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Improved Quality Assessment of Multicamera Image

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Abstract— The quality of image can be observed in two ways- subjective as well as objective. An objective evaluation with multicamera image has been implemented. This paper gives detail of the techniques to implement quality parameter of multicamera images. The quality of the image is determined by using MSSIM, VIF, PSNR, and MIQM techniques. The PSNR, MSSIM and VIF are the commonly used image quality assessment techniques for single camera images, but MIQM techniques is a better alternative to the above mentioned techniques. With implemention of all techniques, multicamera images are observed and simulated. The two distortions in multicamera images mainly considered photometric distortion and geometric distortion. To generate the geometrically distorted images, the two images are combining with different overlap. Some images are simulated which are combination of both photometric distortion and geometric distortion. Finally quality of all simulated images is measured as the PSNR, MSSIM, VIF and MIQM techniques. Results of the Luminance-contrast index, Motion index and Texture index quality measure techniques were compared with implemented quality measure technique which is called MIQM.
Keywords— PSNR, MSE, SSIM, VIF, MIQM

I. INTRODUCTION

Electronics, computing technology increasing, consumers are taking rapid growth but with this growth its cost is required to be rapidly decreasing. If multimedia products are considered then for capturing scenario high quality cameras are required. To satisfy demand, expected features of the cameras required in increase to use them applications like video conferencing, sightseeing, advertisement, security, medical application [1], [2]. Digital images with wide range of variety of distortions during acquisition, processing, compression, storage, transmission as well as reproduction of image any of which results in degradation of the visual quality [2], [3]. To determine the quality of image is becoming effective and efficient way for predicting visual quality. According to availability of reference image, image can be classified as three ways- full reference, reduced reference and no reference. In full reference, the reference image is fully accessible image while evaluating distorted image. In reduced reference method fractional information about reference image is available. In no reference, there is no accessibility with original image. Multicamera images have distortions that are not found in single-view images that occur because of differences in images captured and compressed with different cameras. Three common types of distortion are rotational distortions or perspective, planar or projective distortion and blur. Planar distortion can occur from a calibration problems related to position of camera’s, either due to setup or environmental factors. [1], [2]. PSNR is most widely used objective image quality metric; but it is not well correlated with subjective assessment. Thus, there are many of objective image quality metrics (IQM) developed for replacement to PSNR. The objective of this project is to introduce the objective quality measures for geometrically distorted multicamera images, which has been the better connection with human observation of the distortions. [1]

II. LITERATURE SURVEY

Hui Li, Zhengguo Li, Yih Han Tan et. al. [4] were described the relationship between the Mean Square Error (MSE) and Multi-structure Similarity Index Measure (MSSIM) under additive noise distortion and derived a MSE-based image quality metric, (MSE-SSIM) Mean Square Error-Structure Similarity Index Measure.

Zhou Wang, Alan Conrad Bovik, Eero P. Simoncelli, Hamid Rahim Sheikh, et. al [5] introduced approach for quality assessment based on the degradation of structural quality information. To demonstrate the concept they developed a structural Similarity index.

Chih-Wei Tang, Ching-Ho Chen, Ya-Hui Yu, and Chun-Jen Tsai et. al. described a video bit allocation technique for adopting a visual distortion sensitivity analysis in better rate-visual distortion coding control. That analysis directs the video coder control to assign bits to regions which tolerating larger distortions and accordingly the bit-rate saving was achieved.

Zhou Wang, Qiang Li et. al. described the multiscale information content weighing approach based upon GSM model of natural images. They show that performance improvement of both PSNR and SSIM based image quality assessment algorithms.

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III. DISTORTION TYPES AND QUALITY ASSESSMENT TECHNIQUES WITH MULTICAMERA IMAGES

A. *Types Of Distortions*

The In a multicamera images, it is necessary to simulate the distortions single digital camera was used to capture high resolution images. Each image was then split into multiple sub-images within overlap areas. The overlap areas are varied with each image; however, they were all in the range of 5% –10% of the original image. Then distortion was applied separately on each individual sub-image. The multicamera image was then simulated by compositing the sub-images into one single image, using a multi-resolution spine. The reference image is created by combining all sub-images without any of distortion. The distortion may be created due to camera shake, creating motion blur which prevents from obtaining high quality images. A distortion for multicamera image system is classified in photometric, geometric distortion.

B. *Photometric Distortion*

In Multicamera image, these distortions are the visible changes in brightness level and colour across the entire displayed image. In figure 1 original image is shown and in figure 2 photometrical distorted image is displayed.

Fig 1: Original Image

Fig 2: Photometrically Distorted Image

C. *Geometric Distortion*

In Multicamera image, these distortions can be evaluated as the visible misalignments and blur in the handled image. In manually built Multicamera images, these distortions may also occur due to the mismatch in vertical and horizontal directions among an image and irregular camera rotations. The examples of geometric distortion are given in figure 3, 4 and 5.

Fig 3: Original Image

Fig 4: Geometrically Distorted Image (Blur)

Fig 5: Geometrically Distorted Image Visible Misalignment

D. *Quality Measurement Techniques*

1) *Mean Square Error (MSE):* Here an error signal is obtained by subtracting the distorted signal from the reference signal and then calculating the average energy of that error signal, MSE is calculated.

$$MSE = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}\left(x(i,j) - y(i,j)\right)^2$$

2) *Peak Signal to Noise Ratio (PSNR):* PSNR is mainly an objective technique because it assesses quality of the image by

assessing the error in intensity between the two dissimilar images [1]. PSNR is measured as a function of the mean squared error. PSNR is defined as it is ratio of maximum possible power to corrupting noise. It is given in db as:

$$PSNR = 10 \log_{10} \frac{(2^n - 1)^2}{\sqrt{MSE}}$$

3) *Multistructure Similarity Index Measure (MSSIM):* The extension of SSIM quality metric is multistructure similarity index measure, also proposed for the motionless images. It can be applied pixel by pixel or window by window or frame by frame on the luminance component of image. Then the overall MS-SSIM index can be evaluated by taking average of the above quality score [1].

4) *Visual Information Fidelity (VIF):* To calculate VIF by extracting correlation coefficient matrix diagonal elements between two images to be compared and it is given by the correlation coefficient matrix of n random variables X1.....Xn whose i, j entry is corr(Xi, Xj). If the measures of correlation used are product-moment coefficients, then correlation matrix is the same as the co-variance matrix of standardized random variables Xi / σ(Xi) for i = 1,2,...n. This applied to both the matrix of population correlations (in that "σ" is population standard deviation), and to the matrix of sample correlations (in which "σ" denotes the sample standard deviation).

IV. MATHEMATICAL MODEL AND SYSTEM DEVELOPMENT

A. *Luminance and Contrast Index*

This index measures sudden local changes in the luminance and contrast. To capture such variations, a combination of luminance $L_{I,J}$ and contrast $C_{I,J}$ comparison functions are used, that it is adjusted to give higher weights for structured regions. Let $L_{I,J}$ be the luminance comparison function between the two images I and J, that computed to each blocks. Matrix $L_{I,J}$ of macroblocks is calculated as below equation. Similarly, the matrix $C_{I,J}$ of all macroblock is calculated as:

$$l_{I,J} = \frac{2\,\mu I\,\mu J + C1}{\mu I^2 + \mu J^2 + C1} \qquad c_{I,J} = \frac{2\,\sigma I\,\sigma J + C2}{\sigma I^2 + \sigma J^2 + C2}$$

Where $C_{I,J}$ is the contrast comparison function between I and J computed on each macroblock. Where I is original image and J is distorted image; μ_i is mean intensity of image I, and σ_i is the standard deviation of intensity values of I. The mean and standard deviation are all calculated on macroblock level. C1 and C2 are constants included to avoid instability. [1]

B. *Motion Index*

When geometric distortion in terms as blur means shifting of pixels in the test images (distorted image) with reference to original image. The motion index can be evaluated as:

$$Motion\ Index = \sum_{i=1}^{M} \sum_{j=1}^{N} \left(\frac{\frac{(Xi - Xj)^2}{255^2}}{100} \right)$$

Where X_i is the original image and X_j is the distorted image. The motion index ranges from 1 to 0.

C. *Textural Index*

To get better correlation with subjective quality metric for MSSIM, structural similarity over edge maps should be evaluated. When image is blurred, locations of spatial edges are conserved; the intensity values of these edges changes [1]. Texture index includes mostly two algorithms SSIM and MSSIM. Ci (Iref, Itst) and Si (Iref, Itst) are contrast and structure comparison function, LMs (Iref, Itst) is luminance comparison function.

D. *Multicamera Image Quality Measure (MIQM)*

The multiplication of the three index measures turns into Multiview Image Quality Measure, using a single measurement to capture the quality of a multi-view image, where values ranges from '1' for minimum distortion to '0' for maximum distortion.

$$MIQM_{I,J} = LC_{I,J} \times S_{I,J} \times T_{I,J}$$

MIQM System architecture is shown in figure 6.

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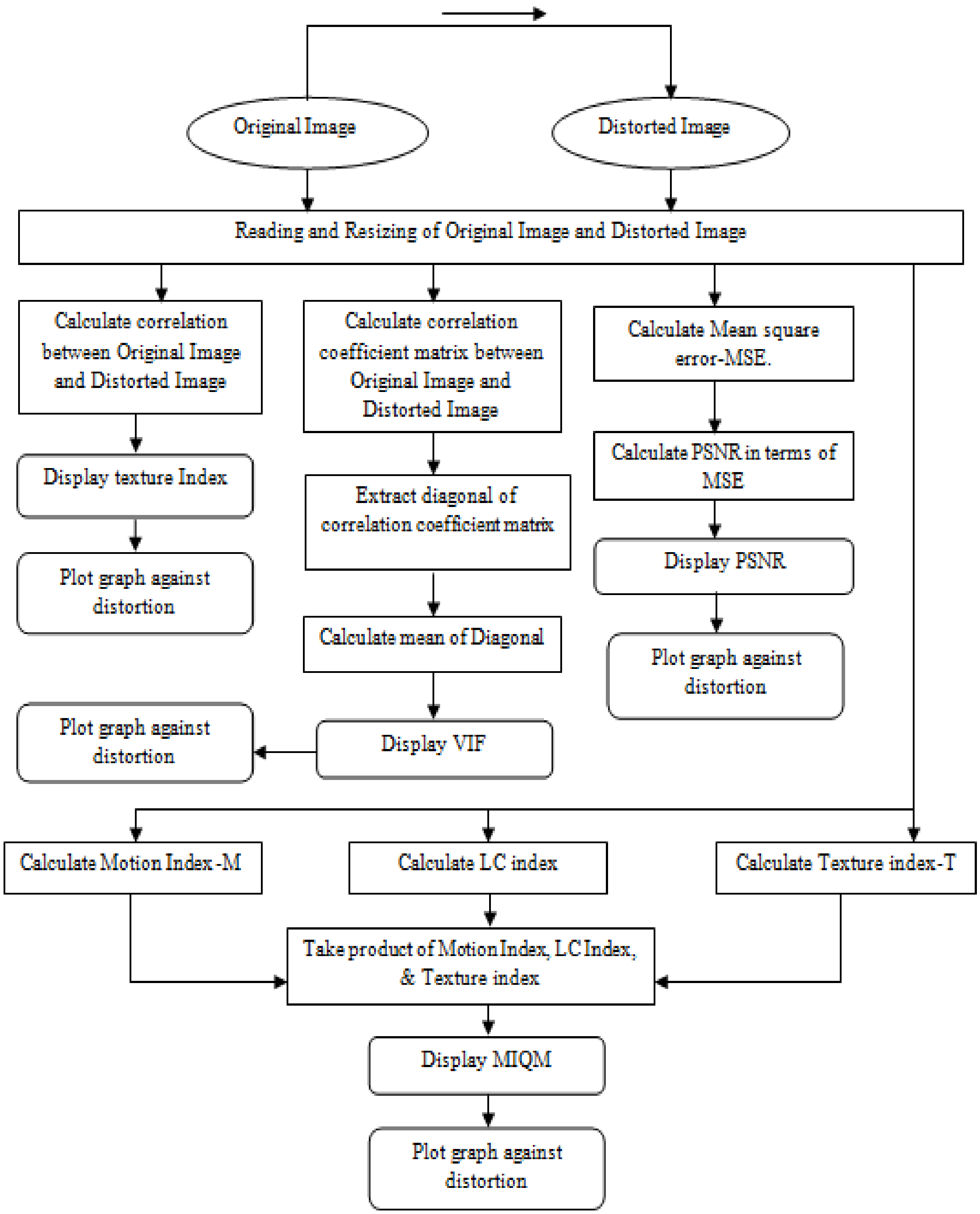

Fig. 6: System Architecture

V. ANALYTICAL RESULTS

As multicamera images are affecting from two types of distortion Geometric and Photometric Distortion. Here single camera images are simulated for both distortions.

A. Photometric Distortion

To simulate the Photometrical Distorted image, the noise is added with original image by salt and pepper technique. The different amounts of noises were added to original image that ranges from (0.01 to 0.9). Table 1 shows comparative analysis of the MIQM with other parameters.

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TABLE I

EXPERIMENTAL RESULTS OF QUALITY PARAMETERS FOR PHOTOMETRIC DISTORTION

Sr. No.	Noise Level	MSSIM	PSNR	VIF	MIQM
1	0	1	1	1	1
2	0.01	0.9325	0.4029	0.9975	0.8758
3	0.02	0.8724	0.3709	0.9945	0.7615
4	0.03	0.8272	0.3553	0.9917	0.6765
5	0.04	0.7900	0.3439	0.9889	0.6026
6	0.05	0.7588	0.3353	0.9859	0.5398
7	0.06	0.7298	0.3294	0.9828	0.4880
8	0.07	0.7062	0.3241	0.9797	0.4421
9	0.08	0.6837	0.3201	0.9770	0.4032
10	0.09	0.6650	0.3155	0.9733	0.3616
11	0.1	0.6438	0.3130	0.9699	0.3325
12	0.2	0.4980	0.2944	0.9293	0.1281
13	0.3	0.4016	0.2867	0.8777	0.0456
14	0.4	0.3245	0.2823	0.8089	0.0071
15	0.5	0.2552	0.2799	0.7186	0.0076
16	0.6	0.1983	0.2782	0.6082	0.0136
17	0.7	0.1104	0.2768	0.4771	0.0149
18	0.8	0.1037	0.2758	0.3204	0.0125
19	0.9	0.0621	0.2752	0.1615	0.0083
20	1	0.0287	0.2746	0.0013	0.0043

Figure 7 shows graphical comparative analysis of Multicamera Image quality measurement techniques for photometrical distortion. From graph it is observed that compare to MSSIM, PSNR as well as VIF; the MIQM shows the better sensitivity to applied distortions.

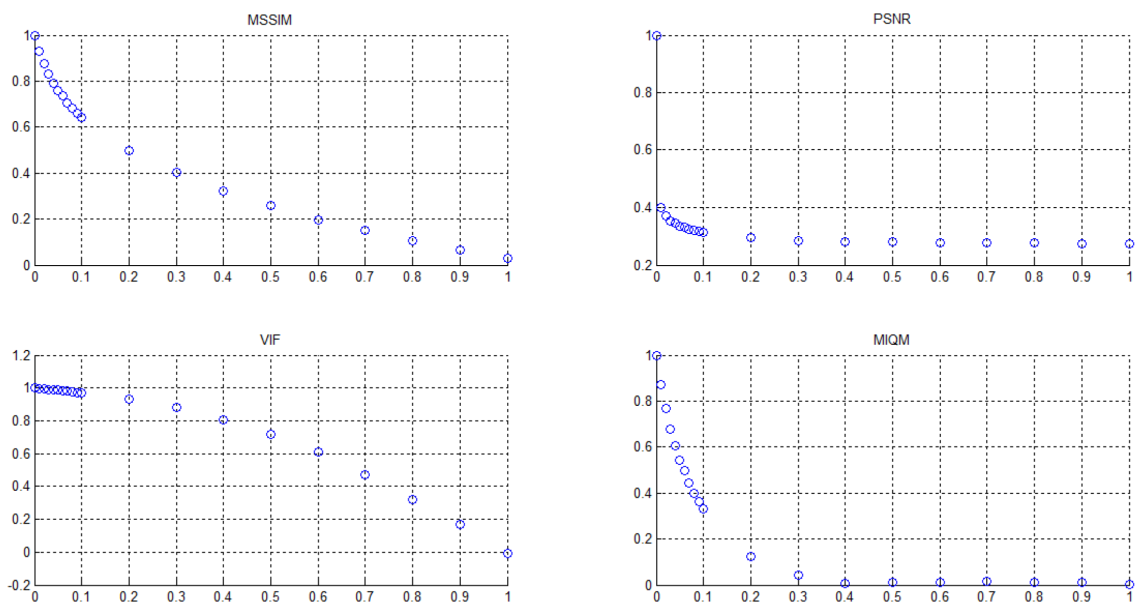

Fig. 7: Graphical experimental results of Multicamera image quality measurement techniques for photometric distortions

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1) *Geometric Distortion*: This type of distortion is the visible blur between the images. The image was simulated which consist of both types of distortions i.e. Photometric Distortion and Geometric Distortion. Here the linear and angular displacements both are varied. The photometric distortion is varied corresponding to linear displacement and three different images are simulated. Figure 8 shows the Low Overlap Multicamera Image, Figure 9 shows Medium overlap Multicamera Image and Figure 10 shows the High overlaps Multicamera Image. Table 2 shows the comparative analysis of Multicamera Image Quality Measurement Techniques for both photometrically and geometrically distorted Images.

Fig. 8: Low Overlap Image

Fig. 9: Medium Overlap Image

Fig. 10: High Overlap Image

TABLE III
EXPERIMENTAL RESULTS OF VISIBLE DISPLACEMENT OF QUALITY PARAMETERS FOR GEOMETRIC DISTORTION

Quality Measurement Technique	Original Image	Low Overlap	Medium Overlap	High Overlap
PSNR	1	0. 3422	0.3196	0.3037
VIF	1	0.9857	0.9501	0.9083
MSSIM	1	0.8719	0.6927	0.4893
MIQM	1	0.6573	0.4059	0.1970

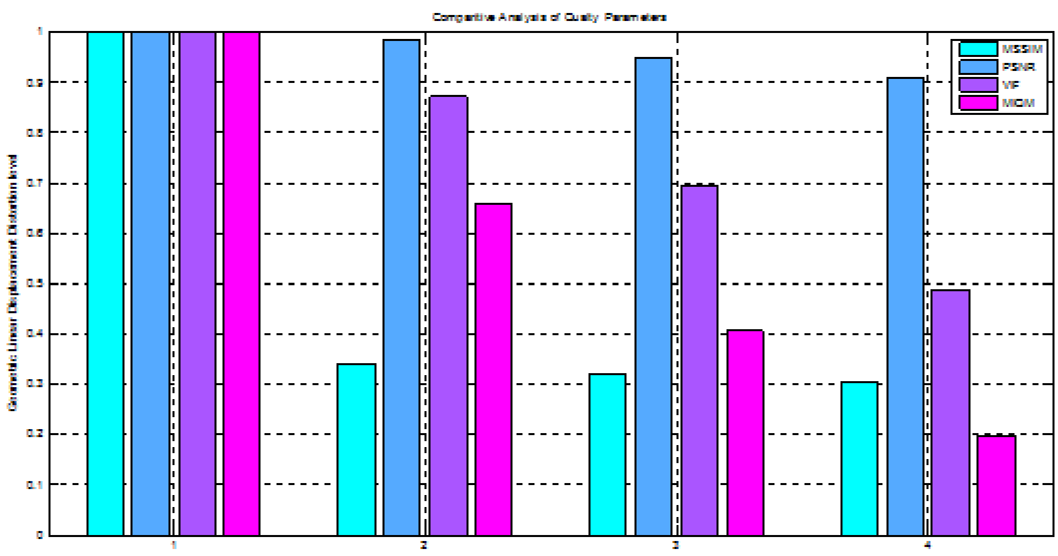

Fig. 11: Comparative analysis of Multicamera Image Quality Measurement Techniques results in the form of Bar graph plot for both photometrically and geometrically distorted Images

Now the system compatibility is shown by different images that are combination of both types of geometric distortions i.e. linear and angular (Planar and Perspective). By changing the values of linear pixel displacement and angle, following results are obtained.

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These results again show the effectiveness of this approach. Figure 12 shows the Original Image. Figure 13 shows the distorted image with linear displacement of 9 and angle 30 and Figure 14 shows the distorted image with linear displacement of 30 and angle 100. Table 3 shows the comparative analysis of Image Quality Measure Methods for both linear and angular geometrically distorted images.


Fig. 12: Original Image


Fig. 13: Distorted image with linear displacement 9 and angular 30


Fig. 14: Distorted image with linear displacement 30 and angular 100

Figure 15 shows graphical Comparative analysis of photometrically distorted Multicamera Image. From graph it is observed that compare to MSSIM, PSNR as well as VIF; the MIQM shows the better sensitivity to applied distortions.

TABLE IIIII
EXPERIMENTAL RESULTS OF LINEAR AND ANGULAR DISPLACEMENT OF QUALITY PARAMETERS FOR GEOMETRIC DISTORTION

Linear Displacement	Angular Displacement	MSSIM	PSNR	VIF	MIQM
5	25	0.9011	0.3423	0.9748	0.6786
10	50	0.78876	0.3230	0.9423	0.4827
15	75	0.7148	0.3161	0.9146	0.3896
20	100	0.6750	0.3114	0.8907	0.3319
25	125	0.5662	0.3006	0.8329	0.1962
30	150	0.4957	0.2969	0.7715	0.1429
35	175	0.5391	0.2981	0.7787	0.1668
40	200	0.4995	0.2945	0.7640	0.1253
45	225	0.4718	0.2928	0.7395	0.1042

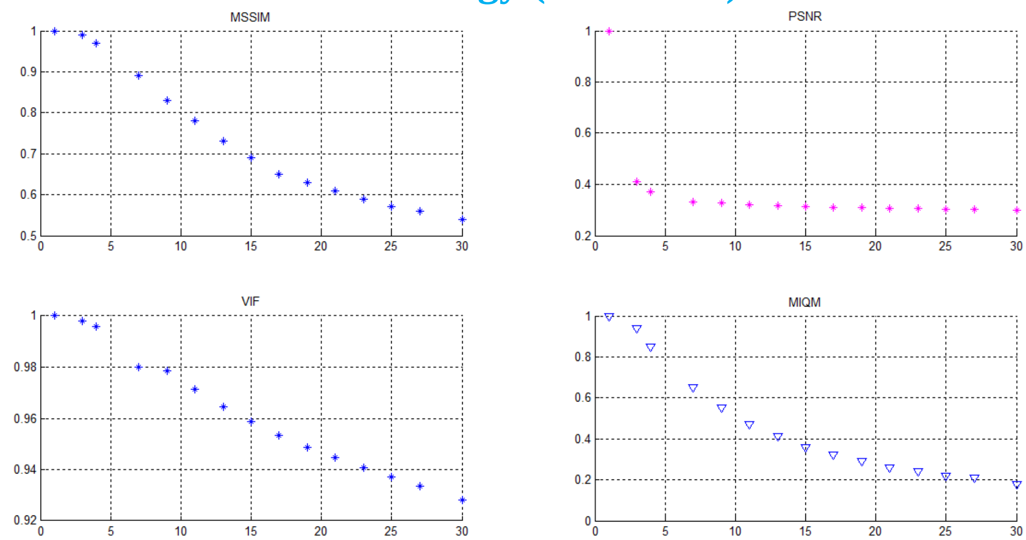

Fig. 15: Graphical experimental results of Multicamera image quality measurement techniques for Geometric distortions

VI. CONCLUSION

To measure the quality of multicamera images, the objective metrics such as PSNR, VIF, MSSIM and MIQM are implemented. As multicamera images affected due to photometric and geometric distortion, so here both the types of distortions are studied and simulated. From analysed results it is observed that for photometrical distorted multicamera images, geometrical distorted images for blurred (pixel shifting) images the multicamera quality measure technique (MIQM) gives the better results compared to other parameters like PSNR, VIF and MSSIM. Here MIQM gives good sensitivity compare to other quality assessment technique.

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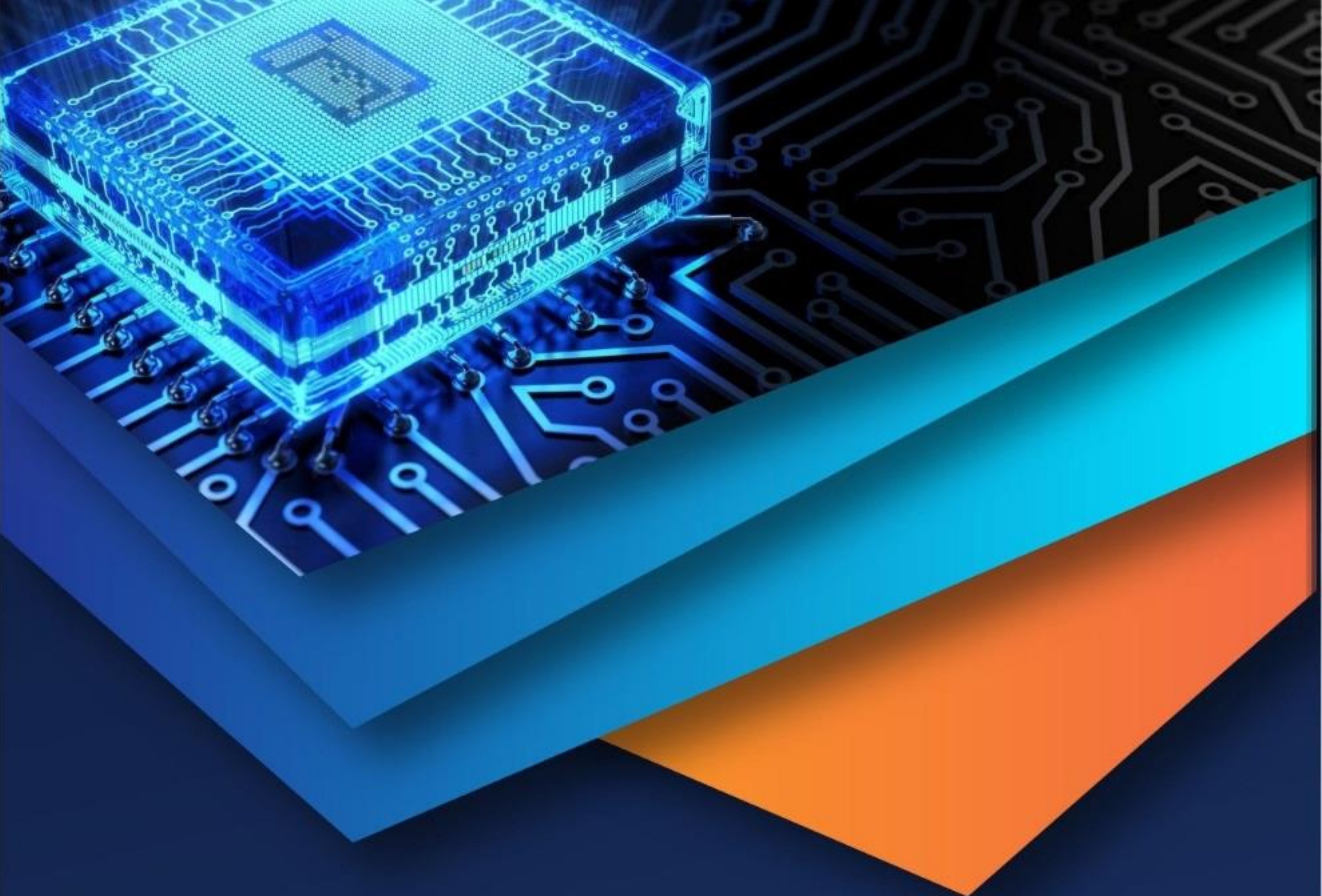

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