Objective Video Quality Assessment of Direct Recording and Datavideo HDR-40 Recording System

Nofia Andreana[1], Arif Nursyahid[2], Eni Dwi Wardihani[3]

[1,2,3]Telecommunication Engineering, State Polytechnic of Semarang, Central Java 50275, Indonesia

Email: [1]nofiandreana@gmail.com, [2]arifnursyahid@gmail.com, [3]edwardihani@polines.ac.id

Abstract—*Digital Video Recorder (DVR) is a digital video recorder with hard drive storage media. When the capacity of the hard disk runs out. It will provide information to users and if there is no response, it will be overwritten automatically and the data will be lost.*
The main focus of this paper is to enable recording directly connected to a computer editor. The output of both systems (DVR and Direct Recording) will be compared with an objective assessment using the Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR) parameter. The results showed that the average value of MSE Direct Recording dB 797.8556108, 137.4346100 DVR MSE dB and the average value of PSNR Direct Recording and DVR PSNR dB 19.5942333 27.0914258 dB. This indicates that the DVR has a much better output quality than Direct Recording.

Keywords—*MSE, PSNR, Video Quality, Objective Video Quality, Objective Video Quality Assessment.*

1. Introduction

Video Tape Recorder (VTR) is one piece of equipmentor components that support the production of television programs. it uses videotape as a storage media, but have limited functionality such as, replay, backup and sharing.

Correspondingly, with technological developments, currently, the recording system has been switched to a digital recording system with hard drive storage media. They use digital media formats such as hard drives, USB Flash Drive and the other for storage of program output. The problem in the digital recording systems is the availability of a backup when the hard disk runs out. If this happens, the system will provide information to the user and if there is no response, it will automatically overwrite so the data will be lost [1]. To solve these problems, in this study made a recording system that can take and transmit data from the personal computer that has been connected to a computer editing so that editors can select and edit the output file with the program easily.

Canadian Broadcast Corporation has been migrated to the video capture card so it can easily make an individual video that can be saved and transferred to the media storage such as HDT and DT. The digital file is automatically transferred to the storage media without any fear of data loss during the recording process. Digital capture process use video capture cards (inside computer box) or external analog-to-digital (ADC) plug-in boxes, using Final Cut Pro, Avid or Adobe Premier software, that are stored on HDD or Data Tape (DT). [2]

One of the most important parameters to evaluate and compare image or video codecs is the Rate/Distortion (R/D). It is measured in terms of PSNR (Peak Signal-to- Noise Ratio). This is important to determine the quality of video parameters so the user can rate them. The analysis of video quality can be done by the implement of video codecs with different bitrates.[3] Try to increase the accuracy of video codec by subtitute the value of PSNR with another video coding schemes.

In this study used both Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR) parameters. We analyze the quality of video objectively using MSU VQMT software. This is measure the quality of video and allows to create an objective comparison of video codecs and perform video processing filters analysis [4].

The organization of the paper is as follows: In section one, we describe the background of this research. In section two, we describe the design of Datavideo HDR-40 recording system and Direct Recording system. In section 3, we describe the result of the data and analyze it using the homogeneity test and independent sample t test. Finally, in section 4 some conclusions are given.

2. Research Method

The design of this system divides into two parts. The first one is the hardware setup and the second is the file sharing (map network drive) set up. The goal of objective image quality assessment is to develop quantitative measurement that can automatically predict perceived image quality.In this research determine the Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR) of Direct Recording and Datavideo HDR-40 recording system. The Datavideo HDR-40 recording system shown at

Fig.1 and Direct Recording is shown at Fig.2 both of system are analyzed the differences in the operational and output of the recording system.
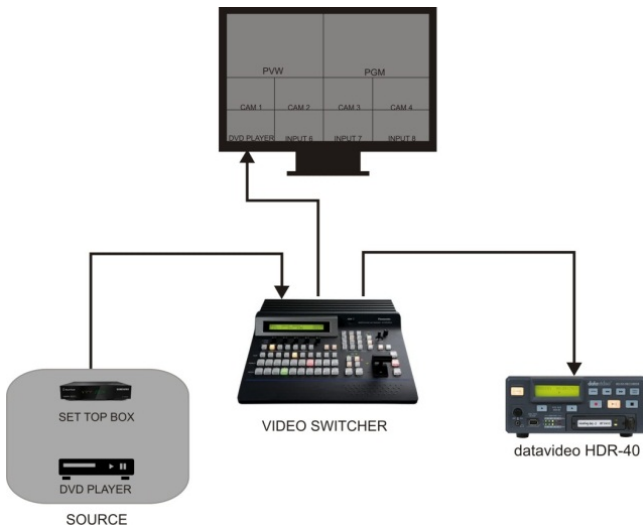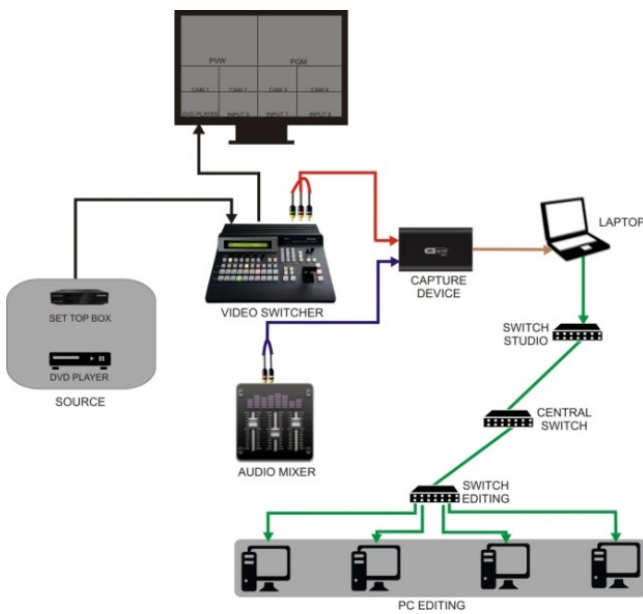

Fig.1 Datavideo HDR-40 Recording System

Fig.2 Direct Recording System

Objective image/video quality parameters is an equation or mathematical calculations. The results of the measurement are expected to correlate well with an assessment of the human perception. Objective video quality metric can be assessed by computing the correlation between the objective scores (MSE and PSNR parameters) and the subjective (human perception) test results.

The peak signal-to-noise ratio (PSNR) measures the logarithm of the ratio of the maximum signal power to the mean square difference (MSE), given by:[6]

$$PSNR = 20.\log 10 \left(\frac{255}{\sqrt{MSE}} \right) \quad (2.1)$$

Where N is the number of samples over which the signal is approximated. Similarly, the MSE for a two-dimensional signal such as image or a video frame with width M and height N is given by:[6]

$$MSE = \frac{1}{M.N} \sum_{i=1}^{M} \sum_{j=1}^{N} \left(f(i,j) - g(i,j) \right)^2 \quad (2.2)$$

Where $f(i,j)$ is the pixel value at location (i,j) of the source image, and $f(i,j)$ is the corresponding pixel value in the reconstructed image. PSNR is usually measured in an image plane, such as the luma or chroma plane of a video frame.

3. Results and Analysis

The method of collecting data is done by connecting the video recording, the DVR Datavideo HDR-40 and U800 Mygica Capture Device to the source video. Then the video recorded for 1 minute with 5 seconds of period. MSE and PSNR value measurement is performed offline using MSU VQMT. Then it used t-test to estimate the average interval of 12 samples.

3.1. Mean Square Error Measurement

Based on measurements using VQMT software, results in **Table 3.1** show that the MSE value on the Datavideo HDR-40 is lower than the value of MSE on Direct Recording. PSNR is using a term mean square error (MSE) in the denominator. So, lowers the error, higher will be the PSNR.

Table 3.1 the average result of MSE between Datavideo HDR-40 and Direct Recording

Duration (s)	Total Frame	Result (AVG)	
		MSE Direct Rec	MSE Datavideo
5	125	659.87695	85.51710
10	250	540.11719	95.51151
15	375	621.74585	107.77870
20	500	530.57104	84.37801
25	625	587.32501	61.36390
30	750	2494.26660	89.21980
35	875	852.13062	64.55264
40	1000	679.19000	100.98051
45	1125	765.16388	119.20049
50	1250	692.45776	706.51642
55	1375	535.00153	60.41979
60	1500	616.42090	73.77645

3.2. Peak Signal to Noise Ratio Measurement

Peak signal-to-noise ratio, often abbreviated PSNR, is an engineering term for the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the result of its representation [7].

Table 3.2the average result of PSNR between Datavideo HDR-40 and Direct Recording

Duration (s)	Total Frame	Result (AVG)	
		PSNR Direct Rec (dB)	PSNR Datavideo (dB)
5	125	19.93365	28.80185
10	250	20.80236	28.32377
15	375	20.19198	15.38472
20	500	20.88019	28.85942
25	625	20.43930	30.24063
30	750	14.16224	28.62046
35	875	18.82347	30.02515
40	1000	19.80816	28.08214
45	1125	19.29146	27.36331
50	1250	19.72430	19.63800
55	1375	20.84395	30.31214
60	1500	20.22974	29.44552

Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE) are used to compare the squared error between the original video and the reconstructed video. There is an inverse relationship between PSNR and MSE. As can be seen in Table 3.2 higher PSNR value indicates the high quality of the video (better).

3.3 Homogeneity Test

In order to use an Independent Sample t-Test, the data should show homogeneity of variance. In other words, the spread of scores in each condition should be roughly similar. Sometimes, it's quite obvious that the variances are very dissimilar. In other cases, it's less obvious, and a more formal test is required. There are various ways to test for homogeneity of variance.

Table 3.3 MSE Homogeneity Test

Independent Samples Test

		Levene's Test for Equality of Variances	t-test for Equality of Means			
					95% Confidence Interval of the Difference	
		Sig.	df	Sig. (2-tailed)	Lower	Upper
Y	Equal variances assumed	.164	22	.001	318.01103	1002.83097
	Equal variances not assumed		13.395	.001	304.79511	1016.04689

Table 3.4 PSNR Homogeneity Test

Independent Samples Test

		Levene's Test for Equality of Variances	t-test for Equality of Means				
						95% Confidence Interval of the Difference	
		Sig.	t	df	Sig. (2-tailed)	Lower	Upper
Y	Equal variances assumed	.051	-5.199	22	.000	-10.48798	-4.50641
	Equal variances not assumed		-5.199	14.298	.000	-10.58420	-4.41018

Based on the result shown in Table 3.3 and Table 3.4, The hypotheses of this test are:
The result has a p <=.05, it means that the data do not show homogeneity of variance.
If the Levene's test is not significant (p >.05) Then the data show homogeneity of variance.
In this case, MSE and PSNR both have Level of Significance (p-value) >.05, it means the data show homogeneity of variance.

3.4 Independent Sample t-Test

The independent-samples t-test (or independent t-test, for short) compares the means between two unrelated groups on the same continuum, dependent variable. Evaluate whether the means of two independent groups are significantly different from each other [8]. The purpose of using independent samples t-test is to compare the quality of two samples, which one is the best or better between the two samples.

3.4.1 MSE Independent t-Test
   The hypotheses in this case can be expressed as:

H0: The average value of MSE on Direct Recording is identical to the average value of MSE on Datavideo HDR-40.

H1: The average value of MSE on Direct Recording is not identical to the average value of MSE on Datavideo HDR-40.

From the hypotheses above,
If: t value > t table = reject H0
t value < t table = accept H0   or,
(Sig.)p-value < 0.05 = reject H0
(Sig.)p-value > 0.05 = accept H0

$$df = n - k = 24 - 4 = 20,$$
$$t_{table} = 2,08596$$

Table 3.5 MSE Independent t-Test

Independent Samples Test

		Levene's Test for Equality of Variances	t-test for Equality of Means				95% Confidence Interval of the Difference	
		Sig.	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Y	Equal variances assumed	.164	4.000	22	.001	660.42100	318.01103	1002.83097
	Equal variances not assumed		4.000	13.395	.001	660.42100	304.79511	1016.04689

   In **Table 3.5** since *p* < 0,001   is less than the chosen significance level *α* = 0.05, the null hypothesis is rejected, and conclude that the that The average value of MSE on Direct Recording and Datavideo HDR-40 is significantly different.

Since the t value 4.000 which is higher than t table 2,05896, the null hypothesis is being rejected and conclude that The average value of MSE on Direct Recording is significantly different than the average value of MSE on Datavideo HDR-40.

The main purpose of using independent samples t-test is to compare the quality of two samples, which is the best or better between the two samples. To determine which one is having the best quality can be seen on the Mean column, shown in Table 3.6. Direct Recording has a higher mean of error than Datavideo which is it means that Datavideo HDR-40 has much better quality than Direct Recording.

Table 3.6 Error Mean of Direct Recording and Datavideo HDR-40

Group Statistics

	X	N	Mean	Std. Deviation	Std. Error Mean
Y	Direct Recording	12	797.8556	542.82693	156.70064
	Datavideo	12	137.4346	180.16906	52.01033

3.4.2 PSNR Independent t-Test
   The first step for using independent t-test states the hypotheses, the null hypothesis (H0)and the alternative hypothesis (H1) of the independent samples T-test can be expressed in two different but equivalent ways:

   H0: The average value of PSNR on Direct Recording is identical to the average value of PSNR on Datavideo HDR-40.

   H1: The average value of PSNR on Direct Recording is not identical to the average value of PSNR on Datavideo HDR-40.

Then set the criterion: α = 5% = 0,05

$$df = n - k = 24 - 4 = 20,$$
$$t_{table} = 2,08596$$

If: t value > t table = reject H_0
          t value < t table = accept H_0 or,
          –tvalue < -t tabel= reject H_0
          (Sig.)p-value < 0.05 = reject H_0
          (Sig.)p-value > 0.05 = accept H_0

Table 3.7 PSNR Independent t-Test

Independent Samples Test

		Levene's Test for Equality of Variances	t-test for Equality of Means				
						95% Confidence Interval of the Difference	
		Sig.	t	df	Sig. (2-tailed)	Lower	Upper
Y	Equal variances assumed	.051	-5.199	22	.000	-10.48798	-4.50641
	Equal variances not assumed		-5.199	14.298	.000	-10.58420	-4.41018

In Table 3.7 since t value -5.199 which is less than t table -2,05896, the null hypothesis is being rejected and conclude that The average value of MSE on Direct Recording is significantly different than the average value of MSE on Datavideo HDR-40. To determine which one has the best output quality can be seen on column Mean. Based on table 3.8 Direct Recording has less PSNR value than Datavideo HDR-40. The higher PSNR value indicates the high quality of the video (better).

Table 3.8 PSNRMean of Direct Recording and Datavideo HDR-40

Group Statistics

	X	N	Mean	Std. Deviation	Std. Error Mean
Y	Direct Recording	12	19.5942	1.82210	.52600
	Datavideo	12	27.0914	4.65152	1.34278

4. Conclusion

Based on comparative analysis of the objective quality assessment of Direct Recording MyGica U800 and Datavideo HDR-40, it can be concluded some of the following:

1. The average value of MSE of Direct Recording is significantly different than the average value of MSE on Datavideo HDR-40. It can be seen in the comparison of t value 4.000 which is higher than t table 2,05896 with Level of Significance (p-value) > 0.05.

2. The average value of MSE of Direct Recording and Datavideo HDR-40 is significantly different. It can be seen in the comparison of t value -5.199 which is less than t table -2,05896 with Level of Significance (p-value) > 0.05.

3. The Datavideo HDR-40 has much better quality output than Direct Recording. Based on the mean column MSE Direct Recording has a higher average than Datavideo (DR= 797.8556108 > DV= 137.4346100). The higher error, the low quality (PSNR) it will be DR= 19.5942333 dB <DV= 27.0914258 dB.

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