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Implementation of high definition video content using high resolution

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Abstract:

Video Quality measurements are highly desirable for the performance evaluation of videos in wireless communications. In literature there are various Video Quality Assessment (VQA) algorithms, which have been developed with varying computational complexities and accuracy. This paper introducing a Full Reference (FR) VQA algorithm is implemented using wavelet and statistical measures. This method can track perceptual quality better with comparable high accuracy and low complexity. This FR algorithm is implemented using MATLAB. An objective VQA method consists of video quality measurement metrics based on models of the Human Visual System that can evaluate the quality of videos automatically without the human intervention.

Index terms:

Discrete Cosine transform, Quality metrics, and Video quality assessment.

1.INTRODUCTION

The purpose of the work is to enhance the visual quality of scalable video sequences. The quality of the video degrades from minute it is captured to the time it is displayed to the human observer. There are several types of of distortions during the video processing such as capturing, storing, processing, compressing, and transmitting etc.

There are two methods followed to evaluating the video quality, the subjective and objective method. The subjective method evolution is considered costly and time consuming. Since we have to choose a number of observers for this experiment, show then a number of videos and ask them to score video quality depending on their own opinion. The objective evolution uses automatic Algorithms to assess the quality of the video without human interfere. Objective video quality matrices are divided into different categories depending on the existence of original video:

- Full-reference: Where the reference video is available
- Reduced-reference: where the reference video exists partially in a set of extracted features as information that helps in the evolution
- No-reference: Where there is no reference video. This is also called "blind quality assessment".

A striped pair comparison has been applied in order to make the test as straightforward as possible for a non-expert participant population. Under these conditions and over this set of sequences, to the average is 54.8% for the sequences. The accuracy and complexity of the video is less by using this striped pair comparison.

Full Reference (FR) VQA algorithm is implemented using wavelet and statistical measures. This method can track perceptual quality better with comparable high accuracy and low complexity. The method consists of wavelet Decomposition for Reference and Distorted Video and Video Quality parameters such as MSSIM, SSSIM, MSE, PSNR and VSSIM.

2. DISCRETE COSINE TRANSFORM

The discrete cosine transform (DCT) calculates the sum of sinusoids of varying magnitudes and frequencies of an image. The discrete cosine transform computes the two-dimensional discrete cosine transform (DCT) of an image. For a normal image, most of the visually predictable information about the image is concentrated over a few coefficients of the DCT. Hence the DCT is often used in image compression applications.

$$D(i,j) = \frac{1}{\sqrt{2N}} C(i) C(j) \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} p(x,y) \cos\left[\frac{(2x+1)i\pi}{2N}\right] \cos\left[\frac{(2y+1)j\pi}{2N}\right]$$

$$C(u) = \left\{ \begin{array}{ll} \frac{1}{\sqrt{2}} & if\ u = 0 \\ 1 & if\ u > 0 \end{array} \right\}$$

P(x,y) is the x,y^th element of the Image , N is the size of the block . The equation calculates one entry(i,j^th) for the pixel values of the transformed image.

$$D(i,j) = \frac{1}{4} C(i) C(j) \sum_{x=0}^{7} \sum_{y=0}^{7} p(x,y) \cos\left[\frac{(2x+1)i\pi}{16}\right] \cos\left[\frac{(2y+1)j\pi}{16}\right]$$

The resulting matrix depends on the horizontal diagonal and vertical frequencies due to the DCT using the cosine function. Therefore an image black with a lot of change in frequency has a very random looking resulting matrix, while an image matrix of just one color, has a resulting matrix of a large value for the first element and zeroes for the other elements.

In our experiment we have both the original and the distorted video and focus on full-reference quality measures. Full reference video quality measures could be classified into five classes of objective video assessment measures.

Multi Scale Structural Similarity index (**MSSIM**) takes the reference and distorted frames, applies a low pass filter and down samples the filtered video frames by a factor of two.

Root Mean Square Error (**RMSE)** and PSNR are used for measuring the video quality by comparing the reference and distorted videos. These typical FR metrics are the most widely used due to its computational simplicity, so it is easy to implement in real time. Quality measurements are done in frame by frame on the luminance component of the video and the overall video quality is taken.

Peak Signal to Noise Ratio (**PSNR**) is also similar to MSE for measuring the video quality assessment by comparing reference and distorted videos. Quality measurements are done in frame by frame on the luminance component of the video and the overall video quality is taken.

Structure Similarity Index (**SSIM)** is a metric based on Natural Visual Statistics, which uses natural visual features and statistical measures such as mean, variance, covariance and distributions. Human Visual System (HVS) is highly adapted for extracting structural information. SSIM metric exploit this feature of HVS. SSIM index is calculated by measuring the luminance, contrast and structure within the sliding window, which moves pixel by pixel from top left to bottom right corner of the video frames. The overall quality of the video is defined as the average of the frame level quality scores.

Video Scale Structural Similarity Index (**VSSIM)** index is calculated on Y, Cb, and Cr components and combined using appropriate weights. At the second level, the local level quality values are weighted and combined to give a frame level quality measure. Frame level quality measures are in turn weighted and averaged to obtain the overall quality of the video sequence.

3. VIDEO QUALITY ASSESSMENT

The aim of pre-processing is an improvement of the image data that suppresses unwanted distortions or enhance some image features important for further processing. Wavelet decomposition is used to extract the features of the image.

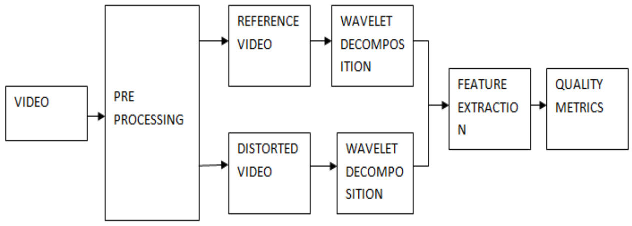


Fig.1: Block diagram

3.1 Video Quality Metrics

a) Mean Square Error (MSE), MSE is defined as average squared intensity of the original image and the resultant image pixels.

$$MSE = \frac{1}{NM} \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} e(m,n)^2$$

Where e(m, n) is the error difference between the original and the distorted video.

b) Peak Signal-to-Noise Ratio (PSNR), Signal–to-noise ratio (SNR) measures the video quality based on the pixel difference between two videos. The SNR calculation is evaluate the quality of reconstructed image compared with original image.

$$PSNR = 10 \log \frac{S^2}{MSE}$$

c) The Structural Similarity Index (SSIM) identifies the image quality degradation caused by processing such as data compression or any other losses in data transmission. It requires two images from the same image capture a reference image and a processed image due to following the full reference algorithm.

$$SSIM(x,y) = \frac{(2\mu_x \mu_Y + C_1)(2\sigma_{xy} + C_2)}{(\mu_x^2 + \mu_y^2 + C_1)(\sigma_x^2 + \sigma_y^2 + C_2)}$$

μ_x, μ_y denotes the mean values of original and distorted images and σ_X, σ_Y denotes the standard deviation of original and distorted images, and

σ_{XY} is the covariance of both images. c_1, c_2 were constants.

d) MSSIM was applied in this video using sliding window technique the size the pixels are moves from horizontal to vertical and covering all the rows and columns of the image, starting from top to left corner of the image. The overall video quality MSSIM is obtained.

$$MSSIM = \frac{1}{P}\sum_{j=1}^{P} SSIM_j$$

e) VSSIM Frame level quality measures are in turn weighted and averaged to obtain the overall quality of the video sequence.

4. METHODOLOGY

First selected video were converted into distorted video using the function of wavelet decomposition in MATLAB, then the metrics were implemented upon these images and last a comparison has been done between five objective evaluations: pixel-difference based measurement Peak Signal-to-Noise Ratio (PSNR), Structural Similarity Index (SSIM), Root Mean Square Error (MSE), Multi Scale Structural Similarity Index (MSSIM), Video Scale Structural Similarity Index (VSSIM) metrics by simulating them using MATLAB software.

MATLAB software is identical for dealing with graphics since it has an image processing tool box, beside it got lots of built in math function that can help in evaluating many statistics.

5. SIMULATION AND RESULTS

5.1 Sample Videos

All used video quality metrics are objective measurements that are automatics and mathematical defined algorithms. The objective video quality assessment for various videos has been compared with different parameters are mention below.

After applying some distortion (contrast enhancement) to the original video, we got the distorted video and the video quality is applied to theses distorted videos and the results are compared.

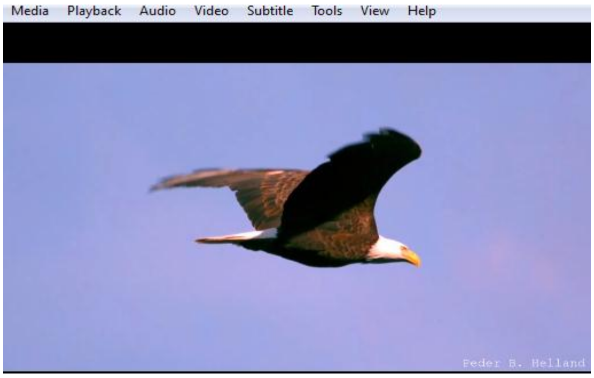


Fig.2: Peder B.hellan-call from the past

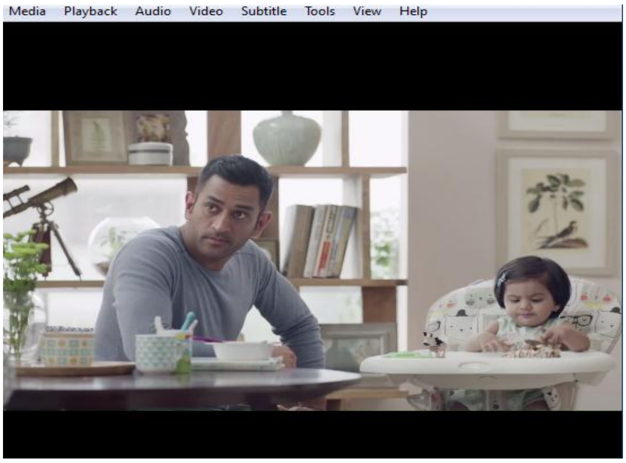


Fig.3: Breakfast time with dad

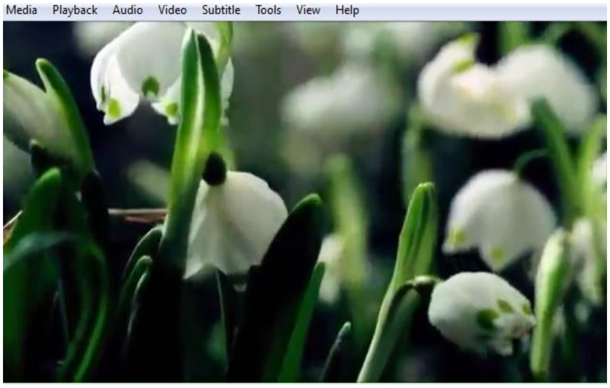


Fig.4: Nature 30 seconds

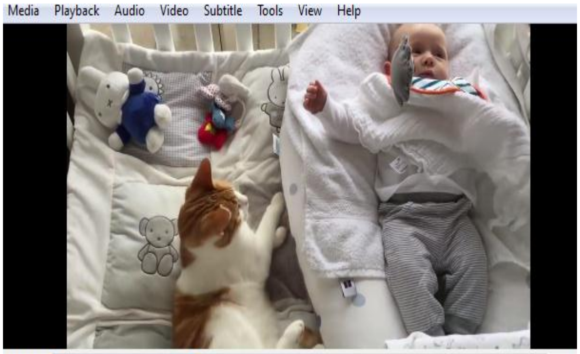


Fig.5: Cute relation between pet and baby

Fig.6: Birthday baby celebration

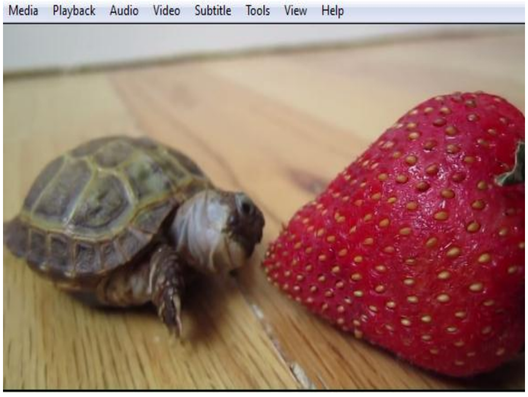


Fig.7: First strawberry

Fig.8: Beautiful face expression of malayali child

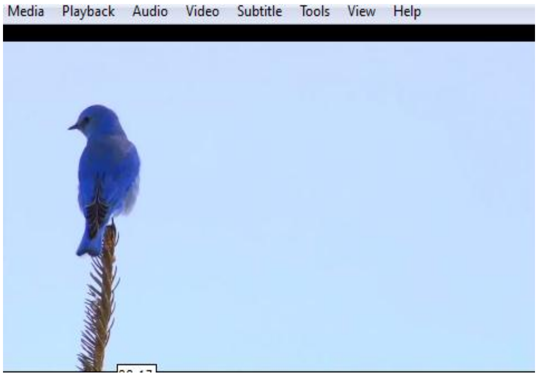


Fig.9: Music of nature

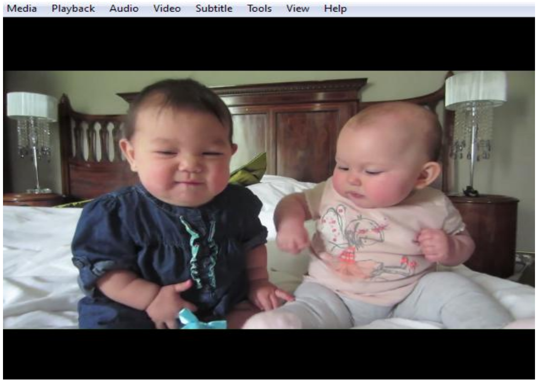
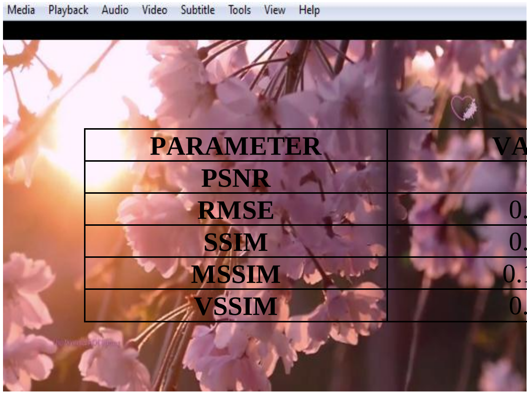


Fig.10: Cutest baby talk ever



PARAMETER	VALUE
PSNR	24
RMSE	0.563
SSIM	0.220
MSSIM	0.1870
VSSIM	0.267

Fig.11: Amazing nature -summer

Measuring video quality for the sample videos gave the results included in TABLE 1

Table.1: ITU Recommended LIVE Database

COMPARISION OF PSNR, SSIM, RMSE, MSSIM AND VSSIM VIDEO QUALITY MEASUREMENTS

Sample Videos		PSNR	RMSE	SSIM	MSSIM	VSSIM
Cutest baby talk ever	Distorted Video	34	0.014	0.01	0.01	0.38
	Proposed Method	35	0.008	0.18	0.4	0.18
Breakfast time with dad	Distorted Video	28	0.012	0.02	0.01	0.38
	Proposed Method	40	0.006	0.2	0.1	0.19
Nature 30 seconds	Distorted Video	38	0.11	0.03	0.03	0.37

	Proposed Method	40	0.006	0.22	0.1	0.19
Cute relation between pet and baby	Distorted Video	34	0.001	0.02	0.02	0.39
	Proposed Method	35	0.006	0.16	0.5	0.18
Birthday baby celebration	Distorted Video	37	0.014	0.01	0.002	0.24
	Proposed Method	40	0.005	0.2	0.5	0.12
First strawberry	Distorted Video	34	0.012	0.03	0.02	0.33
	Proposed Method	38	0.014	0.3	0.1	0.31
Beautiful face expression of malayali child	Distorted Video	33	0.012	0.05	0.04	0.33
	Proposed Method	35	0.014	0.25	0.14	0.3
Amazing nature-summer	Distorted Video	34	0.014	0.01	0.003	0.34
	Proposed Method	37	0.012	0.3	0.35	0.3
Music of nature	Distorted Video	34	0.123	0.03	0.02	0.34
	Proposed Method	30	0.012	0.3	0.1	0.3
Peder B.hellan call from the past	Distorted Video	34	0.015	0.01	0.001	0.34
	Proposed Method	31	0.013	0.27	0.85	0.3
Average		**36.1**	**0.009**	**0.238**	**0.314**	**0.237**

Table.2: Comparisons results of Full Reference Method.

5.3 SIMULATION

Comparison analysis of RMSE, SSIM, MSSIM, VSSIM

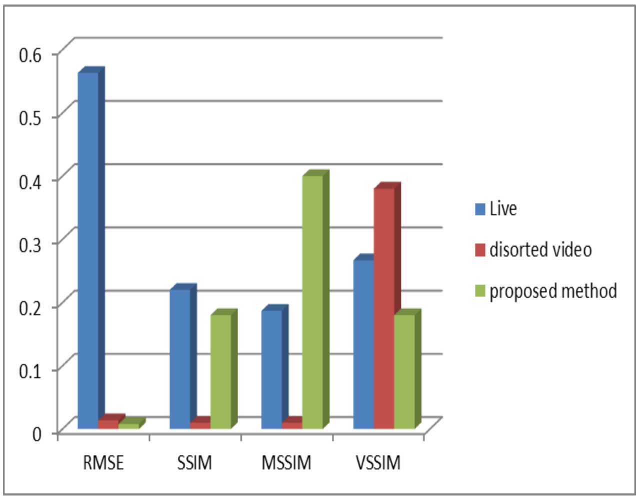


Fig.12: Cutest baby talk ever

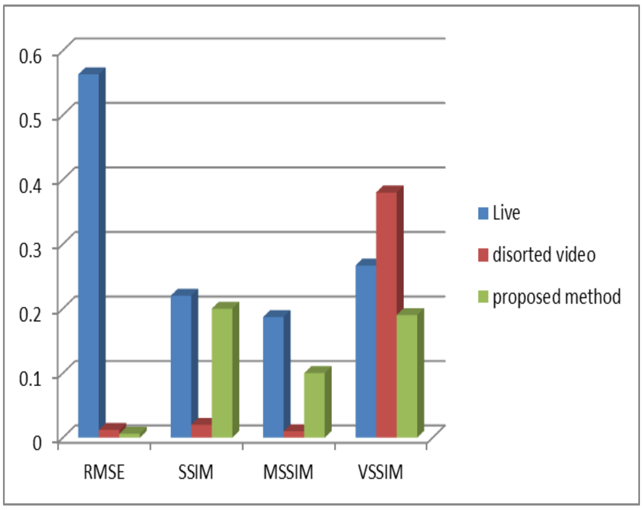


Fig.14: Breakfast time with dad

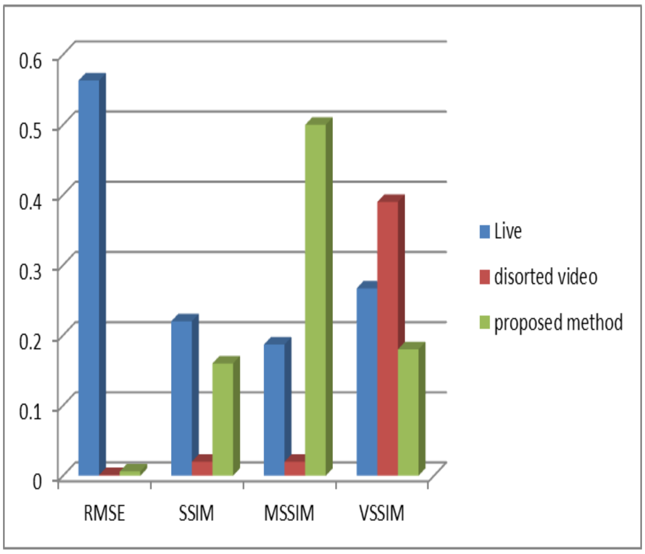


Fig.13: Nature 30 seconds

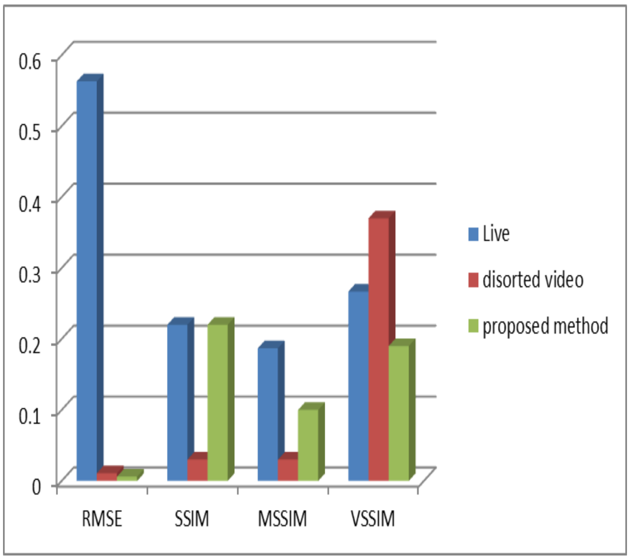


Fig.15: Cute relation between pet and baby

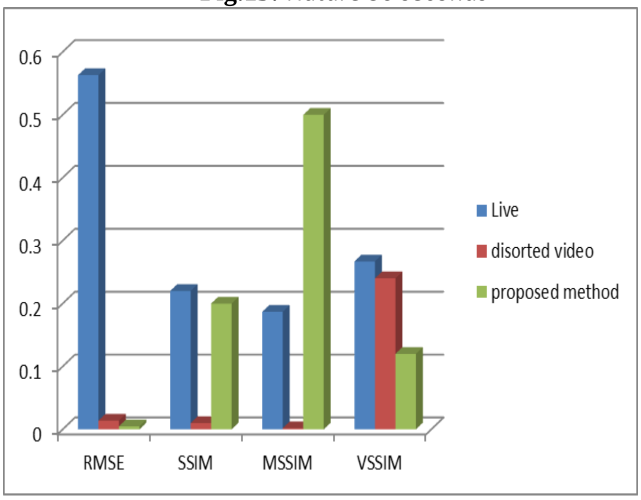


Fig.16: Birth day baby celebration

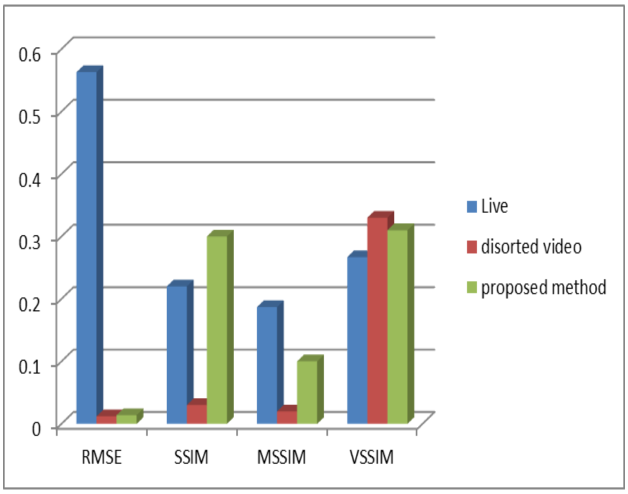


Fig.19: First strawberry

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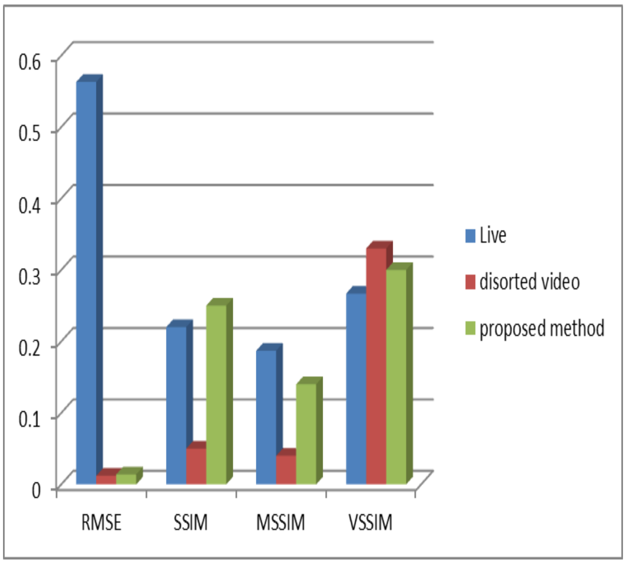

Fig.17: Beautiful face expression of malayali child

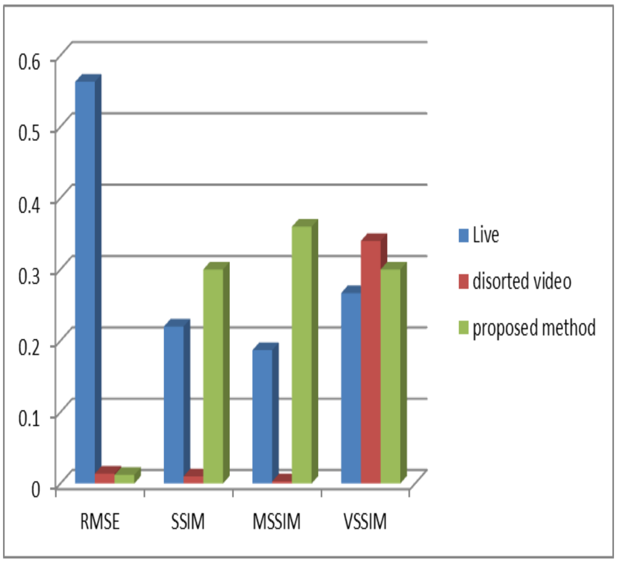

Fig.20: Amazing nature – summer

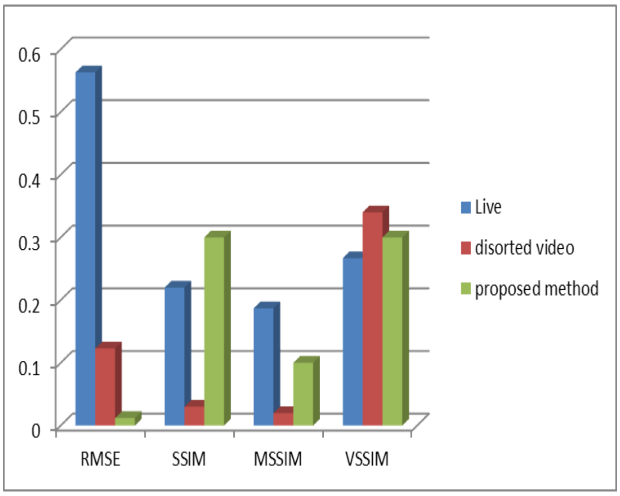

Fig.18: Music of nature

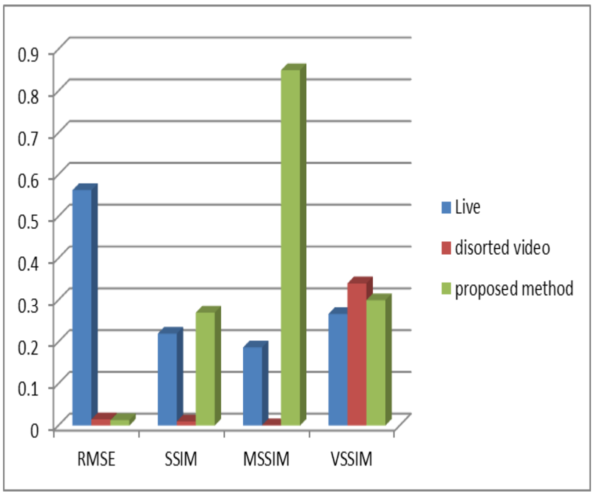

Fig.21: Peder B. Hellan- call from the past

5.4 Comparison analysis of PSNR

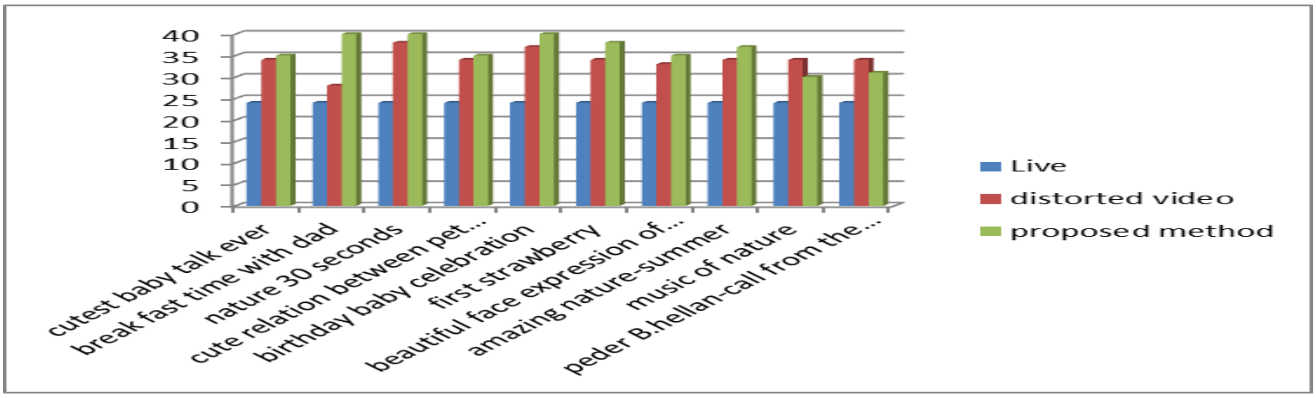

Fig.22: Comparison analysis of PSNR

6. CONCLUSION

There are various types of video quality metrics implemented for enhance the quality of video, but there are still limitations. By using this discrete cosine transform the quality of the video has been enhanced.

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