Abstract — Image fusion is a technique of merging pertinent information from two or more images into a single image. The fused image will be more useful for computer processing task than any of the input images. The image fusion methods based on discrete cosine transforms (DCT) are more suitable and time-saving in real-time systems using DCT based standards of still image or video. Many of the presented methods are based upon transformations therefore it results in some color artifacts which can decrease the performance of the transform based vision fusion methods. In existing work of fusion, there is problem of the uneven illuminate has been neglected. Most of the existing work has focused on gray scale images not much work is done for color images. To overcome the limitations of the earlier work an integrated algorithm has been proposed in this research work. The experimental results have shown that the Alternating Current (AC) coefficients calculated in DCT domain has quite better results.

Keywords — Image Fusion, Discrete Cosine Transformation, Wavelet Transformation, Principle Component Analysis, Multi-focus images.

I. INTRODUCTION

Any piece of information makes logic only when it is capable to express the content across. The precision of information is important. Data fusion is a process which deals with processing of data and information originated from many sources to attain enhanced information source information. A common explanation of image fusion is “the combination of two or more than two different images to get fresh picture with the help of some algorithm”. These days in this digital planet Image Fusion is the emerging field in the area of Image Processing. The main objective of image fusion is to put together different data to acquire additional information than can be derived from each and every of the different single sensor data alone. Its key objective is to unite two or more than two images in such a manner as to maintain the major desirable characteristics of every resultant image.

Image fusion [1] plays a significant role in image processing. Image fusion is a system to merging applicable data from a set of images into a solitary image where the resultant fused image is more instructive image. The fused image will hold all the vital data as contrast to information digital images. The fused image has attained data on the basis of source images. With quick development in technology, it happens to be imaginable to have data predicated on multi-source images to produce a fantastic fused image. The consequence of image fusion is interchange image that remaining parts probably the most attractive information and qualities of input Image. Image fusion is just a useful means of combining the single sensor and multi-sensor images to improve the data. The motivation behind image fusion is to become listed on data from group of images remember the finish goal to produce a graphic that communicates just the accommodating information. Image fusion is an activity by which images are obtained from distinctive sensors with a specific algorithm so the resultant image is more consistent, clear, and reasonable. Image fusion method like discrete cosine transform is right and efficient in continuous framework. A proficient technique for fusion of multi focus images is focused around variance calculated in DCT domain.

While observing medical fusion image, doctors can effortlessly verify the spot of sickness. In this field of medical science to evaluate or to inspect the internal body parts various radiometric scanning techniques can be used. With the rapid advancement in technology, it is now possible to obtain information from multi source images to produce a high quality fused image with spatial and spectral information. In other words, it is a process of combining all significant and corresponding information from various images of same source or various sources into a particular composite image without loss of information. The aim of image fusion is to improve the spatial and spectral resolution.
from numerous low resolution images. Due to this reason image fusion has turned to be an interesting topic for many researchers.

Levels of Image Fusion

The principal objective of image fusion would be to generate a fused image that offers the complete and consistent data. Image fusion perform at three separate levels i.e. pixel, feature and decision, expects to accomplish the more correct, complete and consistent image description of the exact same scene.

1. **Pixel level fusion:** Pixel-based fusion or Signal level image fusion has taken place on a pixel-by-pixel wise. It creates a fused image in which information related with each and every pixel that is determined from a set of pixels in input images to get better performance of image processing like segmentation. This fusion represents fusion at the lowest level, where a number of unprocessed input image signals are combined to create a single fused image signal.

2. **Feature level fusion:** Feature-based fusion or Object level image fusion fuses at feature level needs withdrawal of items known to various data sources. It needs extraction of relevant features which are depending on their surroundings such as pixel intensities, boundaries or textures. These similar features from input images are fused. It fuses feature, object labels and property descriptor information which have already been extracted from individual input images.

3. **Decision-level fusion:** Decision-based fusion or symbol level image fusion comprises integration of information at a top level of abstraction, combines the outcome from numerous algorithms to get a final fused result. Input images are processed independently for information extraction. The obtained information is then combined by applying decision system to strengthen regular interpretation. The highest level, decision or symbol level image fusion represents fusion of probabilistic decision information that has been obtained by local decision makers working on the outcomes of feature level processing on image data created from individual sensors.

Techniques of Image Fusion

**Discrete Cosine Transform (DCT)** – Spatial domain image fusion techniques are convoluted and prolonged which are difficult to be performed on ongoing images. Besides, when the origin images are coded in Joint Photographic Experts Group (JPEG) format or once the fused image will undoubtedly be saved JPEG format, then a fusion approaches which are connected in DCT domain will undoubtedly be exceptionally proficient. To execute the JPEG coding, a picture is initially subdivided into blocks of 8x8 pixels. The Discrete Cosine Transform (DCT) is then executed on each block. This creates 64 coefficients which are then quantized to lessen their extent. The coefficients are then reordered right into a one-dimensional array in a crisscross way before further entropy encoding happens. The compression is attained in two stages the very first is aimed quantization and the 2nd aimed the entropy coding procedure. JPEG decoding may be the reverse means of encoding.

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The task utilizes a differentiation measure as choice basis to become listed on together the few blurred images in a solitary decent quality image. This complexity measure is focused across the transformation of the image from the spatial domain to the frequency domain through the processing of the DCT.

DCT coefficients [4] are computed for each image and fusion rule is applied in order to get fused DCT coefficients, thereafter, IDCT is applied on the fused coefficients to produce the fused final image/block.

**Discrete Wavelet Transform :-** The wavelet transform decays the image into low-low, low-high, high-low, high-high spatial frequency bands at diverse scales. The LL band provides the estimate coefficients while alternate bands contain directional data due to spatial orientation. LH band provides the vertical point of interest coefficients; HL band provides the diagonal detail coefficients furthermore contain the bigger absolute estimations of wavelet coefficients compare to remarkable features such as for example edges or lines.

**Principle component analysis based image fusion :-** Principle component analysis is just a mathematical tool which converts a couple of correlated variables into a couple of uncorrelated variables [3][7]. Principle component analysis can be used extensively in image classification and image compression. It calculates a concise and optimal description of the information set. The original principal
component represents however a lot of the rest of the difference as could reasonably be expected.

Iterative Block Level Principal Components Averaging (IBLPCA)- Iterative block level principal components averaging (IBLPCA) [2] also known as a novel pixel level fusion algorithm has been proposed for fusion of noise free and noise filtered MR brain images. It evaluates principal components by splitting images into image blocks. Sizes of image blocks are decided based on average mutual information (AMI) between fused image and source image. Then the average of principal components of all blocks is evaluated to have weight for fusion rule.

Applications of Image Fusion

Multi Focus Image Fusion: Multi-focus Image fusion has methodology of merging data of more than two images of landscape and therefore has “all in focus” image. At the point when one scene contains objects in distinctive separation, the camera might be focused on each one object one after the other, making set of pictures. At the point when an image of a 3-D scene is caught, just scene parts at the focus plane appear sharp. Scene parts before or behind of or behind the focus plane appear blurred [8]. To make an image where all scene parts appear sharp, it is important to catch images of the scene at diverse focus levels and fuse the images. At that point, using image fusion method, an image with better focus over all area can be produced. There are numerous multi focus image fusion routines, today.

Medical Image Fusion: Along with the advancement of the medical image technology, medical image fusion gets to be progressively important in medical analysis and diagnosis. Medical image fusion has very extremely paramount estimation of use for medical image analysis and judgment. Case in points, doctors can every year join together the computer tomography [6] and magnetic resonance imaging medical images of a patient with a tumor to make a more exact judgment, yet it is awkward and exhausting to finish this job. For instance computer tomography scan can obviously express human bone data, however it cannot recognize the delicate tissue points of interest; oppositely. Magnetic resonance imaging can obviously express delicate tissue data, yet it is not touchy to bone tissue. Fusing computer tomography and Magnetic resonance imaging images can get a complete picture which contains both clear tissue and delicate tissue data. To lessening doctor’s workload it is important to create the automatic image fusion framework and enhance the consistence of analysis.

II. LITERATURE REVIEW

R. Amutha et al. (2014) “Discrete Cosine Transform based fusion of multi-focus images for visual sensor networks” [1] had discussed that simple and proficient multi-focus image fusion framework clearly planned for wireless visual sensor framework organized with assets constrained, unsafe setting for example battlefields. The fusion of multi-focus images is focused around higher esteemed Alternating Current coefficients computed in Discrete Cosine Transform domain. Discrete cosine transform defeats the computation and energy confinement of low power gadgets and is explored in terms of image quality and computation energy. It confirms the important efficiency improvement of the proposed system in yield quality and energy consumption, when contrasted with other fusion techniques in DCT domain.

Vijayarajan R. et al (2014) “Iterative block level principal component averaging medical image fusion” [2] had discussed new fusion i.e. novel pixel level fusion called Iterative block level principal component averaging fusion in which source images are divided into smaller blocks, so that principal components can be considered for appropriate block of source images. Principal components average of all the blocks has been taken or provided weights for fusion rule, so that meaning is provided to blocks of source images. The fusion results with maximum average mutual information provided by Iterations that are built-in the form of size of blocks of source images. This algorithm is tested for the fusion process of noise free medical images and noise filtered of the images. The results for both the cases show that the algorithm performs well in terms of average mutual information and mean structural similarity index.

Desale, R.P. et al. (2013) “Study and analysis of PCA, DCT & DWT based image fusion techniques.” [3] had examined the various image fusion methods such as for example PCA (principal Component Analysis), DCT (Discrete Cosine Transform)and DWT (Discrete Wavelet Transform) based image fusion methods. Authors have recommended the choice of DWT based fusion method for top quality and exactness applications. In this paper two algorithms focused around DWT are proposed like, Pixel averaging and maximum pixel replacement algorithm. The execution of above said DWT’s have already been contrasted and the PCA and DCT fusion techniques. The examination has been carried out focused around seven parameters named as PSNR, MSE, Normalize absolute error, Maximum Difference, Average difference, Normalized Cross-Correlation and structural content. The outcome portrays that the execution of DWT based fusion strategies is altogether better as contrast having an alternate routines for image fusion.
Y. Asnath et al. (2013) “Discrete Cosine Transform Based Fusion of Multi-Focus images for visual sensor network” [4] has proposed a basic and proficient DCT based image fusion technique. Authors have recommended the adoption of this system on the ground that DCT based fusion beats the computation and energy limit of low power gadget. In this fusion method, the image obstructs with higher estimation of AC coefficients is absorbed into the fused image. It is great degree quick as it doesn’t include any complex floating point arithmetic operations like mean or variance calculation. The proposed fusion strategy significantly diminishes the computational complexity without trading off image quality and for energy consumption dissection; it utilizes the ATmega128 processor of Mica 2 mote at 8MHz with a dynamic force consumption of 22mW as the target state.

Sruthy, S et al. (2013) “Image Fusion technique using DTCWT” [5] has discussed the utilizing Dual Tree Complex Wavelet Transform. In this fusion system, fusion is performed utilizing the masks to concentrate data from the decomposed structure of DT-CWT. Fusion methodology includes the arrangement of a fused pyramid using the DT-CWT coefficients which are acquired from the decomposed pyramids of the input images. At long last the resultant fused image is acquired by applying the inverse dual tree complex wavelet transform. This result demonstrates a huge lessening of distortion.

Ling Tao et al. (2011) “An Improved Medical Image Fusion Algorithm Based on Wavelet Transform” [6] has examined that medical image fusion has extremely vital estimation of application for medical image study and judgment. The traditional system for wavelet fusion is enhanced and another algorithm of medical image fusion is introduced. At that point when picking high frequency coefficients, the regional edge intensities of each one sub-image are calculated to acknowledge adaptive fusion the low frequency coefficient choosing is focused around edges of images, so that the fused image can protect all valuable data and shows up plainly. Apply the traditional and enhanced fusion algorithms focused around wavelet transform to fuse images and furthermore assess the fusion outcomes. It has been proved that the algorithm can successfully hold information of unique images and upgrade their edges and texture features. This new algorithm is superior to traditional fusion algorithm focused around wavelet transform.

Ujwala Patil et al. (2011) “Image fusion using hierarchical PCA” [7] proposed that combining several registered images of the indistinguishable place to have numerous educational images is known as image fusion. Principal component analysis is just a prominent approach for feature extraction and dimension reduction. Image fusion algorithm combines pyramid and principal component analysis techniques and remove the product quality analysis of hierarchical principal component analysis fusion algorithm without implication image. There's a developing requirement for the product quality examination of the fusion algorithms. We show fusion using wavelet and principal component analysis fusion methods and takeout creation analysis for these fusion strategies using unique quality measures for number of information sets and demonstrate that proposes image fusion using hierarchical principal component analysis is ideal for the fusion of multimodal imaged.

Drajic Dejan, et al. (2007) “Adaptive fusion of multimodal surveillance image sequences in visual sensor networks” [8] had presented a new method of fusion of the sequences of images obtained from multimodal surveillance cameras and which leads to distortions that are usual for visual sensor networks environment. This method uses a technique i.e. Structural Similarity Measure (SSIM) to compute a noise level in regions of a received image in order to optimize the selection of regions in the fused image. The region-based image fusion algorithm using the Dual-Tree Complex Wavelet transform (DT-CWT) is used to fuse the selected regions. The performance of the proposed method had widely tested for a number of multimodal surveillance image sequences and outperformed the state-of-the-art algorithms, raising significantly the superiority of the fused image, both visually and in terms of the Petrovic image fusion metric.

Jondhale K C, et al. (2010) “Modified double bilateral filter for sharpness enhancement and noise removal” [9] has proposed a new function i.e. median-metric weighting function introduced by incorporating a 3 × 3 median filter into a second bilateral filter. The corrupted pixel has been removed by the median value or by its neighboring pixel value in new proposed method. As a result of this the noise can effectively removed even at high level as 90%. The edges can be preserved without any loss up to 80% of noise level. The new proposed median filter is used for restoration of images that are highly disturbed by impulse noise.

Pei, Yijian, Huayu Zhou, Jiang Yu, and Guanghui Cai, et al. (2010) [10] have proposed an improved discrete wavelet framework based image fusion algorithm. The improvement is the careful consideration of the high frequency subband image region characteristic. The algorithms can efficiently synthesize the useful information of the each source image retrieved from the multi sensor. The multi focus image fusion experiment and medical image fusion experiment can verify that proposed algorithm has the effectiveness in the...
image fusion. The author studies the quality assessment of the image fusion, and summarize and quantitatively analysis the performance of algorithms.

II. RESEARCH METHODOLOGY
To attain the goal, step-by-step methodology is used. Subsequent are the dissimilar steps which are used to accomplish this work. Following are the variety of steps used to accomplish the objectives of the dissertation.

The steps of proposed methodology are as follows:

**Step 1: Input images**: Input 2 images image 1 and image 2 by which image 1 is left blurred and image 2 is right blurred.

**Step 2: RGB2PCA**: Now RGB to PCA conversion will soon be done in relation to the certain vector values. Also division of every PCA image may also be done into PCA1, PCA2 and PCA3

**Step3: Apply AC-DCT based fusion**: The next phase is to use AC-DCT based fusion on first PCA as highest variations located on the first PCA plane. And chrominance fusion comes into play action for other PCA planes i.e. PCA2 and PCA3.

**Step4: Concatenation**: Now concatenate the consequence of each plane and obtain the fused image.

**Step5: Trilateral Filter**: Now trilateral filter comes into play action to preserve edges of the fused image. We convert the first image to cosine transform. Then inverse cosine transform is put on that image. When inverse cosine transform is applied then noise is occurred in fused image then trilateral filter is put on remove noise while still preserving fine details and color artifacts that'll introduced as a result of transform domain method i.e. DCT

**Performance metrics**
This section contains the cross validation in the middle of existing and proposed procedures. Some well-known image
execution parameters for computerized images have been chosen to demonstrate that the execution of the proposed algorithm is superior to the current techniques. Some of the parameters that are used are: Mean Square Error, Peak Signal Noise Ratio, Normalized Cross-Correlation, Average Difference and Root Mean Square Error.

**Mean square error (MSE)**

Mean square error is a measure of image quality record. The huge estimation of mean square suggests that image is a low quality.

\[
MSE = \frac{1}{mn} \sum_{i=1}^{m} \sum_{j=1}^{n} (A_{ij} - B_{ij})^2
\]

Where, \( A \) - the perfect image, \( B \) - the fused image to be assessed, \( i \) – pixel row index, \( j \) – pixel column index, \( m, n \) - No. of row and column.

**Root mean square error (RMSE)**

Root mean square error between the remade image and the unique image presents mistake as a rate of the mean force of the first image. The RMSE is given by

\[
RMSE = \sqrt{\frac{1}{M \times N} \left[ \sum_x \sum_y (I_{true}(x,y) - I_{fused}(x,y))^2 \right]}
\]

Where \( I_{true}(x,y) \) is the reference image, \( I_{fused}(x,y) \) is the fusion image and \( M,N \) are the dimensions of the images.

**IV. IMPLEMENTATION OF PROPOSED FUSION APPROACH**

To be able to execute the proposed algorithm, design and implementation has been carried out in MATLAB using image processing toolbox. Bearing in mind the finish goal to complete cross validation we’ve likewise executed the upgraded DCT based image fusion using nonlinear enhancement. The created methodology is analyzed against some well-known image fusion techniques accessible in literature. After these comparisons, we are considering proposed methodology against DCT with a couple execution measurement. Result demonstrates our proposed methodology gives superior results than the existing techniques.

**V. PERFORMANCE ANALYSIS OF PROPOSED SYSTEM**

Here, provides the cross validation in the center of existing and proposed procedures. Some well-known image execution parameters for computerized images have now been chosen to show that the execution of the proposed algorithm is better than the existing techniques.

1. **Mean Square Error Evaluation**

Mean square error is really a way of measuring image quality record. The huge estimation of mean square declares that image is really a low quality.

**Table 1 Mean Square Error Evaluation**

<table>
<thead>
<tr>
<th>Image</th>
<th>DCT</th>
<th>PCA</th>
<th>Proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>74.20576</td>
<td>2994.29177</td>
<td>8.57685</td>
</tr>
<tr>
<td>2</td>
<td>2.37184</td>
<td>5010.21734</td>
<td>0.91478</td>
</tr>
<tr>
<td>3</td>
<td>189.13082</td>
<td>6113.8865</td>
<td>0.25783</td>
</tr>
<tr>
<td>6</td>
<td>34.31736</td>
<td>3011.27018</td>
<td>16.71256</td>
</tr>
<tr>
<td>9</td>
<td>1226.95636</td>
<td>7961.66115</td>
<td>8.415</td>
</tr>
<tr>
<td>10</td>
<td>40.85986</td>
<td>3809.14245</td>
<td>32.97421</td>
</tr>
<tr>
<td>16</td>
<td>182.83489</td>
<td>2466.59612</td>
<td>1.85193</td>
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<tr>
<td>18</td>
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<td>1931.57461</td>
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</tr>
<tr>
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<td>7470.11064</td>
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<tr>
<td>24</td>
<td>318.90244</td>
<td>1701.89751</td>
<td>1.41485</td>
</tr>
</tbody>
</table>

Table 1 is demonstrating the quantized analysis of the mean square error. As mean square error must be lessened which means proposed algorithm is demonstrating the superior results compared to the accessible methods as mean square error is fewer in each case.

![Fig. 5: MSE for different images](image-url)
Figure 5 has demonstrated the quantized analysis of the mean square error of distinctive images. This diminishing symbolizes improvement in the target nature of the image.

**Root Mean Square Error Evaluation**

Root mean square error between the remade image and the unique image presents mistake as a rate of the mean force of the first image.

Table 2: Root mean square error Evaluation

<table>
<thead>
<tr>
<th>Image</th>
<th>DCT</th>
<th>PCA</th>
<th>Proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8.61428</td>
<td>54.72012</td>
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<td>2</td>
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<td>70.78289</td>
<td>0.95644</td>
</tr>
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<td>3</td>
<td>13.75248</td>
<td>78.19135</td>
<td>0.50777</td>
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<td>54.87504</td>
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<td>89.22814</td>
<td>2.90086</td>
</tr>
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<td>10</td>
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<td>5.74232</td>
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<tr>
<td>16</td>
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<td>24</td>
<td>17.85784</td>
<td>41.25406</td>
<td>1.18947</td>
</tr>
</tbody>
</table>

![Fig. 6: RMSE for different images](image)

Table 2 has demonstrated the quantized analysis of the Root Mean Square Error. As Root Mean Square Error must be decreased this way the proposed algorithm is demonstrating the superior outcome compared to accessible techniques as Root Mean Square Error is less in most case.

VI. CONCLUSION

The most of the DCT based techniques has focused on grayscale images so integration of PCA and DCT domain has also been done in order to authenticate the results for color images. The comparison among DCT based fusion, PCA based fusion and proposed technique has also been drawn to explore the significant improvement of the proposed algorithm to authenticate the proposed work. The comparative analysis has shown the significant improvement of the proposed technique over available image fusion techniques. This work has not considered any optimization techniques like genetic algorithm, swarm intelligence, artificial bee colony etc. in order to enhance the results further. Therefore in near future we will enhance the results using swarm intelligence based techniques.

VII. REFERENCES