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Quality Enhancement of Image Fusion Technique using Wavelet Transform

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***Abstract*— Image fusion is an emerging technology to integrate information from multiple input images to create a fused one that is more informative. The main objective of this paper is to enhance the quality of the fused images by using the wavelet transform. The quality assessment of multiexposure multifocus image fusion is evaluated based on three main key factors namely sharpness, structure preservation and contrast preservation. The improved image fusion algorithm is used to modify the different alignments of the images. Fusion algorithms with various rules can be used to combine the images. Wavelet transform is first performed on each source images, and then a fusion decision map is generated based on a set of fusion rules. The fused wavelet coefficient map can be constructed by using support vector machine algorithm and the final image is obtained by performing inverse wavelet transform.**

Keywords— Image fusion, Wavelet transform, Sharpness, Contrast preservation, Structure preservation

I. Introduction

Digital Imaging System has been used in various image processing domains such as satellite and commercial domain like Voter ID. The proposed system uses JPEG images and it supports two-dimensional (2-D) images. The quality of the image is measured using Peak-Signal- Noise Ratio (PSNR) which is measured by decibel (dB). It mainly concentrates on Depth of Field (DOF) of an image. In the proposed work the input images are in the form of sequence of two or more images which is taken at various situations such as with flash, without flash, with light and without light. The various steps are carried out and thus the result obtained is a fusion of the images which is clear and the quality of image is good. It shows best result when compared with the existing system. The fusion algorithm techniques are used for fusion of images based on contrast and gradient level. This is done in a multi-resolution of brightness variation in the sequence. Gaussian filter method and Laplacian methods are used so that up-scaling and down-scaling is done success Multi Sensor Image Fusion is the process of combining relevant information from two or more images into a single image. The resulting image gives more information than any of the input images.

The increasing availability of space borne sensors gives a motivation for different image fusion algorithms, in remote sensing applications. Several situations in image processing require high spatial and high spectral resolution in a single image. An image fusion technique helps for the integration of different information sources. A fused image could have complementary spatial and spectral resolution characteristics. Yet, the standard image fusion techniques can alter the spectral information of the multispectral data while merging.

The Panchromatic (PAN) images are obtained by satellites which are transmitted with the maximum resolution available and the multispectral data are transmitted with smoother resolution. The PAN image is merged with the multispectral data to convey more information at the receiver station. The images taken by a remote sensing satellite are transmitted to Earth through telecommunication.

The bandwidth of the telecommunication channel sets a limit to the data volume for a scene taken by the imaging system. A small number of spectral bands or a smaller area of coverage may be accepted to allow high spatial resolution imaging.

Image fusion can be performed using many existing methods. High pass filtering technique is one of the basic techniques. Image fusion techniques are based on Discrete Wavelet Transform, Uniform Rational Filter Bank and Laplacian Pyramid. The benefit of fusion is that the higher signal-to-noise ratio of the long exposure image is combined with the sharp details of the short exposure image. Image fusion plays vital role on image quality.

A. Need for Image Fusion

Multi sensor data fusion has become an authority which demands more general formal solutions to a number of application cases. Several situations in an image processing require both high spatial and high spectral information in a single image which is important for remote sensing. But, the instruments are not capable of providing such information either by design or of observational constraints.

II. IMAGE FUSION TECHNIQUES

Image fusion algorithms can be classified into different levels such as low, middle and high; or pixel, feature and symbolic levels. The pixel-level method works either in the spatial domain or in the transform domain. The prerequisite for such an operation is that the image has been acquired by homogeneous sensors, such that the images reproduce similar or comparable physical properties of the scene. The fusion methods, such as averaging, the Brovey method, Principle Component Analysis (PCA), and IHS based methods fall under the spatial domain approaches.

The images that are used in image fusion should be already registered. A major source of error in an image fusion is mis-registration. Some of the well-known image fusion methods are mentioned below:

- High pass filtering technique
- IHS transform based image fusion
- PCA based image fusion
- Wavelet transform image fusion
- Pair-wise spatial frequency matching

The feature-level algorithms typically segment the image into contiguous regions and fuse the regions together using their properties. The features used may be calculated separately from each image or they may be obtained by the simultaneous processing of all the images.

The Infrared and visible light cameras has their own features. Images occupied in the visual spectrum tend to preserve good appropriate information, while in night vision they are generally shown poor perception among the objects because of the low contrast. Infrared images are almost obvious to the change of light condition, so it may be most consistent to differentiate the targets from the background by the thermal contrast. The contrast histogram equalization is done before the image fusion in order to improve the contrast.

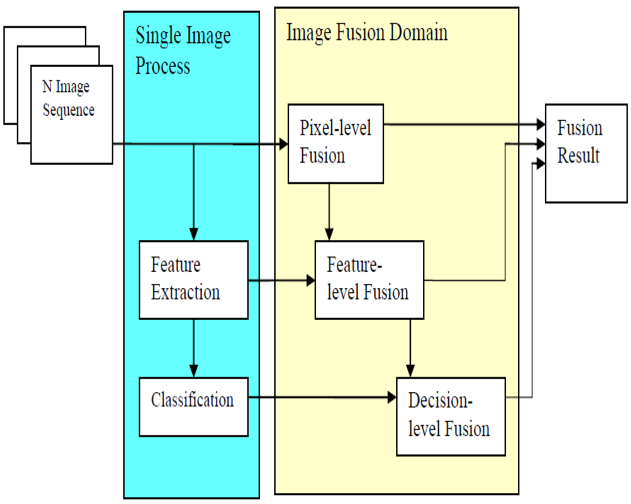

Fig. 1. Image Fusion Block Scheme of Different Abstraction

A. Levels

The theory of image fusion has advanced quickly in the past few years. The image fusion approaches that are developed recently are complex. As previously stated, the fused image usually contains more information about the target or scene than any of the individual images used in the fusion process. The images used for fusion can be taken from multi-modal imaging sensors or from the same imaging sensor at different times. The target or scene in the images can be exactly the same or partially the same, for example, some objects and labels might have disappeared or new objects may be added to the images.

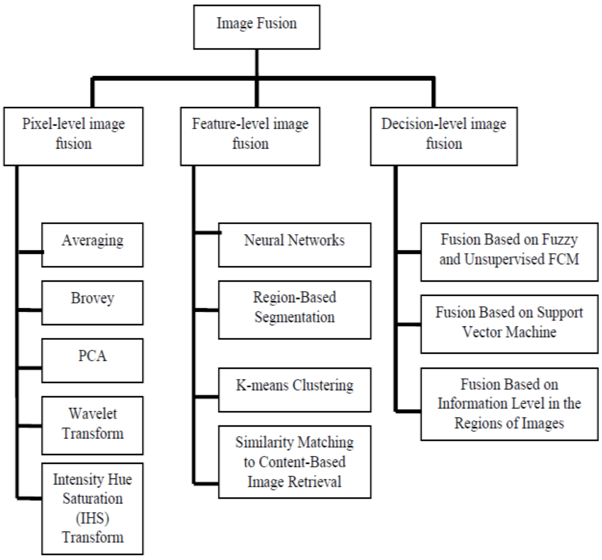

Fig. 2. Image Fusion Methods

III. WAVELET TRANSFORM

Image fusion can be well-defined as the process of combining multimodal source images into a single representation, stressing the most salient features of the surrounding environment. According to an image fusion algorithm should preserve as closely as possible all relevant information contained in the source images and not introduced any artifacts or inconsistencies that could interfere with analysis. In the fused image, the unrelated features or noise should also be suppressed to a maximum extent. The actual fusion process can take place at different levels of information illustration. These methodologies fall into three basic categories, i.e. pixel, feature and decision level fusion. At the lowest processing pixel level, the sets of pixels in the source images are merged pixel to pixel according to a defined decision rule to form the corresponding pixel in the fused image. An accurate spatial registration is required at this level for fusion of the images from different sensors prior to applying the fusion operator. In feature level fusion, the relevant features are first abstracted from the data and then fused to form the fused feature set.

The features can be extracted using segmentation procedures and differentiated by characteristics such as size, shape, contrast and texture. The resulting probability features in the fused image increases as the fusion based on identified features in the sources. At the decision level, decisions or detections based on the outputs from the individual sensors are fused together and used to reinforce common interpretation or resolve any differences.

A pixel level fusion method is the most nature among the fusion methods, as it has the advantage of directly using the source images that contain the original information. The commonly used algorithm for discrete wavelet transform is Mallat algorithm.

IV. WAVELET TRANSFORMATION

The fundamental idea behind the wavelet transform is to analyze a signal at different scales or resolutions. The wavelet transformation can be interpreted in the Fourier domain as set of band-pass filters and the signal is examined in both the space and frequency domains. These transformations allows a signal f (t) to be projected onto different wavelets or basis functions instead of the sin and cosine basis functions that are used in Fourier transform. These basis functions are obtained from a single prototype wavelet called the mother wavelet by dilations and translations. The larger wavelets give the approximate signal representation while the smaller wavelets zoom in to the details or minor variations in the signal in case of wavelet transformation. While sinusoids are useful in analyzing periodic and time-invariant phenomena, wavelets are well suited for the analysis of transient, time-varying signals. The great interest in the use of wavelets for signal and image analysis lies in ability to represent functions efficiently with localized features. Compared to pyramid transformations, discrete wavelet transformation is also more compact and offers directional information. In image analysis, the 1-dimensional wavelet transform is extended to the 2-dimensional wavelet transform to perform spatial-frequency decomposition of the source image.

(a)

(b)

Information provided by different sensors is often complementary; therefore improvements are possible with the enhancement and subsequent fusion of the images captured into a single representation. Among the different fusion schemes, the multi-resolution approach based on the Luminance Extraction offers one of the most promising solutions to effectively extract and combine the salient features in the source images. By means of analyzing and fusing the source images at different scales, the back-propagation technique provides a more reliable means to preserve the spectral information of the multispectral images.

Therefore, this work seeks to implement a Luminance Extraction Image Fusion Algorithm to fuse images received from dissimilar image sensors, in particular, complementary images from thermal and night vision sensor systems. In addition, this proposed also explores other concept Depth of Field (DOF) techniques to improve the fusion results. The result of image fusion is a single image which is more suitable for human and machine perception or for further image processing tasks. Image Fusion is carried out by using gradient exposure. The contrast of the image is increased by using the color direction

The above picture illustrates the sharpness, structure preservation and contrast preservation. The first picture the image is not focused clearly and the second image is clear when compared to the first one. Therefore, objective quality assessment approaches without assuming the availability of a “ground truth” image are highly desirable. Several quality measures relate fused image quality with different aspects of information content preservation. The purpose of the current work is to develop an objective quality model for multi-exposure multi-focus image fusion. The general approach of our method is to separate the problem into the assessment of three important factors of fused image quality contrast preservation, sharpness, and structure preservation. Our work is partially motivated by the design principle of the SSIM approach, where local image fidelities are split into luminance, contrast and structural similarities. The importance of luminance preservation varies across different image fusion tasks. In the current application, we found that directly preserving the luminance of the input images is not of critical importance in improving the overall image quality, and thus we focus on contrast and structure preservation.

V. PROPOSED ARCHITECTURE SYSTEM

In general, the fusion scheme carried out will be slow; expensive cannot be included into automotive frameworks for the systems. In general application scenarios of multi-exposures and multi focus image fusion and most importantly, an ideal image is not possible. Six fusion algorithms with various rules to extract and combine image structures from the input image pairs are employed to create the fused images.

Many fusion algorithms mainly emphasis only on the images which has been arranged in a spatially adaptive manner whereas, typical fusion rules that include choose maximum absolute coefficient (CM), weighted average (WA) and choose maximum consistency verification (CMCV).

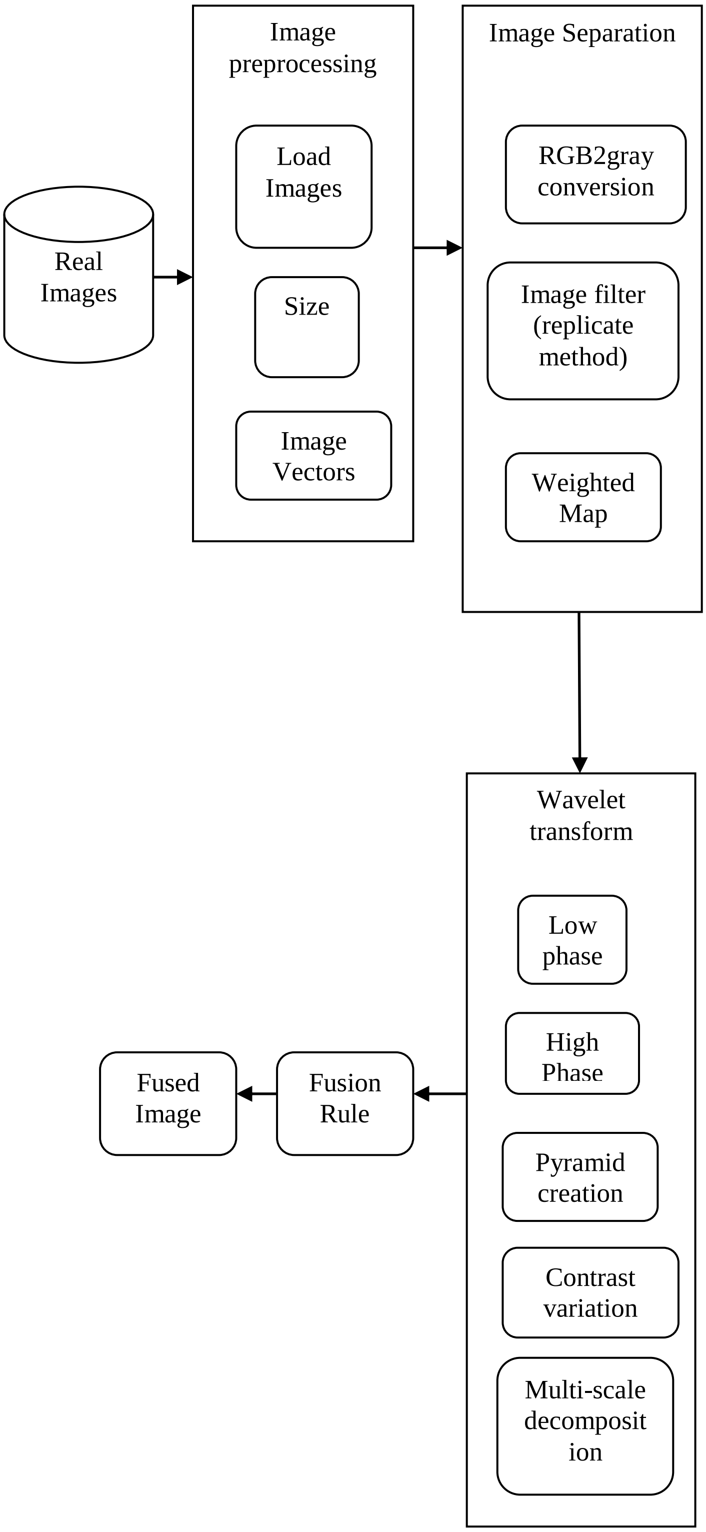

Fig. 3. Proposed architecture system

Subjective tests are done using six fusion algorithms and ranking is given from 1 to 6.1 for best perpetual quality and ‘0’ for the worst quality. The statistical analysis was done on this fusion technique. In order to achieve high quality image we prefer wavelet transform.

VI. CONCLUSION

In this paper, we have presented a decomposition technique to fuse two images based on wavelet transform. The main objective of the image fusion technique is to improve reliability and capability. The proposed work the input images are in the form of sequence of two images which is taken at various situations such as with flash, without flash, with light and without light. The various steps are carried out and thus the result obtained is a fusion of the images which is clear and the quality of image is good. Due to the large number of applications of fusion techniques considerable measures has been taken in order to get better image. Wavelet transform is first performed on every source images, then a fusion decision map is generated based on a set of fusion rules .The fused wavelet coefficient map can be constructed by using this algorithm and the final image is obtained by performing inverse wavelet transform. The color constancy, sharpness and the structure preservation is made.

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