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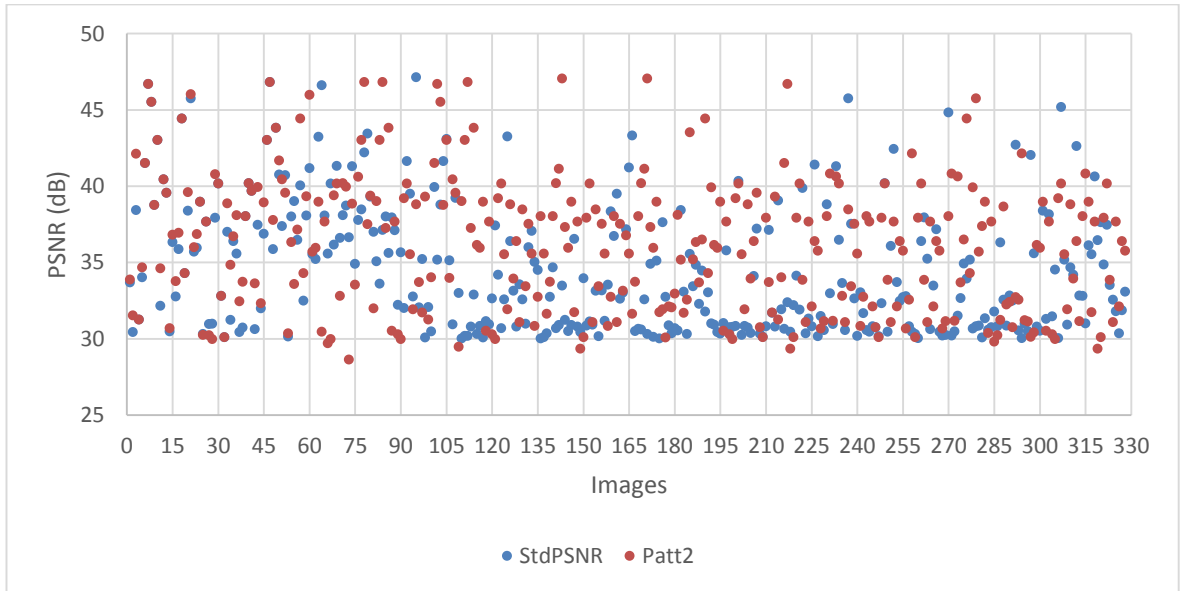
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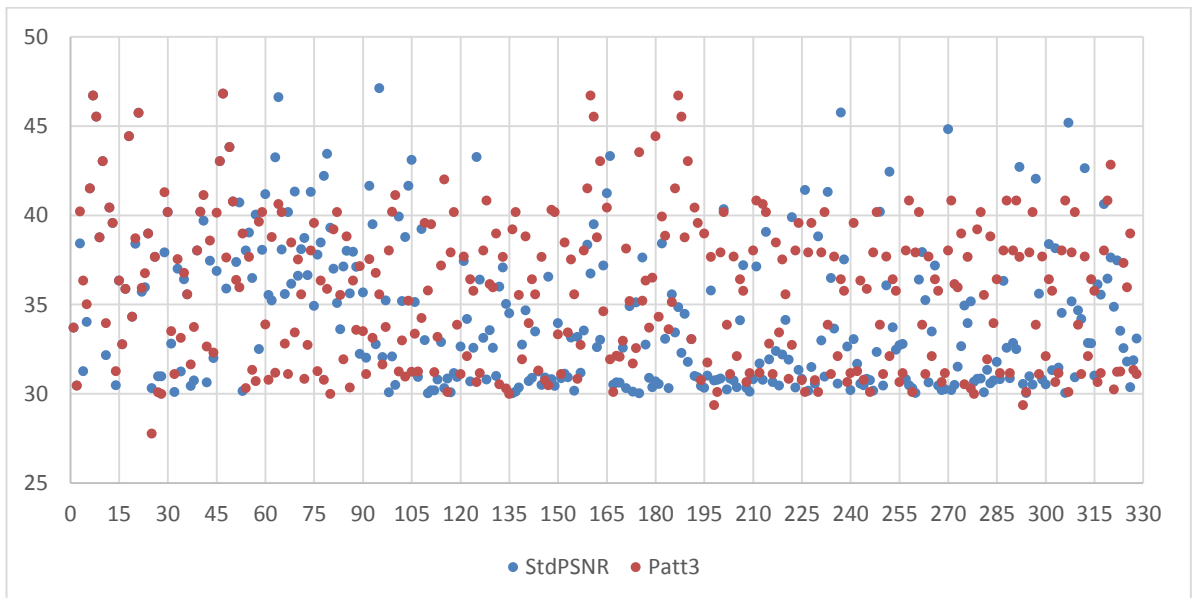
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APPENDIX A: COMPARISON OF PSNR VALUES FOR STANDARD HIDING PATTERN AND FIFTEEN GENERATED DATA HIDING PATTERNS

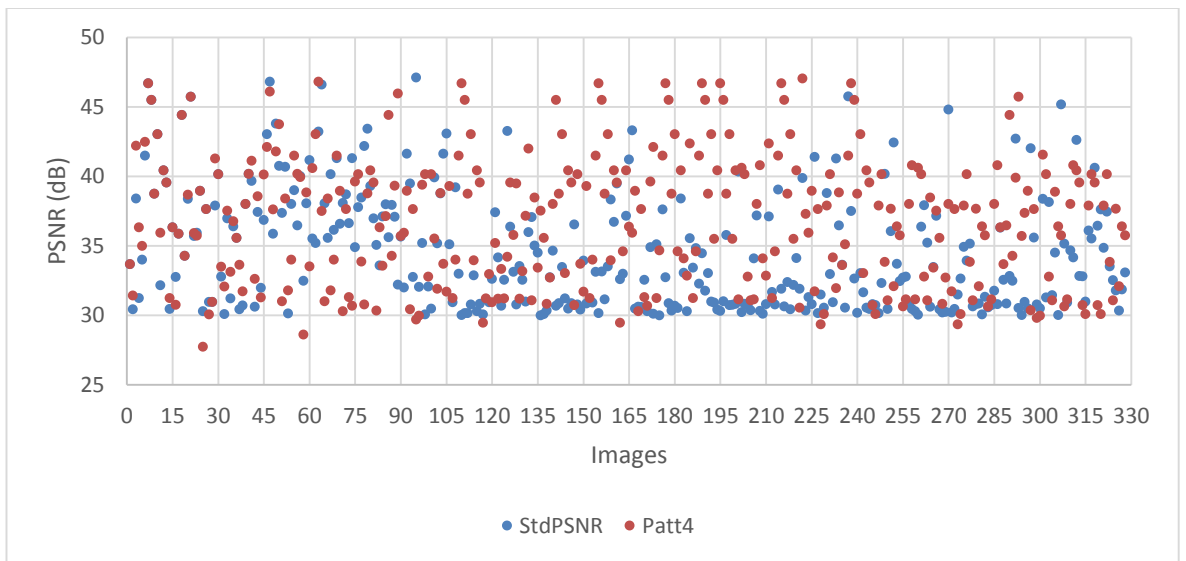
Pattern 2 vs StdPSNR



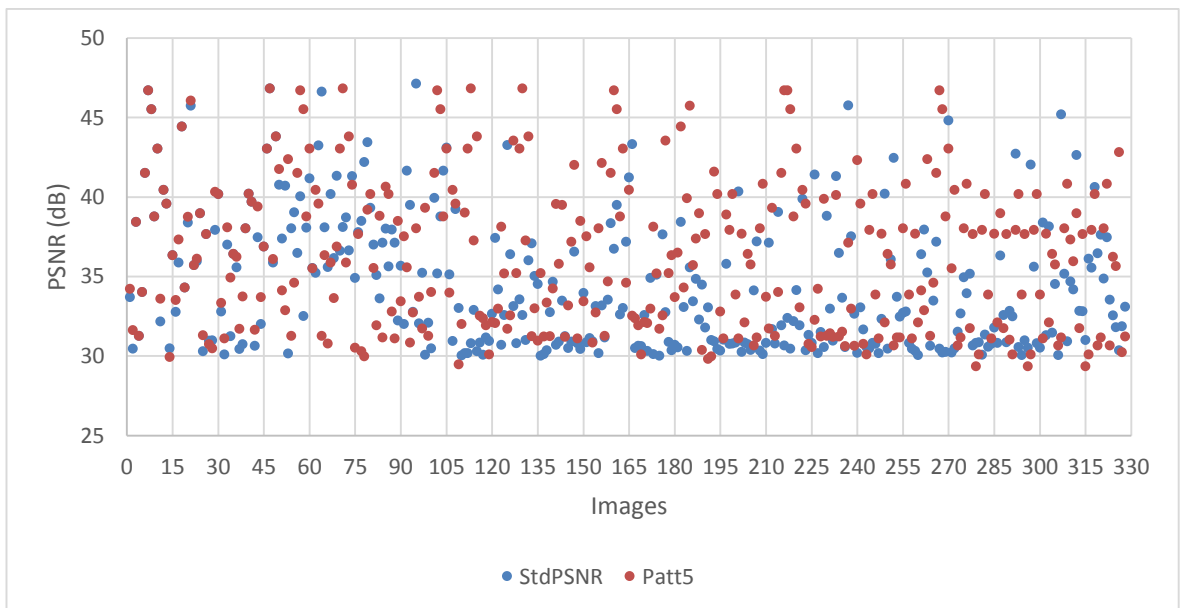
Pattern3 vs StdPSNR



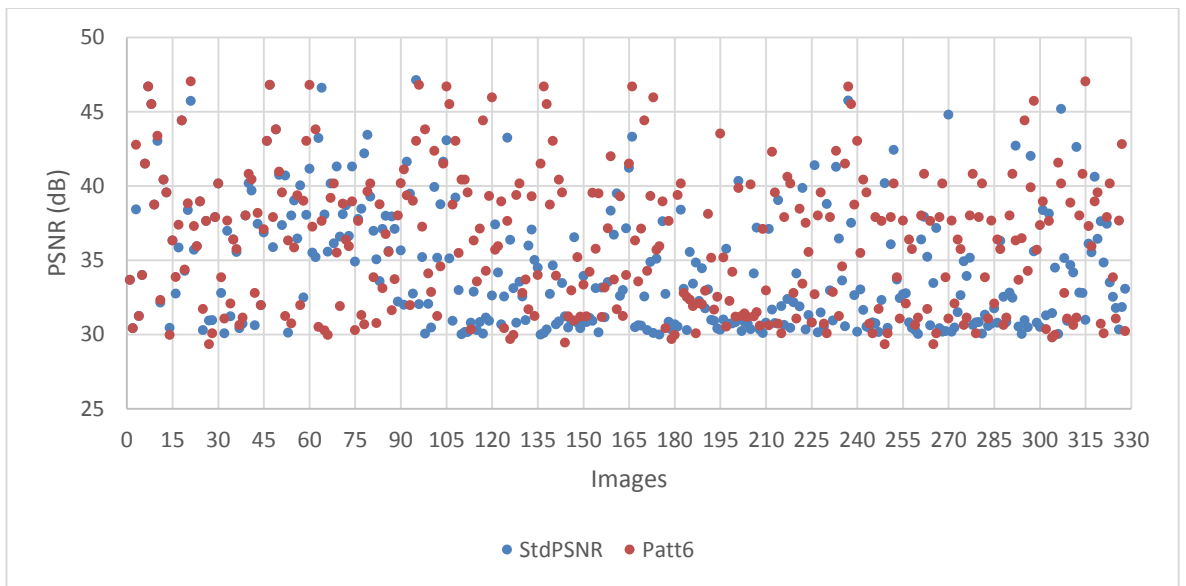
Pattern 4 vs StdPSNR



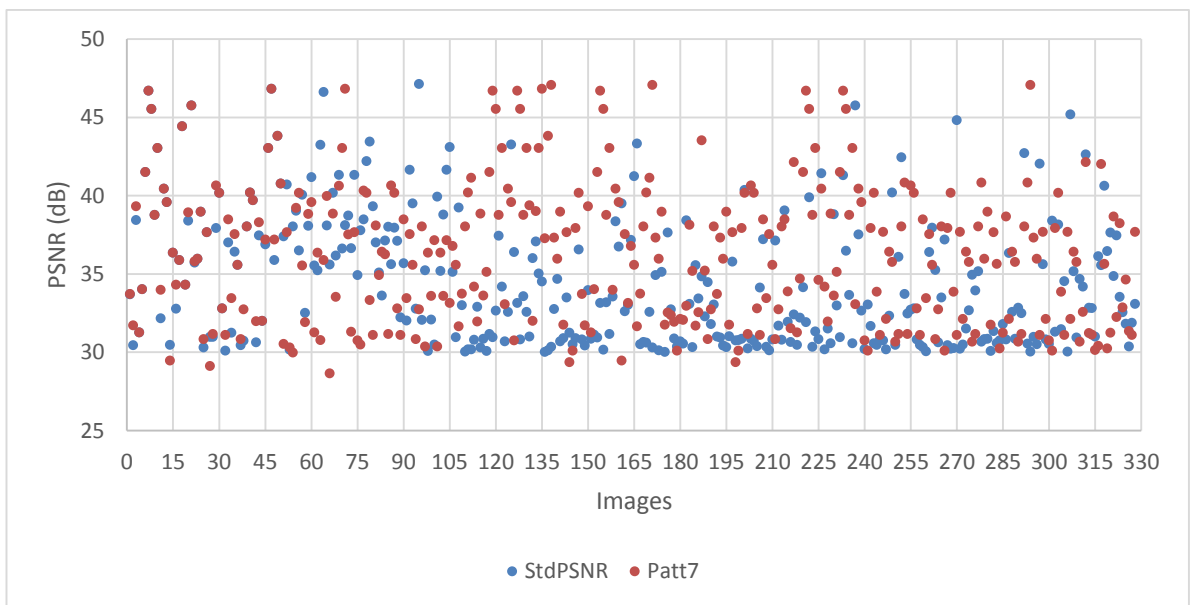
Pattern 5 vs StdPSNR



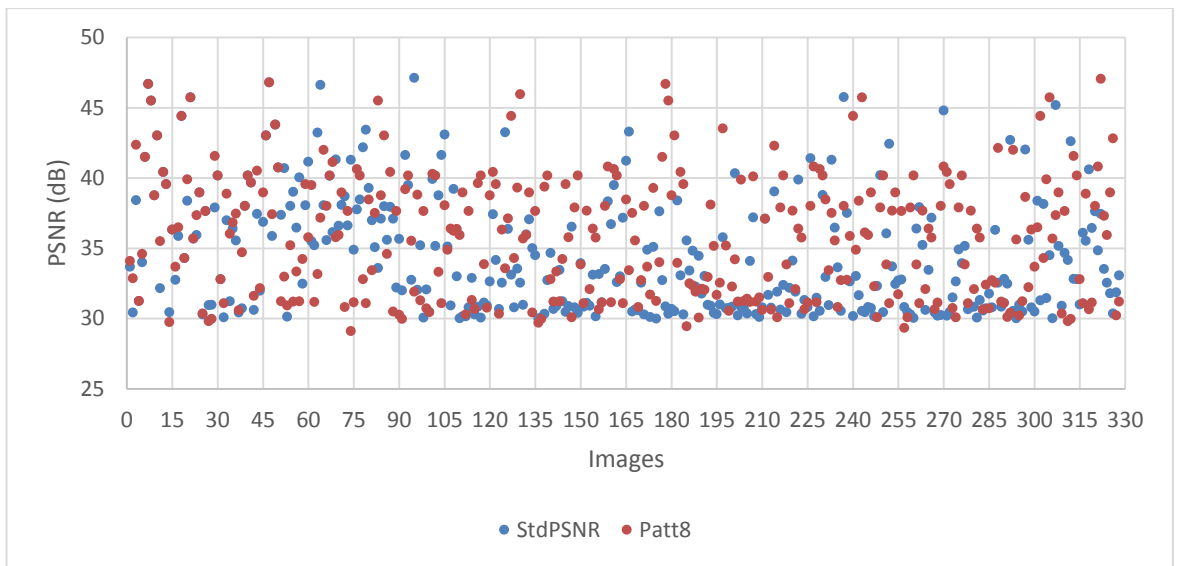
Pattern 6 vs StdPSNR



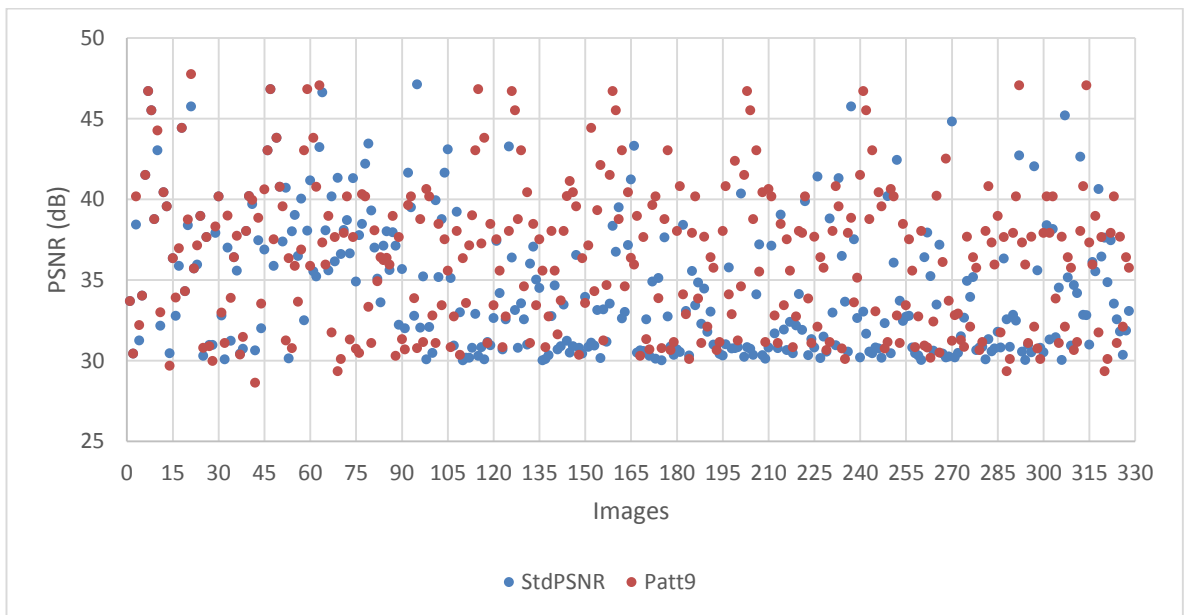
Pattern 7 vs StdPSNR



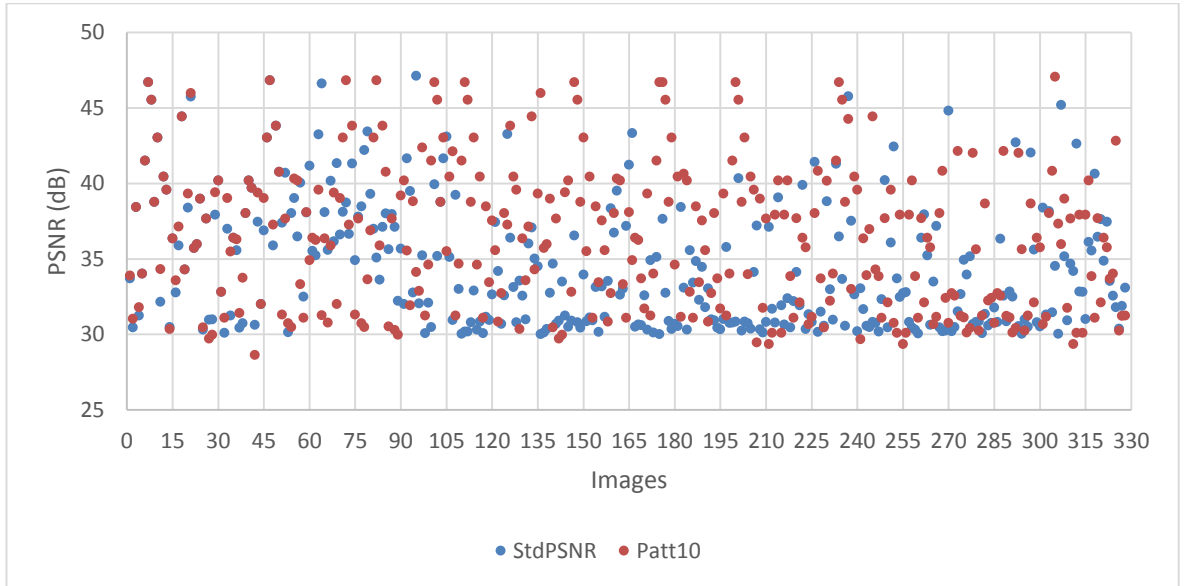
Pattern 8 vs StdPSNR



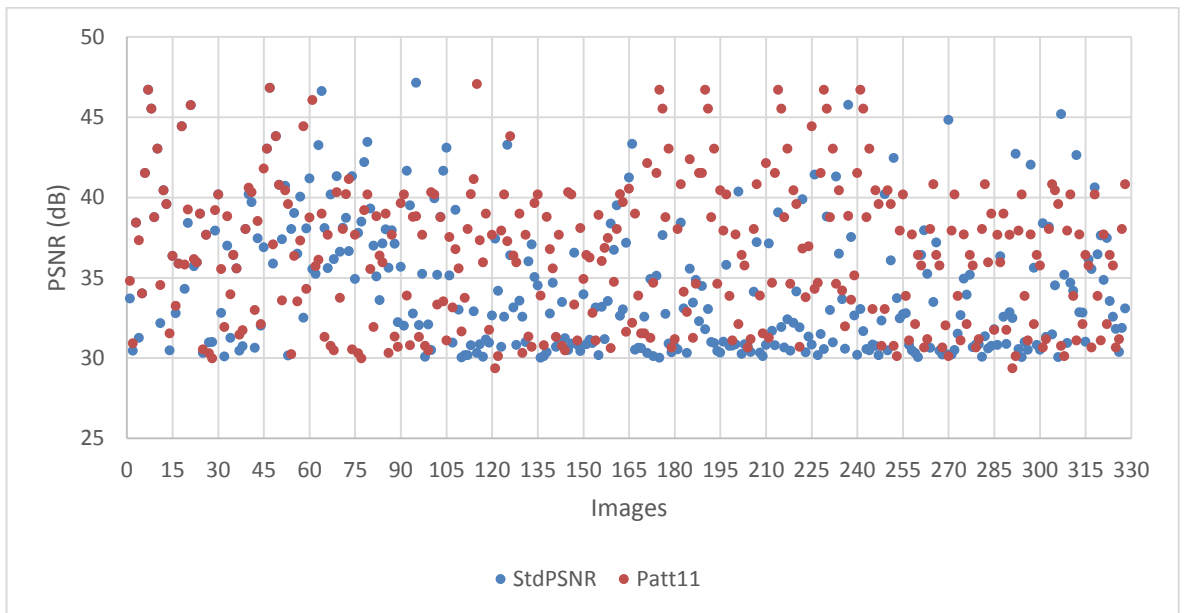
Pattern 9 vs StdPSNR



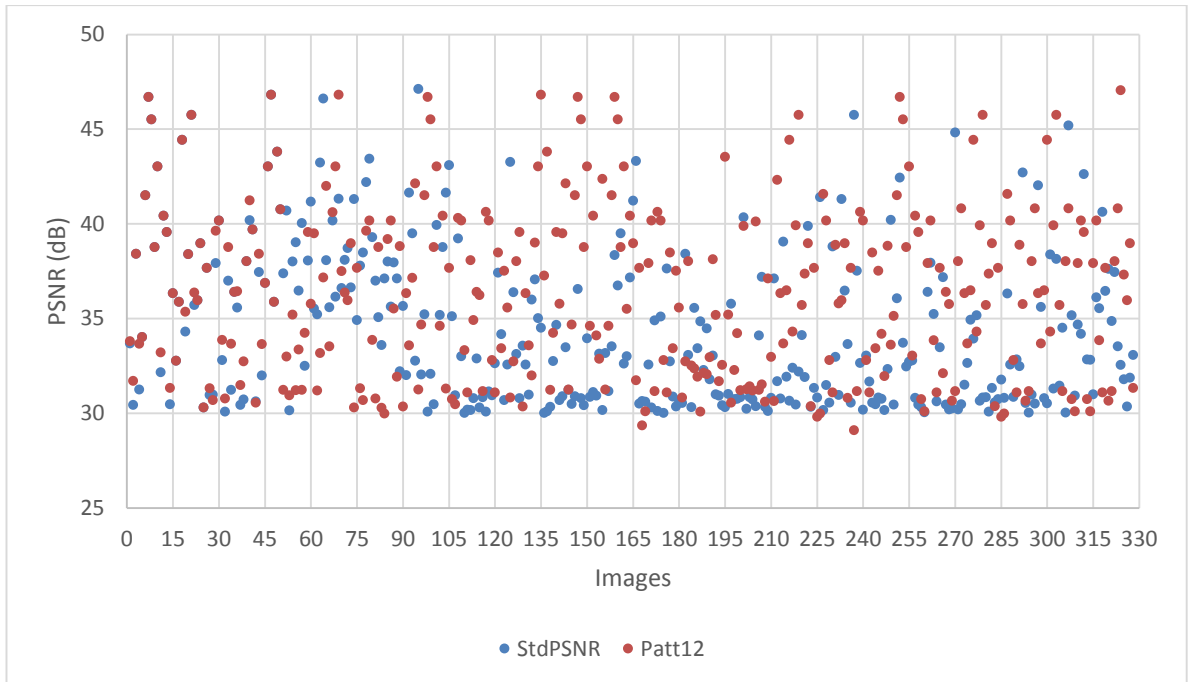
Pattern 10 vs StdPSNR



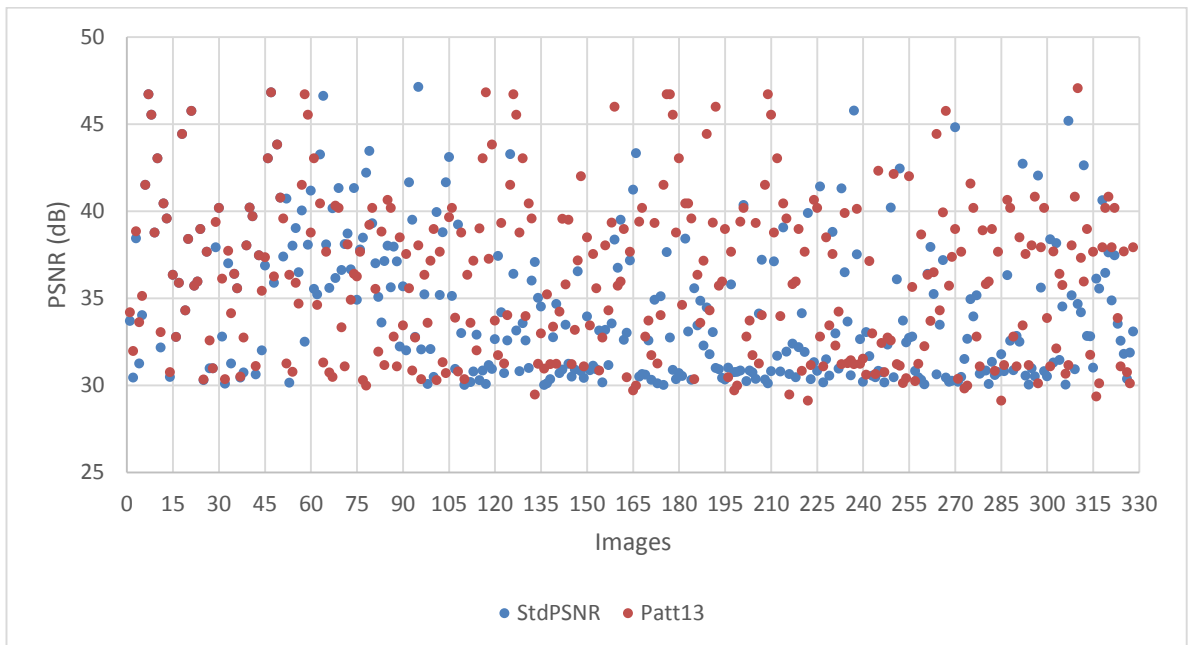
Pattern 11 vs StdPSNR



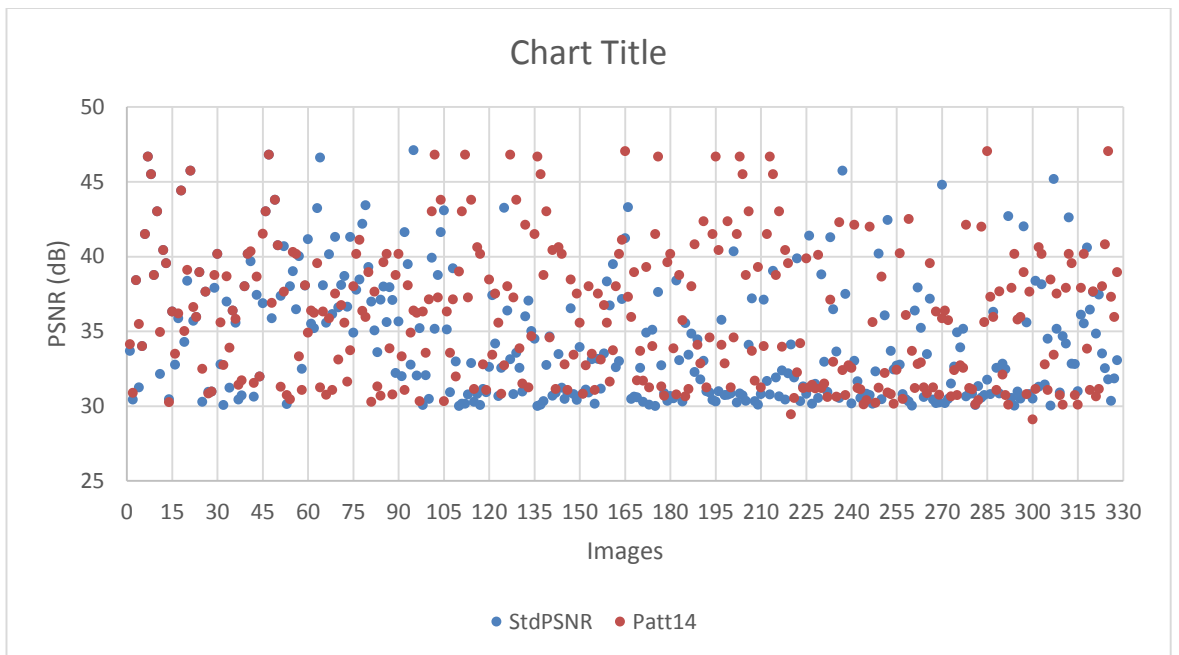
Pattern 12 vs StdPSNR



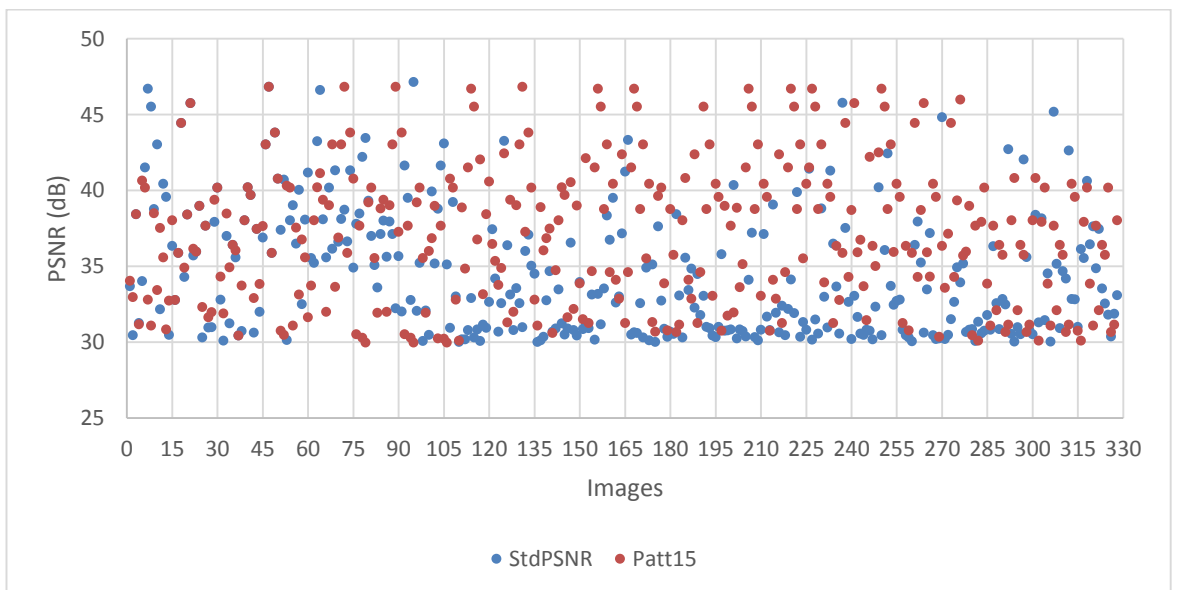
Pattern 13 vs StdPSNR



Pattern 14 vs StdPSNR

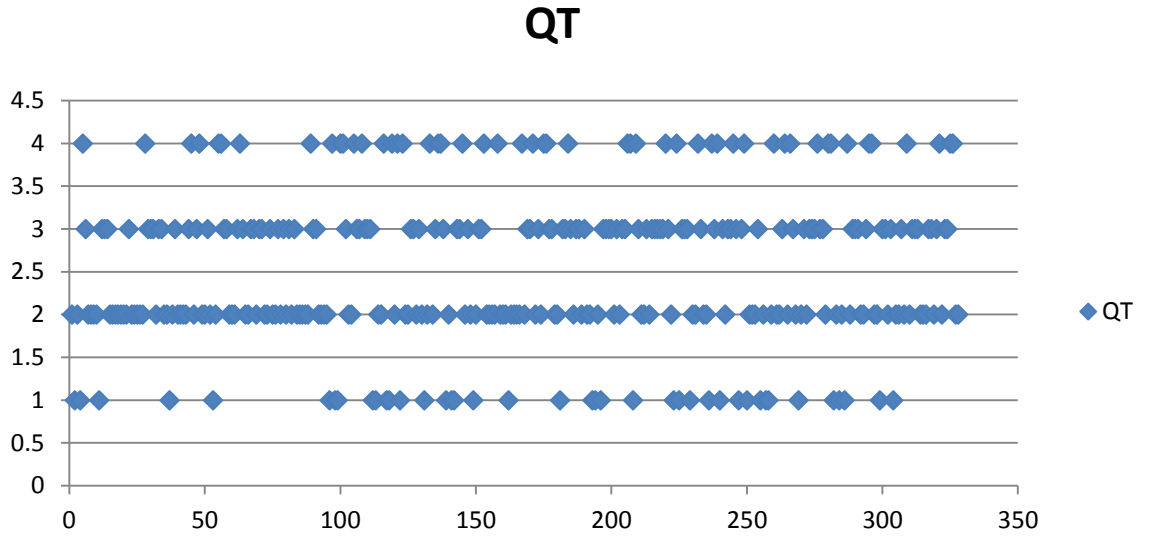


Pattern 15 vs StdPSNR

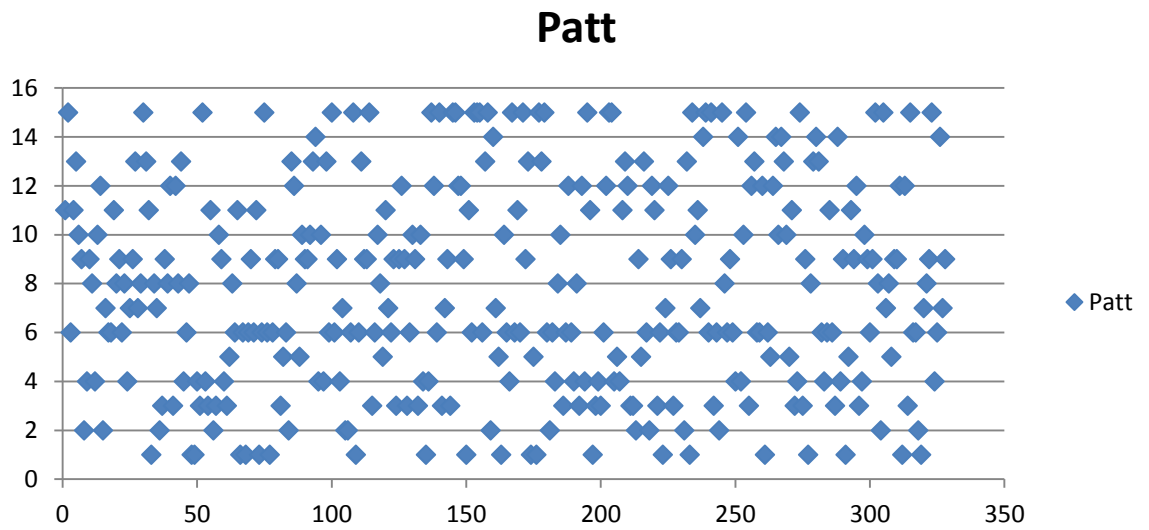


APPENDIX B: RESULTS OF SELECTED QUANTIZATION TABLES AND RELEVANT DATA PATTERNS FOR IMAGE SET







Quantization tables (QT) - $QS_k, 1 \leq k \leq 4$



Data hiding patterns Patt- $P_g, 1 \leq g \leq 15$



**APPENDIX C: RESULTS OF THE COMPARISON OF VISUAL
OBSERVATION OF SAMPLE COVER AND STEGO IMAGES
WITH RESPECT TO QUANTIZATION TABLE AND SELECTED
DATA HIDING PATTERN**

Cover image	Stego Image (QT, P)
 <p>image_0001</p>	 <p>image_0001_Patt_11_Tabel_2</p>
 <p>image_0002</p>	 <p>image_0002_Patt_15_Table_1</p>
 <p>image_0003</p>	 <p>image_0003_Patt_6_Table_2</p>



image_0004



image_0004_Patt_11_Table_1



image_0005



image_0005_Patt_13_Table_4



image_0006



image_0006_Patt_10_Table_3



image_0007



image_0007_Patt_9_Table_2



image_0008



image_0008_Patt_2_Table_2



image_0009



image_0009_Patt_9_Table_2



image_0010



image_0010_Patt_9_Table_2



image_0011



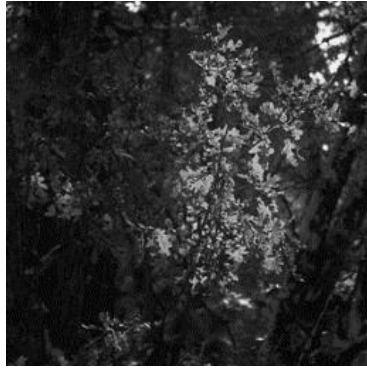
image_0011_Patt_8_Table_1



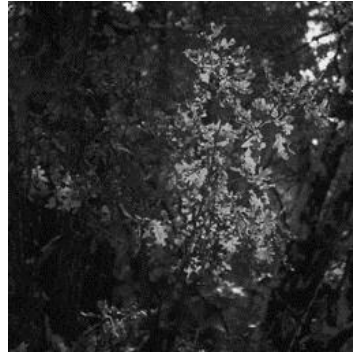
image_0012



image_0012_Patt_4_Table_3



image_0013



image_0013_Patt_10_Table_3



image_0014



image_0014_Patt_12_Tabel_3



image_0015



image_0015_Patt_2_Table_2

APPENDIX D: RESULTS OF STATISTICAL MODLE FOR DIFFERENT COMBINATION OF FEATURE VECTORS

Results 1: Combining the statistical features of DCT elements of cover images with QT using R library

```
> a=lm(QT~X1 + X2 + X3 + X4 + X5 + X6 + X7 + X8 + X9 + X10 + X11 + X12 +
X13 + X14 + X15 + X16 + X17 + X18 + X19 + X20,data=data)
```

```
> Summary (a)
```

Call:

```
lm(formula = QT ~ X1 + X2 + X3 + X4 + X5 + X6 + X7 + X8 + X9 + X10 + X11 +
X12 + X13 + X14 + X15 + X16 + X17 + X18 + X19 + X20, data = data)
```

Residuals:

Min	1Q	Median	3Q	Max
-2.0129	-0.5974	-0.1662	0.5972	1.8388

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	2.006e+00	2.097e-01	9.566	< 2e-16 ***
X1	5.143e-04	2.089e-04	2.461	0.01411 *
X2	-3.603e-03	7.439e-03	-0.484	0.62834
X3	6.261e-03	8.640e-03	0.725	0.46892
X4	-1.215e-02	1.300e-02	-0.935	0.35027
X5	4.043e-02	2.014e-02	2.008	0.04508 *
X6	1.230e-02	1.085e-02	1.133	0.25775
X7	-1.344e-02	1.598e-02	-0.841	0.40064
X8	-2.043e-02	1.540e-02	-1.326	0.18528
X9	-3.821e-02	1.587e-02	-2.407	0.01636 *
X10	-1.638e-02	1.423e-02	-1.152	0.24989
X11	-9.969e-06	4.642e-04	-0.021	0.98287

X12	9.342e-03	4.412e-03	2.117	0.03462 *
X13	-1.342e-02	4.835e-03	-2.776	0.00567 **
X14	3.172e-02	1.080e-02	2.938	0.00342 **
X15	-1.633e-02	1.463e-02	-1.116	0.26482
X16	-9.335e-03	9.399e-03	-0.993	0.32098
X17	-5.408e-03	1.010e-02	-0.536	0.59242
X18	3.509e-02	1.702e-02	2.062	0.03958 *
X19	-1.074e-02	1.592e-02	-0.675	0.50021
X20	-1.851e-02	1.108e-02	-1.670	0.09544 .

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.8797 on 635 degrees of freedom

Multiple R-squared: 0.06919, Adjusted R-squared: 0.03988

F-statistic: 2.36 on 20 and 635 DF, p-value: 0.0007634 – Positive Relationship

Model

Coefficients:					
(Intercept)	X1	X2	X3	X4	X5
2.006e+00	5.143e-04	-3.603e-03	6.261e-03	-1.215e-02	4.043e-02
X6	X7	X8	X9	X10	X11
1.230e-02	-1.344e-02	-2.043e-02	-3.821e-02	-1.638e-02	-9.969e-06
X12	X13	X14	X15	X16	X17
9.342e-03	-1.342e-02	3.172e-02	-1.633e-02	-9.335e-03	-5.408e-03
X18	X19	X20			
3.509e-02	-1.074e-02	-1.851e-02			

Results 2: Combining the statistical features of DCT elements (DCT-mean, DCT-std) of cover images with data hiding Pattern

```
> a=lm(Patt~X1 + X2 + X3 + X4 + X5 + X6 + X7 + X8 + X9 + X10 + X11 + X12 + X13 + X14 + X15 + X16 + X17 + X18 + X19 + X20,data=data)
```

```
> Summary (a)
```

Call:

```
lm(formula = Patt ~ X1 + X2 + X3 + X4 + X5 + X6 + X7 + X8 + X9 + X10 + X11 + X12 + X13 + X14 + X15 + X16 + X17 + X18 + X19 + X20, data = data)
```

Residuals:

Min	1Q	Median	3Q	Max
-9.889	-2.953	-0.007	2.978	9.345

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	5.8800266	0.9493284	6.194	1.05e-09 ***
X1	-0.0005198	0.0009459	-0.550	0.58284
X2	0.0373551	0.0336732	1.109	0.26770
X3	0.0065309	0.0391119	0.167	0.86744
X4	-0.0095197	0.0588574	-0.162	0.87156
X5	0.0805030	0.0911568	0.883	0.37750
X6	-0.0845951	0.0491370	-1.722	0.08563 .
X7	0.2108195	0.0723567	2.914	0.00370 **
X8	-0.4473427	0.0697228	-6.416	2.74e-10 ***
X9	-0.2342216	0.0718490	-3.260	0.00117 **
X10	0.0263684	0.0643966	0.409	0.68233
X11	0.0020615	0.0021011	0.981	0.32690

X12 0.0523471 0.0199735 2.621 0.00898 **
 X13 0.0172489 0.0218866 0.788 0.43093
 X14 0.0136415 0.0488757 0.279 0.78025
 X15 -0.1382812 0.0662264 -2.088 0.03720 *
 X16 -0.1356348 0.0425461 -3.188 0.00150 **
 X17 0.1124124 0.0457064 2.459 0.01418 *
 X18 0.1355000 0.0770326 1.759 0.07906 .
 X19 0.0296486 0.0720447 0.412 0.68082
 X20 -0.0551435 0.0501720 -1.099 0.27215

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.982 on 635 degrees of freedom

Multiple R-squared: 0.1471, Adjusted R-squared: 0.1202

F-statistic: 5.476 on 20 and 635 DF, p-value: 4.598e-13 < 0.05 Positive relationship

Model






Coefficients:					
(Intercept)	X1	X2	X3	X4	X5
5.8800266	-0.0005198	0.0373551	0.0065309	-0.0095197	0.0805030
X6	X7	X8	X9	X10	X11
-0.0845951	0.2108195	-0.4473427	-0.2342216	0.0263684	0.0020615
X12	X13	X14	X15	X16	X17
0.0523471	0.0172489	0.0136415	-0.1382812	-0.1356348	0.1124124
X18	X19	X20			
0.1355000	0.0296486	-0.0551435			

Correlation

```
> set.seed(100)
> trainingRowIndex <- sample(1:nrow(mydata), 0.8*nrow(mydata))
> trainingData <- mydata[trainingRowIndex, ]
> testData <- mydata[-trainingRowIndex, ]
> lmMod <- lm(Patt ~ X1 + X2 + X3 + X4 + X5 + X6 + X7 + X8 + X9 + X10 + X11
+ X12 + X13 + X14 + X15 + X16 + X17 + X18 + X19 + X20, data=mydata)
> distPred <- predict(lmMod, testData)
Error: object 'distPred' not found
> distPred <- predict(lmMod, testData)
> summary(lmMod)
Call: lm(formula = Patt ~ X1 + X2 + X3 + X4 + X5 + X6 + X7 + X8 + X9 +
X10 + X11 + X12 + X13 + X14 + X15 + X16 + X17 + X18 + X19 +
X20, data = mydata)
Residuals:
    Min     1Q   Median     3Q    Max
-9.889 -2.953 -0.007  2.978  9.345
Residual standard error: 3.982 on 635 degrees of freedom
Multiple R-squared:  0.1471,    Adjusted R-squared:  0.1202
F-statistic: 5.476 on 20 and 635 DF,  -p-value: 4.598e-13
> actuals_preds <- data.frame(cbind(actuals=testData$Patt, predicted=distPred))
> correlation_accuracy <- cor(actuals_preds)
71.22%
```

**APPENDIX E: SAMPLE UNKNOWN IMAGES FOR MODEL
VALIDATION AND**

Sample Image set – 25 MIT gray images

Cover Image	Stego-image
	
	
	
	

APPENDIX F: UNSATISFACTORY RESULTS OF UNKNOWN IMAGES FOR THE MODEL

image_0026	4	1	29.321	2.21E+00	2.85E+00
image_0027	4	2	31.201	2.10E+00	2.92E+00
image_0028	1	14	30.1	4.23E+00	9.42E+00
image_0029	2	10	30.2301	2.57E+00	8.63E+00
image_0030	2	11	30.4112	2.63E+00	5.79E+00
image_0031	2	10	31.012	5.41E+00	5.23E+00
image_0032	2	5	32.6301	3.12E+00	5.85E+00
image_0033	1	6	29.4521	5.41E+00	1.22E+01
image_0034	3	1	31.561	5.63E+00	1.03E+01
image_0035	4	2	31.23	4.12E+00	3.23E+00
image_0036	1	15	32.005	2.52E+00	1.06E+01
image_0037	1	10	31.203	4.32E+00	1.21E+01
image_0038	3	12	30.1425	4.52E+00	1.02E+01
image_0039	3	3	28.521	3.33E+00	8.42E+00
image_0040	4	6	29.1003	1.06E+00	1.32E+00
image_0041	2	1	29.6301	2.28E+00	1.02E+01
image_0042	3	4	33.3321	4.52E+00	1.11E+01
image_0043	4	8	31.21	1.20E+00	8.12E+00
image_0044	4	7	31.251	4.56E+00	7.85E+00
image_0045	1	2	30.0623	2.59E+00	5.40E+00
image_0046	1	6	30.2561	4.21E+00	6.24E+00
image_0047	1	6	32.0471	5.28E+00	6.21E+00
image_0048	2	3	31.85	2.82E+00	3.75E+00
image_0049	3	2	29.0054	1.41E+00	1.13E+00
image_0050	1	7	31.23	1.76E+00	4.18E+00

APPENDIX G: PUBLICATIONS BASED ON THIS RESEARCH STUDY

Peer Reviewed Journal Article

V.Senthooran, L.Ranathunga, “An Experimental Investigation of Statistical Model based Secure Steganography for JPEG images”, *Indian Journal of Science and Technology*, Vol 10(2017), DOI:10.17485/IJST/2017/V10i27/111440, July 2017.

IEEE Indexed Conference Publications

V.Senthooran, L.Ranathunga, “DCT coefficient dependent quantization table modification steganographic algorithm, First International Conference on Networks & Soft Computing (ICNSC), 2014, pp. 432–436.

V.Senthooran, L.Ranathunga, “An investigation of quantization table modification table on JPEG steganography, 8th IEEE International Conference on Industrial and Information Systems (ICIIS), pp.2014, 622-626