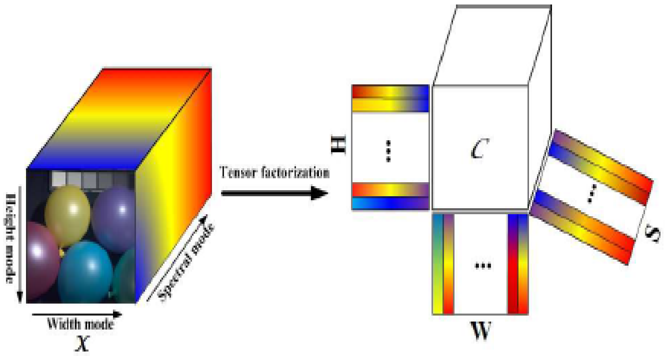
Hyper spectral imaging based on space borne or airborne imagery has strong potential for applications in remote sensing because each pixel of the hyper spectral data, which are composed of a continuous spectral profile, includes a detailed description of the spectral features of the image. These descriptions allow for an analysis of the specific differences in the characteristics of the earth's surface.

Several satellites based hyper spectral sensors, such as the Hyperion spectrometer of the National Aeronautics and Space Administration (NASA), and various airborne sensors, including the Airborne Imaging Spectrometer for Applications (AISA), Compact Airborne Spectrographic Imager (CASI), and HyMap, are currently available. Image resizing is one of the most common image operations. Almost all display and editing software employs this operation. This is necessary for example when we adapt images to displaying devices of different dimensions, when we want to explore in more details some regions of the image (e.g. in visual surveillance), when we want to map image textures to 2D/3D shapes, to name a few. The down sampling of images usually does not pose a challenge, a suitable linear pre-filtering technique doing the job [5].

Hyper spectral imaging has been recently applied in many computer vision tasks, including the tracking, face recognition and segmentation. However, hyper spectral images (HSIs) usually have abundant spectral information, but limited spatial resolution due to hardware restrictions. On the contrary, the high-resolution (HR) gray images and multispectral images (MSIs) with much less spectral bands can be easily obtained by current imaging sensors. To enhance the spatial resolution of the HSI, the low-resolution (LR) HSIs are generally fused with these HR images [7].



(a) Matrix factorization based HR-HSI decomposition.



(b) Tensor factorization based HR-HSI decomposition.

Figure 2: Illustration of the traditional matrix decomposition and tensor decomposition of the HR-HIS.

To obtain HSS data, plenty of resolution enhancement methods can be found in literature. Under certain circumstances, auxiliary information can be hard to acquire, and single image super-resolution aims to reconstruct high spatial resolution data from low-resolution HS images. The basic approach through traditional interpolators was simple and fast, but it did not enhance the details. Various regularization-based methods were proposed to solve such an ill-posed problem including total variation regularization, sparse representation, and self-similarity grouping .The introduction of regularization terms can preserve the edges and textures, so better performances were realized during the super-resolution process [11].

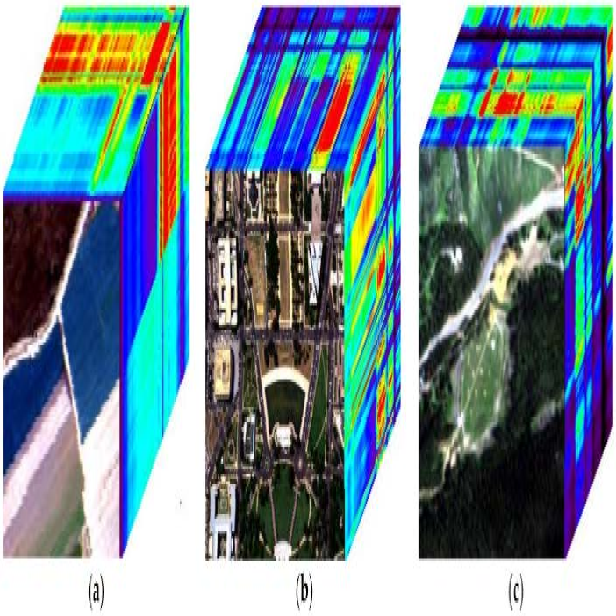


Figure 3: Experimental Reference Datasets: (**a**) hyper spectral image of Salinas; (**b**) hyper spectral image of Washington D.C.; (**c**) hyper spectral image of Montana.

In general, radiometric calibration of optical remote sensing instruments could be conducted with the combined efforts during pre- and post-launch periods, including laboratory, on-board and vicarious/cross calibration methods. The laboratory calibration takes advantage of a controlled environment, where the responses of detectors could be calibrated using external stable illumination sources. On-board standard calibrators enable calibrations to be performed with high-temporal frequency, such as the solar calibrators for TM (Thematic Mapper) /ETM+ (Enhanced Thematic Mapper) and solar diffusers for MODIS (Moderate Resolution Imaging Spectro-radiometer) [13].

A spectral resolution enhancement method (SREM) for remotely sensed MSI has been introduced using auxiliary multispectral/hyper spectral data [9]. In this method, a number of spectra of different materials is extracted from both the MSI and HSI data. Then, a set of transformation matrices is generated based on linear relationships between MSI and HSI of specific materials. In a computationally efficient algorithm for fusion of HSI and MSI based on spectral un mixing (CoEf-MHI) is described. The CoEf-MHI algorithm is based on incorporating spatial details of the MSI into the HSI, without introducing spectral distortions [14].

The rest of this paper is organized as follows in the first section we describe an introduction of about the image fusion and RGB color model. In section II we discuss about the radiometric calibration overview, In section III we discuss about the related work, their comparative study. Finally in section IV we conclude and discuss the future scope.

II RADIOMETRIC CALIBRATION

The aim of radiometric calibration is to correctly convert raw data into physically-meaningful reflectance values, while removing deviations caused by the hyper spectral sensor itself and the atmosphere. Raw data from hyper spectral imaging sensors contain information about the interaction of solar radiation with the atmosphere, the Earth's surface and the imaging sensor and they are significantly affected by these environmental conditions and sensor characteristics. Accurate radiometric calibration of hyper spectral imaging data is necessary to improve the consistency of datasets from different sources and to perform quantitative remote sensing analyses by reducing spatiotemporal variability in environmental and instrumental effects. Radiometric calibration can be achieved by physically or empirically-based methods. In low-altitude applications, a linear approximation is feasible for generating reflectance products [15].

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III RELATED WORK

[1] This paper proposes a multispectral image super-resolution algorithm, referred as SRIF, by fusing the low-resolution multispectral image and the high-resolution (HR) RGB image. It deals with the general circumstance that image intensity is linear to scene radiance for multispectral imaging devices while is nonlinear and unknown for most RGB cameras. The SRIF algorithm first solves the inverse camera response function and a spectral sensitivity function of RGB camera, and establishes the linear relationship between multispectral and RGB images. Then the unknown HR multispectral image is efficiently reconstructed according to the linear image degradation models. Meanwhile, the edge structure of the reconstructed HR multispectral image is kept in accordance with that of the RGB image using weighted total variation regularizer. The effectiveness of the SRIF algorithm is evaluated on both public datasets and our image set. Experimental results validate that the SRIF algorithm outperforms the state-of-the-arts in terms of both reconstruction accuracy and computational efficiency. [2] In this paper, they described their systematic processing procedure and, in particular, the technique used to bring images affected by atmospheric dust into visual consistency with the mosaic. They outlined how the same method is used to produce a relative colour mosaic which shows local colour differences. They demonstrated the results and show that the techniques may also be applied to images from other orbital cameras. [3] In this paper, their work takes one of the most successful instruments in remote sensing, MODIS, and demonstrates, through geo-statistical techniques, that the role of the spatial patterns of the spectral bands can effectively improve image selection in a complex (for climate, relief, and vegetation and crop phonology) region of 63;700 km2. The results show that band 01 (red) is the preferred one, as it achieves a 13% higher success than when only using quality bands criteria: a 94% global accuracy (66 true classifications, and only four omissions and one commission error). A second, important finding, is that the geo-statistical selection improves results when using any band, except for band 02 (NIR1), this makes their proposal potentially useful for most remote sensing missions. Finally, the method can be executed in a reasonable computing time due to previously developed high-performance computing techniques. [4] In this paper, they presented an unsupervised change-detection algorithm based on statistical analyses of spectral profiles; the profiles are generated from a synthetic image fusion method for multi-temporal hyper spectral images. This method aims to minimize the noise between the spectra corresponding to the locations of identical positions by increasing the change-detection rate and decreasing the false-alarm rate without reducing the dimensionality of the original hyper spectral data. Using a quantitative comparison of an actual dataset acquired by airborne hyper spectral sensors, they demonstrated that the proposed method provides superb change-detection results relative to the state-of-the-art unsupervised change-detection algorithms. [5] In this paper, they jointly learnt a collection of regressors, which collectively yield the smallest super resolving error for all training data. After training, each training sample is associated with a label to indicate its 'best' regressors, the one yielding the smallest error. During testing, their method bases on the concept of 'adaptive selection' to select the most appropriate regressors for each input patch. They assumed that similar patches can be super-resolved by the same regressors and use a fast, approximate kNN approach to transfer the labels of training patches to test patches. The method is conceptually simple and computationally efficient, yet very effective. Experiments on four datasets show that our method outperforms competing methods. [6] In this paper, they presented an overview of the operations, calibration, geodetic control, photometric standardization, and processing of images from the Mercury Dual Imaging System (MDIS) acquired during the orbital phase of the MESSENGER spacecraft's mission at Mercury (18 March 2011–30 April 2015). They also

provided a summary of all of the MDIS products that are available in NASA's Planetary Data System (PDS). Updates to the radiometric calibration included slight modification of the frame-transfer smear correction, updates to the flat fields of some wide-angle camera (WAC) filters, a new model for the temperature dependence of narrow-angle camera (NAC) and WAC sensitivity, and an empirical correction for temporal changes in WAC responsively.

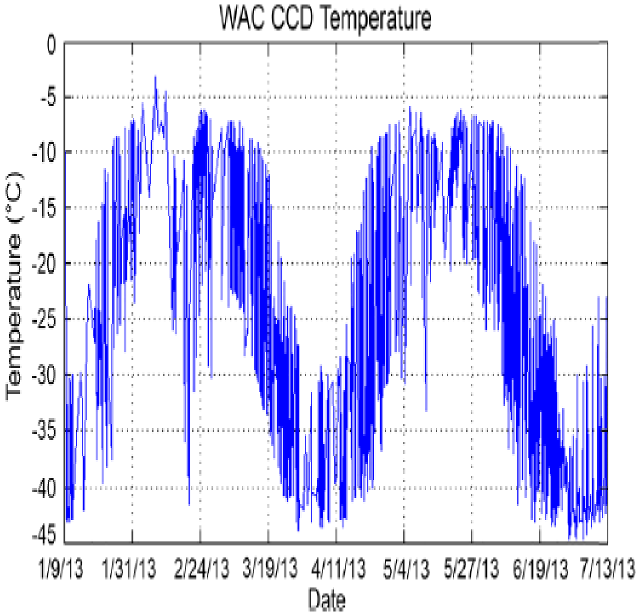

Figure 4: WAC CCD temperature as a function of time over approximately two Mercury years [6].

[7] In this paper, a novel HSI super-resolution method based on non-local sparse tensor factorization (called as the NLSTF) is proposed. The sparse tensor factorization can directly decompose each cube of the HSI as a sparse core tensor and dictionaries of three modes, which reformulates the HSI super-resolution problem as the estimation of sparse core tensor and dictionaries for each cube. To further exploit the non-local spatial self similarities of the HSI, similar cubes are grouped together, and they are assumed to share the same dictionaries. The dictionaries are learned from the LR-HSI and HR-MSI for each group, and corresponding sparse core tensors are estimated by spare coding on the learned dictionaries for each cube. Experimental results demonstrate the superiority of the proposed NLSTF approach over several state-of-the-art HSI super-resolution approaches. [8] In this work, they jointly processed high spectral and high geometric resolution images and exploit their synergies to generate a fused image of high spectral and geometric resolution; and improved (linear) spectral un mixing of hyper spectral end members at sub pixel level they right that the pixel size of the hyper spectral image. They assumed that the two images are radio metrically corrected and geometrically co-registered. The scientific contributions of this work are a simultaneous approach to image fusion and hyper spectral un mixing, and enforcing several physically plausible constraints during un mixing that are all well-known, but typically not used in combination, and the use of efficient, state-of-the-art mathematical optimization tools to implement the processing. The results of our joint fusion and un mixing has the potential to enable more accurate and detailed semantic interpretation of objects and their properties in hyper spectral and multispectral images, with applications in environmental mapping, monitoring and change detection. [9] In this paper, they have developed two versions of a spatio spectral camera and used them in a variety of conditions. They presented a summary of three missions with the in-house developed COSI prototype camera (600 – 900 nm) in the domains of precision agriculture (fungus infection monitoring in experimental wheat plots), horticulture (crop status monitoring to evaluate irrigation management in strawberry fields) and geology (meteorite detection on a grassland field).
[11] In this paper, a new fusion method is proposed to improve the fusion performance by taking further advantage of the distribution characteristics of ground objects. First, they put forward a local adaptive sparse un mixing based fusion (LASUF) algorithm, in which the sparsity of the abundance matrices is appended as the constraint to the optimization fusion, considering the limited categories of ground objects in a specific range and the local correlation of their distribution. Then, to correct the possible original

sub pixel mis-registrations or those introduced by the fusion procedures, a sub pixel calibration method based on optimal matching adaptive morphology filtering (OM-AMF) is designed. Experiments on various datasets captured by different sensors demonstrate that the proposed fusion algorithm surpasses other typical fusion techniques in both spatial and spectral domains. The proposed method effectively preserves the spectral composition features of the isolated ground objects within a small area.

IV CONCLUSION AND FUTURE SCOPE

Image fusion is the process of enhancing the perception of a scene by combining information captured by different modality sensors. Image fusion reduces uncertainty and also minimizes redundancy in the output, thus maximizing relevant information from two or more images of a scene. Image fusion techniques consider the several applications discussed include medical diagnosis, remote sensing, surveillance systems, biometric systems, and image quality assessment. In this paper we present the comparative study for the various image fusion techniques for the spatial and transfer domain techniques in the various real life applications, In future we implement the feature based image fusion for the purpose of above mentioned applications.

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