Mariadas Ronnie C.P, International Journal of Computer Science and Mobile Applications,
Vol.6 Issue. 2, February- 2018, pg. 50-61 **ISSN: 2321-8363**
**Impact Factor: 5.515**

# Retrieving Unrecognized Objects using Hyperspectral Imaging

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***Abstract - This paper deals with the analysis for retrieving unrecognized objects from an image using Hyper spectral camera and high-resolution image. Retrieving unrecognized objects from an image is made possible using spectral analysis and spatial analysis. The method proposed to retrieve unrecognized object from a high-resolution image is more efficient in comparison with the other image retrieval techniques. To identify objects in an image, it should be detected and the detection technique to identify objects in an image is accomplished in two steps: anomaly detection based on the spectral data and the classification phase, based on spatial analysis. During the classification phase, the detected points of the searched object are projected on to the high-resolution images through registration algorithms. After that, each detected point is classified using linear discrimination functions and decision surfaces based on spatial features. The two detection steps possess spectral and spatial information. In order to overcome the problems associated with the smoothness of the edges of an image, transcoding technique is used using filter arrays.***
***Keywords — Anomaly suspect, spectral and spatial analysis, linear discrimination functions, Discrete Wavelet Transform (DWT), Pre-processing, Refinement mapping. Registration algorithms, Transcoding, Filter arrays.***

## I. INTRODUCTION

The process of retrieving unrecognized objects from an image is a trivial task. For retrieving unrecognized objects from a high-resolution image, some form of object extraction method is necessary. Remote sensing is often used for detection of predefined targets, such as vehicles, man-made objects, or other specified objects. To overcome the problem of identifying moving object in a camera from distant location, we use hyper spectral camera to identify the object. A new technique is therefore applied that combines both spectral and spatial analysis for detection and classification of such targets. Th fusion of data from two sources, such as a hyper spectral cube and a high-resolution image, is used as the basis of this technique. Hyper spectral images supply information about the physical properties of an object while suffering from low spatial resolution. Since the Hyper spectral image does not identify what an object is, but only detects the presence of an object and the high-resolution image does not show the presence of an object, some sort of mechanism is needed to combine these two. Therefore, the fusion of the Hyper spectral image and the high-resolution image are used to successfully retrieve the unrecognized object from an image. The usage of high-resolution image enables high-fidelity spatial analysis in addition to the spectral analysis. To identify the objects in an image, the task is accomplished in two steps. One is, anomaly detection based on the spectral data and the second is, classification phase, which relies on spatial analysis. During the classification phase, the detection points are projected on the high-resolution images via registration algorithms. It is done to identify the object since high-resolution image does not show the object presence. After that, each detected point is classified using linear discrimination functions and decision surfaces based on spatial features. The two detection steps possess spectral and spatial information. At the spectral detection phase, we achieve very high probability of detection, while at the spatial step, the number of false alarms is reduced. The problem is thus identifying a specific area in a high-resolution image to know the presence of objects in that area. Each region selected upon the user's interest should be able to detect any presence of objects in that area. Related to the implementation of Trans coding, the work is as follows. The objective of this work is to study the relationship between the operational domains for prediction, based on the temporal redundancies between the sequences that is to be encoded. Based on the motion characteristics of the inter frames, the system will adaptively select the spatial or wavelet domain for prediction. A temporal predictor exploits the motion information among adjacent frames using very less information. The temporal predictor works without the requirement of the transmission of complete motion vector set and hence much overhead would be reduced due to the omission of motion vectors.

*Comparison of Spatial and Wavelet Domain:*

Image compression has become a subject of interest in both data storage and data transmission from remote platforms (satellites or airborne) because, after compression, the storage space and transmission time of the image are much reduced. So, there is a need to compress the data to be transmitted in order to reduce the transmission time and effectively retrieve the data after it is received by the receiver. The compression is to be done without losing the image characteristics. The aim is therefore to determine the operational mode of image sequence compression according to its motion characteristics. The operational modes are of two types: spatial domain and wavelet domain. The wavelet domain is much used for compression due to its excellent energy compaction. When using motion estimation in the wavelet domain, it might become inefficient due to shift invariant properties of wavelet transform. Hence, we are not able to predict all kinds of image sequences in the spatial domain alone or in the wavelet domain alone. Thus, a method is used to determine the

prediction mode of an image sequence adaptively according to its temporal redundancies. Temporal redundancy is estimated by the inter frame correlation coefficients of the image sequence. The inter frame correlation coefficient between frames is thus calculated. If the inter frame correlation coefficients appear to be smaller than a predefined threshold, then the sequence is likely to be a high motion image sequence. Therefore, motion compensation and coding the temporal prediction in wavelet domain would become inefficient. Thus, it is wise to operate the sequence in spatial mode. The sequences which have larger inter frame correlation coefficients are predicted to be in direct spatial domain. The frames that have more similarities with very few motion changes are coded using wavelet domain.

*Discrete Wavelet Transform (DWT)*

In a hyperspectral image, different pixel intensities will be existing among nearby spectral components or in the same component due to different absorption properties of the atmosphere or the surface that is imaged. Thus, two kinds of correlations are found in hyper spectral images: One is, intra-band correlation among nearby pixels in the same component, and the second is, inter-band correlation among pixels across adjacent components. Inter-band correlation allows a more compact representation of the image by packing the energy into fewer numbers of bands, enabling a higher compression performance. To remove correlation across the spectral dimension, the two main approaches are used for hyper spectral images: One is, KLT and the second is, DWT which is Discrete Wavelet Transform. DWT is the most popular transform for image-based application since they have lower computational complexity and it also provides component and resolution scalability and progressive transmission. A 2-dimensional wavelet transform is applied to the original image in order to decompose it into a series of filtered sub band images. At the top left of the image is a low-pass filtered version of the original and moving to the bottom right, each component contains progressively higher-frequency information that adds the detail of the image. The higher-frequency components are sparse, which means that many of the coefficients in these components are zero or insignificant. The wavelet transform is thus an efficient way of decorrelating or concentrating the important information into a few significant coefficients. The wavelet transform is used for still image compression and is adopted as part of the JPEG 2000 standard and is also used for still image texture coding in the MPEG-4 standard.

*Preprocessing, Refinement Mapping and Transcoding*

Preprocessing is a method used to improve the quality of an image. In addition to the original image pattern, one or more versions of the filtered image are used. Preprocessing, when used with wavelet transform improves the quality of the image. The image is corrected from different errors before processing by breaking the image down into sub images and is done before image enhancement. The important step in preprocessing is edge detection and noise reduction. Preprocessing suppresses information that are not related to exact image processing or analysis and is more accurate in detecting complex and filtering various kinds of noise. Image filtering and edge detection are necessary operations in image processing since factors such as projection, mix and noise are produced when the image is acquired which can lead to image blurring and distortion. It could also cause difficulty in extracting the edges of objects in the image. Mathematical morphology operators are widely used to filter noise and to detect complex edges in an image.

 

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Standard wavelet compression techniques do not reconstruct the original image because the floating point coefficients used in coding is rounded up to integer value caused by coding itself. The filters used in wavelet transformation normally have floating point coefficients. Since image when inputted has integer values, during filtering, the filtered output no longer contains floating point coefficients and losses will result from rounding. Hence, for lossless coding, it is necessary to make a reversible mapping between an integer image input and wavelet representation. Thus, to warp an image, two methods are used. They are forward mapping and reverse mapping. Forward mapping scans the source image pixel by pixel and copies them o the destination image at the appropriate position in the destination image. Reverse mapping goes through the destination image, pixel by pixel, and samples the correct pixel from the source image.

Transcoding is used to make the multimedia content adaptable to the capabilities of diverse network and devices in it. Transcoding performs one or more operations such as bit rate and format conversions, to transform compressed data from one to another. It enables multimedia devices of diverse capabilities and formats to exchange data between heterogeneous networks. Thus, it is an essential component for current and future multimedia systems which aims to provide universal access. Transcoding is used since it is a bridge between many applications. By Transcoding, the image can be displayed in a wide variety of devices making it more users friendly. Quantization, spatial and temporal downscaling are the most popular Transcoding algorithms. There are three types of transcoding. They are lossy to lossy, lossless to lossless, lossless to lossy. Lossy to lossy is used in low bit rate applications where the user is much less concerned about the sound quality than storage space. Lossless to lossless is used to avoid quality disruption. Lossless to lossy transcoding requires that the lossless data should be maintained if in case the output obtained is not desirable and needs to re encode the lossless data again to get the output. Transcoding is basically a lossy process but transcoding can be lossless if the output is losslessly compressed or uncompressed. Transcoding from lossy to lossless compression does not make any information loss. There are some basic requirements in Transcoding. They are;

1. Information in the original bit stream should be exploited.
2. The quality of the new bit stream should be high or as close to the bit stream created by coding the original bit rate at a reduced amount.
3. The transcoding delay and memory requirement should be minimized to meet real time applications.

### *Predicting Motion Estimation*

Motion estimation is the estimation of the displacement of image structures from one frame to another. It is used in many application areas such as scene analysis and image coding. It obtains the motion information by finding motion field between the reference frame and the current frame. It exploits temporal redundancy of an image sequence, and thus, the required storage or transmission bandwidth is reduced. Block matching is one of the most popular and time-consuming methods of motion estimation. This method compares blocks of each frame with the blocks of its next frame to compute a motion vector for each block. Thus, the next frame can be generated using the current frame and the motion vectors for each block of the frame. The Block matching algorithm is the simplest motion estimation technique that compares one block of the current frame with all of the blocks of the next frame to decide the location of the matching block. The computations that are to be done for each motion vector is as follows. Each frame of the image is partitioned into windows of size H*W pixels. Each window is then divided into smaller macro blocks of size 8*8 or 16*16 pixels. Each block of the current frame is compared to all of the blocks of the next frame within the search range and the Mean Absolute Difference for each matching block is calculated to calculate the motion vector. The block which is having the minimum value of the Mean Absolute Difference is the matching block. The location of that block is the motion displacement vector for that block in current frame. The motion activities of the neighboring pixels for a specific frame are different. But they are highly correlated since they usually have very similar motion structures. Therefore, motion information of the pixel can be approximated by the neighboring pixels in the same frame. The initial motion vector of the current pixel is approximated by the motion activity of the upper-left neighboring pixels in the same frame.

### *Prediction Coding*

An image normally requires enormous storage. To transmit an image over a modem with less than 512 kbps speed would take nearly 5 minutes. The purpose for image compression is to reduce the amount of data required for representing images and therefore reduce the cost for storage and transmission. Image compression plays a key role in many important applications which includes image database, image communications, remote sensing. The image that is compressed are gray scale with pixel values between 0 to 255. The image compression techniques are broadly classified into two classes called lossless and lossy compression. In lossless compression, no information regarding the image is lost. The reconstructed image from the compressed image is identical to the original image. But in lossy compression, some image information is lost. The reconstructed image from the compressed image is similar to the original image but not identical to it. Huffman codes are used for encoding temporal prediction and data compression which uses a variable length code instead of a fixed length code, with fewer bits to store the common characters, and more bits to store the rare characters. It means that the frequently occurring symbols are assigned short codes and symbols with less frequency are coded using more bits. The Huffman code is constructed using a tree. The probability of each intensity level is computed and a column of intensity level with descending probabilities is created. The intensities of this column constitute the levels of Huffman code tree. At each step, the two tree nodes having minimal probabilities are connected to form an intermediate node. The probability assigned to this node is the sum of probabilities of the two branches. The procedure is repeated until all branches are used and the probability sum is 1. Each edge in the binary tree, is having value either 0 or 1, and each leaf corresponding to the sequence of 0s and 1s are traversed to reach a particular code. Since no prefix is shared, all legal codes are at the leaves, and decoding a string means following the edges, according to the sequence of 0s and 1s in the string, until a leaf is reached. The code words are constructed by traversing the tree from root to its leaves. At each level, 0 is assigned to the top branch and 1 to the bottom branch. This procedure is repeated until all the tree leaves are reached. Each leaf corresponds to a unique intensity level. The code word for each intensity level consists of 0s and 1s that exist in the path from the root to the specific leaf.

## **II.** TECHNIQUE

In the past decades, the problem was identifying unrecognized objects from a high-resolution image. If the image is created from a hyper spectral camera, the problem still laid in identifying what actually the object was, since the hyper spectral image detects only the presence of an object, not what an object actually is. Derivations [2] and performance [3] computing methods were used in order to obtain the specific property of the image. But since the above method does not specify what the object property was, there should be a method in order to specify what the object in an image actually was. Since the image taken from a hyper spectral camera suffers from low resolution, we could not identify what actually the particular object was, even though it detects the presence of an object. There is a need for image applications in the detection of objects from a distant location. Normally, the image would be such that the presence of an object could not be detected from it. But, from a hyper spectral camera, the object, if it was on that location, could be captured in the hyper spectral camera. Also, an image taken from a hyper spectral camera suffers from low resolution and thus does not show the exact properties of an image. Since the identification of moving object in a camera is not possible from distant location, to overcome this problem we can use hyper spectral camera to identify the object. But hyper spectral camera will only provide the presence of objects, but not what object is. Thus, the problem areas are such that there should be a methodology in identifying an object from a high-resolution image. That is, it should detect the points from a hyper spectral image which are the points that specify the particular objects in the image. Secondly, the point that resembles the object in the hyper spectral image should be able to be used in retrieving the objects from the high-resolution image. A variety of simple interpolation methods, such as Pixel Replication, Nearest Neighbour Interpolation, Bilinear Interpolation and Bi-cubic Interpolation have been widely used for CFA demosaicking. But these simple algorithms produce low quality images. More complicated algorithms like the edge-directed interpolation have generated better quality image than simple interpolation methods. But these algorithms still generate the artefacts. Some algorithms have been developed to improve these problems. These algorithms often require huge computation power, so it is impossible to be implemented in real time system.

## **III.**DATA

The problem areas are divided into,

1. Target detection on a specific region of the image.
2. Classification of objects based on that region.
3. Transmission of the compressed images to a particular destination.

 

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To handle the problem of Target detection, the hyper spectral analysis is used. That is, it is used to identify the objects and its background. The background of an object will be always constant. Since the object emits various amounts of energies, the energy analysis of the object is made. If the object is moving then there will be varying amount of emissions for the objects. That will be analysed. Since the background is a constant, and the objects which are moving emits various amounts of energies, the objects can be identified using energy analysis. The precision/accuracy of the object is the case in order to detect the target. For that, the hyper spectral analysis is used in order to identify the background of the object. Smoothening of objects in an image can be done by using filter arrays so that the manipulation of the concerned object by the receiver, when an image is received, can be effectively carried out. The transmission of compression images is done using transcoding techniques in order to successively compress and transmitting the data and decompress them in order to obtain the original image.

## **IV.** FIGURES

PREPROCESSING AND REFINEMENT MAPPING

Fig.1: Original image

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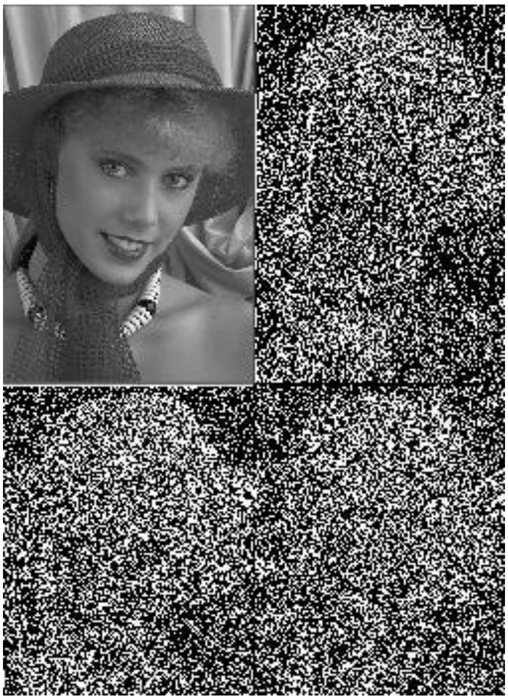

Fig.2: Wavelet transformed image

Fig.3: Preprocessed image

 

Fig.4: Refinement mapping

Fig.5: Restored refined image

 

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IMAGES APPLYING REFINEMENT MAPPING

Fig.6: Original image

Fig.7: Image converted to grayscale

 

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Fig.8: Example of an image with background removal


Fig.9: Example of an image that zooms a location

 

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Fig.10: Example of an image smoothened

## V. CONCLUSIONS

The classification problem of objects is handled by local detection method to identify the characteristics of the object. Local detection is made by superimposing the points obtained from the hyper spectral image into the high-resolution image there by obtaining the characteristics of the object. Since an accuracy of what object has been identified was not possible on previous methods, a Filter Array is set to identify the background with other objects. These Filter Array will be used to define the pixel information clearly and making these data available with less corruption.

## ACKNOWLEDGEMENT

The author would like to thank all the people who helped in preparing and carrying out the experiments and data collection.

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