

Content of the document

In the following pages, we show decompression results. The images are not compressed at all, in order to avoid not-already-existing artefacts. This explains the huge size of the pdf file (133 megabytes).

The tested decompression algorithms are described in *Compression Artefacts Reduction Using Variational Methods : Algorithms and Experimental Study* by Pierre Weiss, Laure Blanc-Féraud, Thomas André, Marc Antonini, submitted to ICASSP08.

We used a simple image coder which consists of a 5-levels 2D wavelet transform using the 9/7 filters, a uniform quantizer designed optimally by minimizing the MSE error, and an arithmetic coder.

In all figures :

- The Up-Left image is the original image to be compressed.
- The Up-Right image is the compressed image. The bitrate is written in the title.
- The Bottom-Left image is the denoised image without a contrast enhancement procedure.
- The Bottom-Right image is the denoised image with a contrast enhancement procedure.

The parameters of the algorithms are μ (regularization parameter) and N (a quantization step for the contrast enhancement procedure). In all further experiments, we took $\mu = 1$ and $N = 256$.

Three different measures of quality have been performed. The first one is the classical PSNR. The two others are 'perceptual' measures of quality.

The SIM measure (structural similarity index) is described in Z. Wang and A.C. Bovik and H.R. Sheikh and E.P. Simoncelli, IEEE Transactions on Image Processing, avril, number 4, pages 600-612, *Image quality assessment : From error visibility to structural similarity*, <http://www.cns.nyu.edu/~zwang/>, volume 13, 2004.

The NQM measure (noise quality mesure) is described in N. Damera-Venkata and T.D. Kite and W.S. Geisler and B.L. Evans and A.C. Bovik, IEEE Transactions on Image Processing, April 2000, Number 4, Pages 636-650, *Image quality assessment based on a degradation model*, <http://users.ece.utexas.edu/~bevans/papers/2000/imageQuality/index.html>, Volume 9.

The images come from a the **USC-SIPI Image Database**. It is available here : <http://sipi.usc.edu/database/database.cgi?volume=misc>.

All images are 512×512 . They have different contents in order to propose a complete analysis of the performances of the algorithms.

Algorithms evaluation

In this part we give the main conclusions about the proposed algorithms.

First it is easily noticed that the algorithms are useless at high bitrates. Even if there is no perceptual difference between the compressed image and the 'denoised' version, the quality measures indicate that the denoising step is not efficient.

Let's concentrate on the results at 'low' bitrates. Most generally, the denoised and enhanced image has the best computational and perceptual quality. Even though, the results differ depending on the image contents.

- For smooth by piece images with little grain, the results are good. In the best case, we gain around $1dB$. See for instance Elaine, Lena, 4.2.01.
- For widely textured and oscillating images, the quality measures of the compressed image are slightly better than those of the 'denoised+enhanced' image. However, the differences are small (no more than 0.2 dB) and not visible. See for instance pictures baboon or 5.2.10.

Our conclusion is that at low bitrates, the proposed procedure effectively improves image quality.



FIG. 1 – Image :elaine.512 *** Bitrate :2.29 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	42.712	41.222	42.337
<i>SIM</i>	0.995	0.994	0.994
<i>NQM</i>	41.538	41.260	41.455

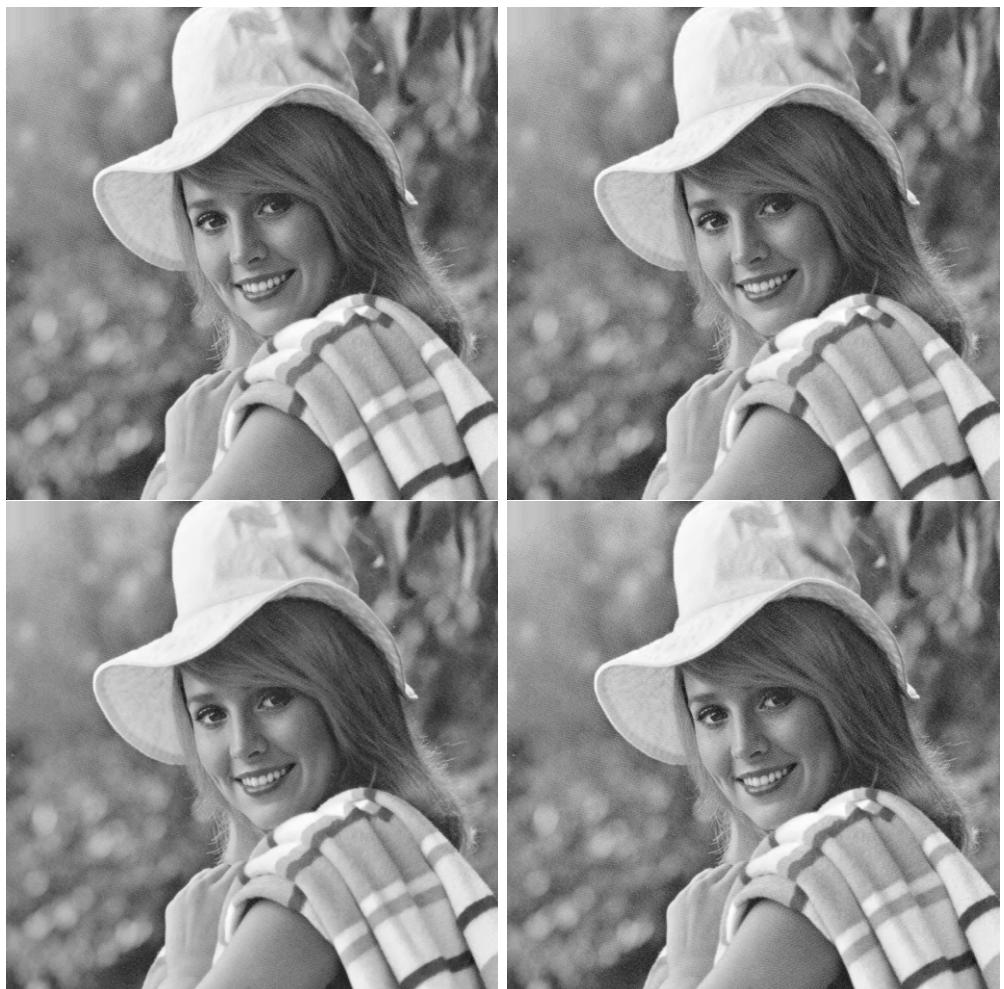


FIG. 2 – Image :elaine.512 *** Bitrate :1.8 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	39.658	38.745	39.331
<i>SIM</i>	0.990	0.989	0.989
<i>NQM</i>	38.752	38.471	38.646



FIG. 3 – Image :elaine.512 *** Bitrate :0.485 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	32.604	32.460	32.488
<i>SIM</i>	0.960	0.951	0.956
<i>NQM</i>	34.538	31.874	34.295



FIG. 4 – Image :elaine.512 *** Bitrate :0.214 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	31.541	31.136	31.410
<i>SIM</i>	0.940	0.925	0.936
<i>NQM</i>	31.440	28.037	30.898



FIG. 5 – Image :elaine.512 *** Bitrate :0.173 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	31.183	30.749	31.064
<i>SIM</i>	0.932	0.914	0.927
<i>NQM</i>	29.900	26.547	29.339



FIG. 6 – Image :elaine.512 *** Bitrate :0.141 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	30.805	30.388	30.720
<i>SIM</i>	0.922	0.903	0.917
<i>NQM</i>	28.227	25.100	27.840



FIG. 7 – Image :elaine.512 *** Bitrate :0.119 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	30.466	30.073	30.400
<i>SIM</i>	0.912	0.891	0.907
<i>NQM</i>	26.949	23.915	26.526



FIG. 8 – Image :elaine.512 *** Bitrate :0.0748 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	29.302	28.996	29.301
<i>SIM</i>	0.885	0.862	0.880
<i>NQM</i>	23.812	21.130	23.579



FIG. 9 – Image :elaine.512 *** Bitrate :0.0549 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	28.546	28.248	28.591
<i>SIM</i>	0.859	0.836	0.855
<i>NQM</i>	21.149	19.036	21.198



FIG. 10 – Image :elaine.512 *** Bitrate :0.0413 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	27.700	27.546	27.792
<i>SIM</i>	0.832	0.812	0.828
<i>NQM</i>	18.860	17.408	19.105

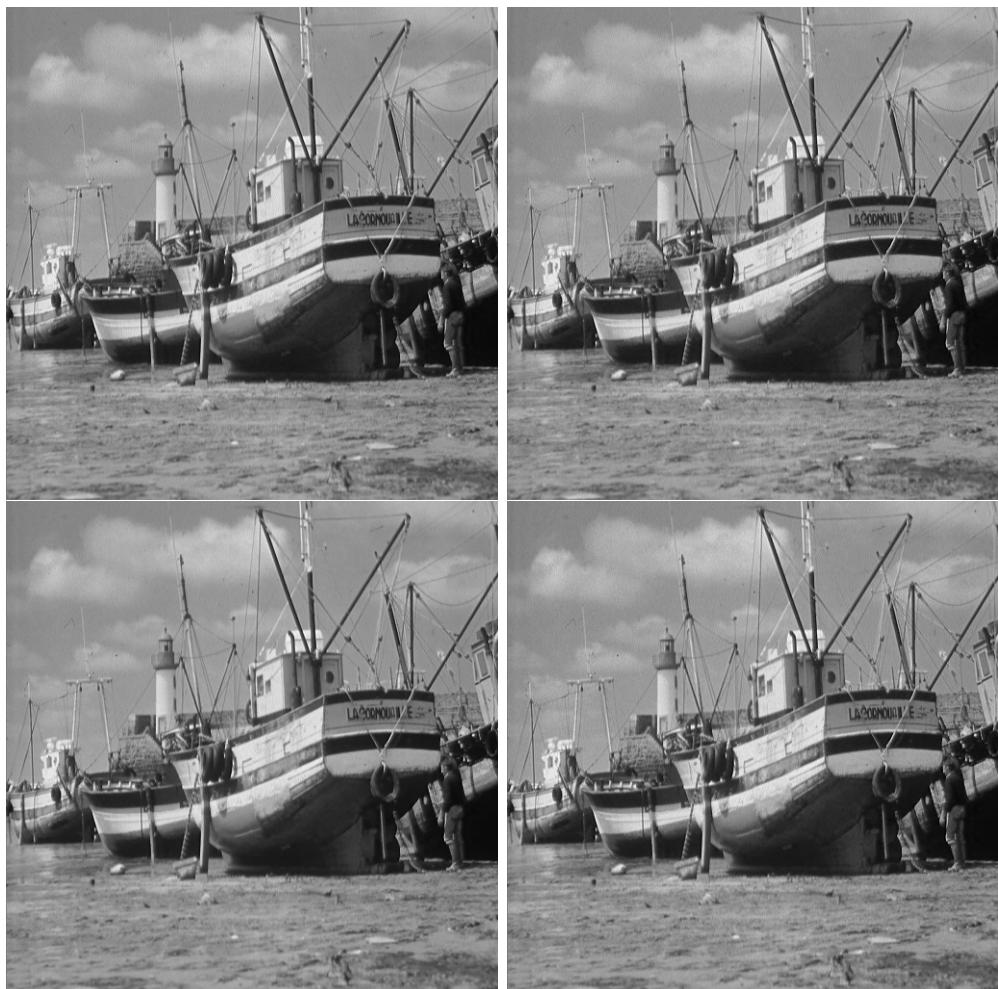


FIG. 11 – Image :boat.512 *** Bitrate :2.22 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	42.415	41.407	42.060
<i>SIM</i>	0.995	0.994	0.994
<i>NQM</i>	41.002	40.667	40.882

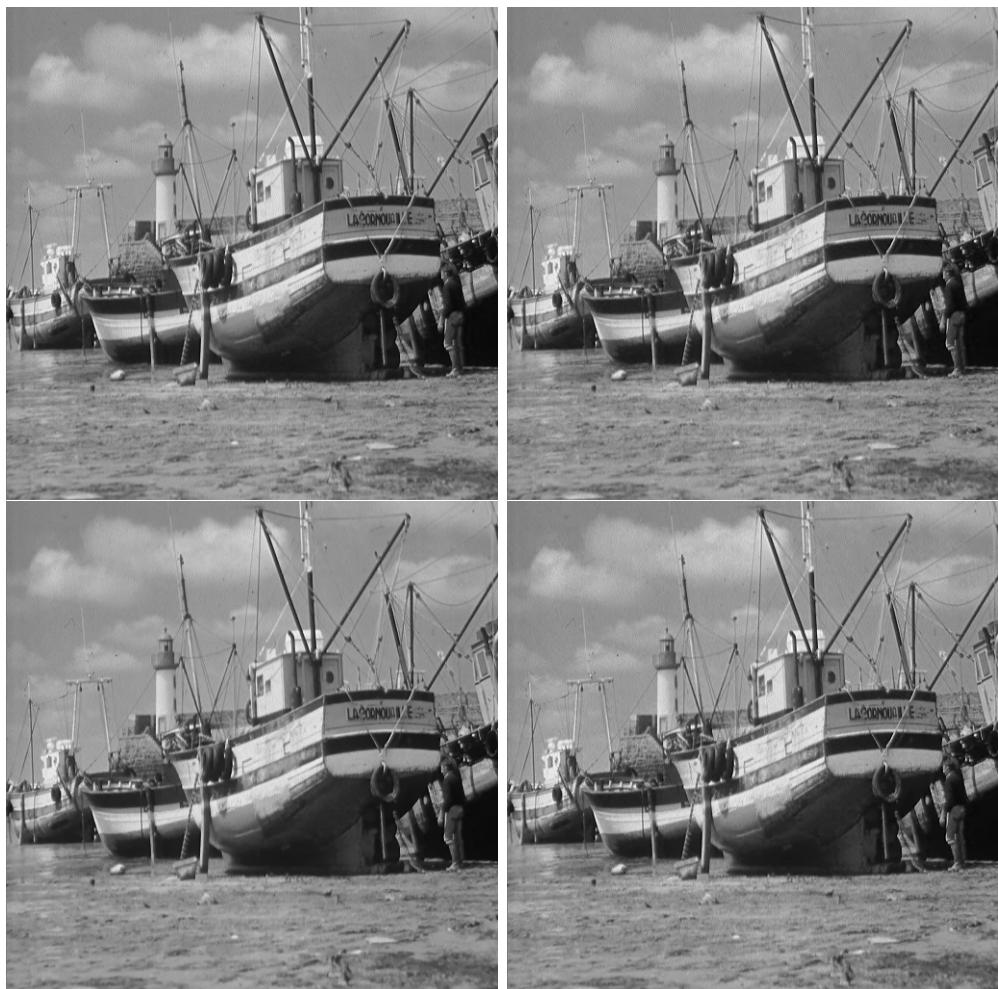


FIG. 12 – Image :boat.512 *** Bitrate :1.69 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	39.304	38.711	39.051
<i>SIM</i>	0.990	0.989	0.989
<i>NQM</i>	37.620	37.222	37.510

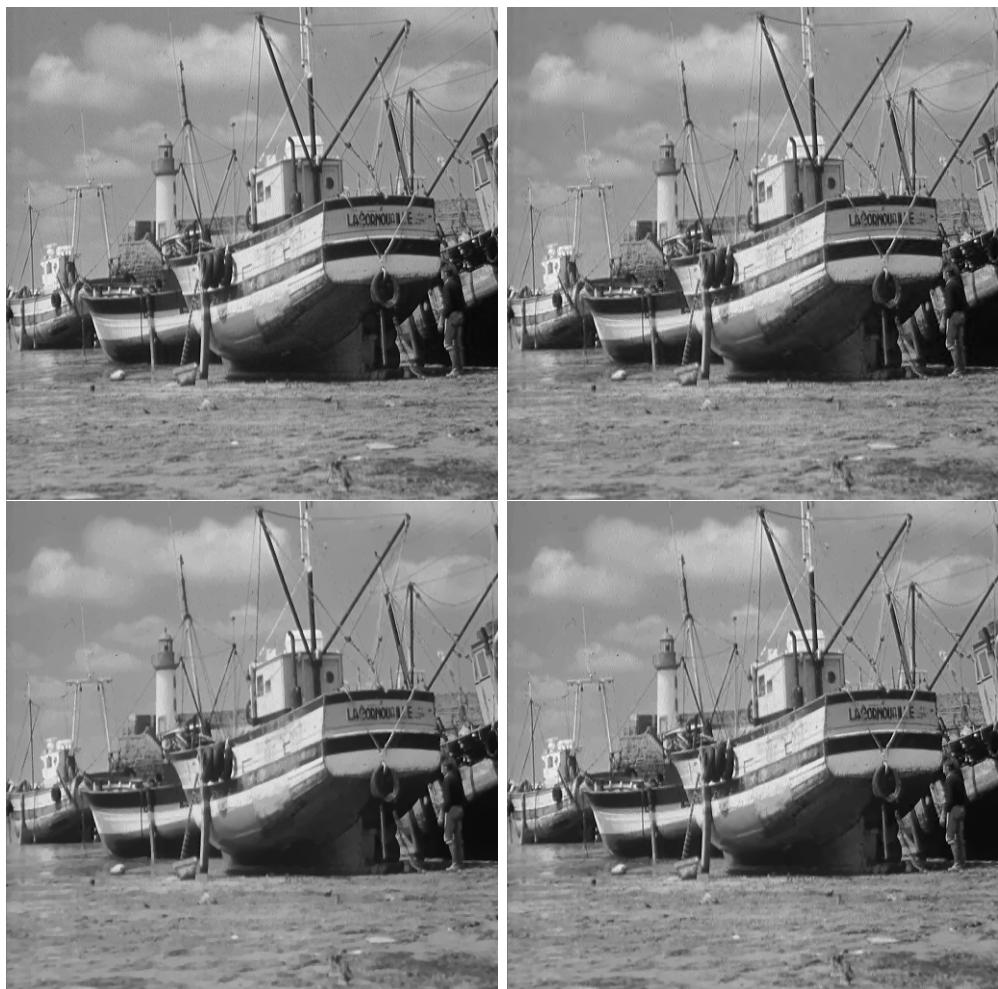


FIG. 13 – Image :boat.512 *** Bitrate :0.806 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	34.652	33.700	34.416
<i>SIM</i>	0.977	0.968	0.975
<i>NQM</i>	33.587	31.560	33.342

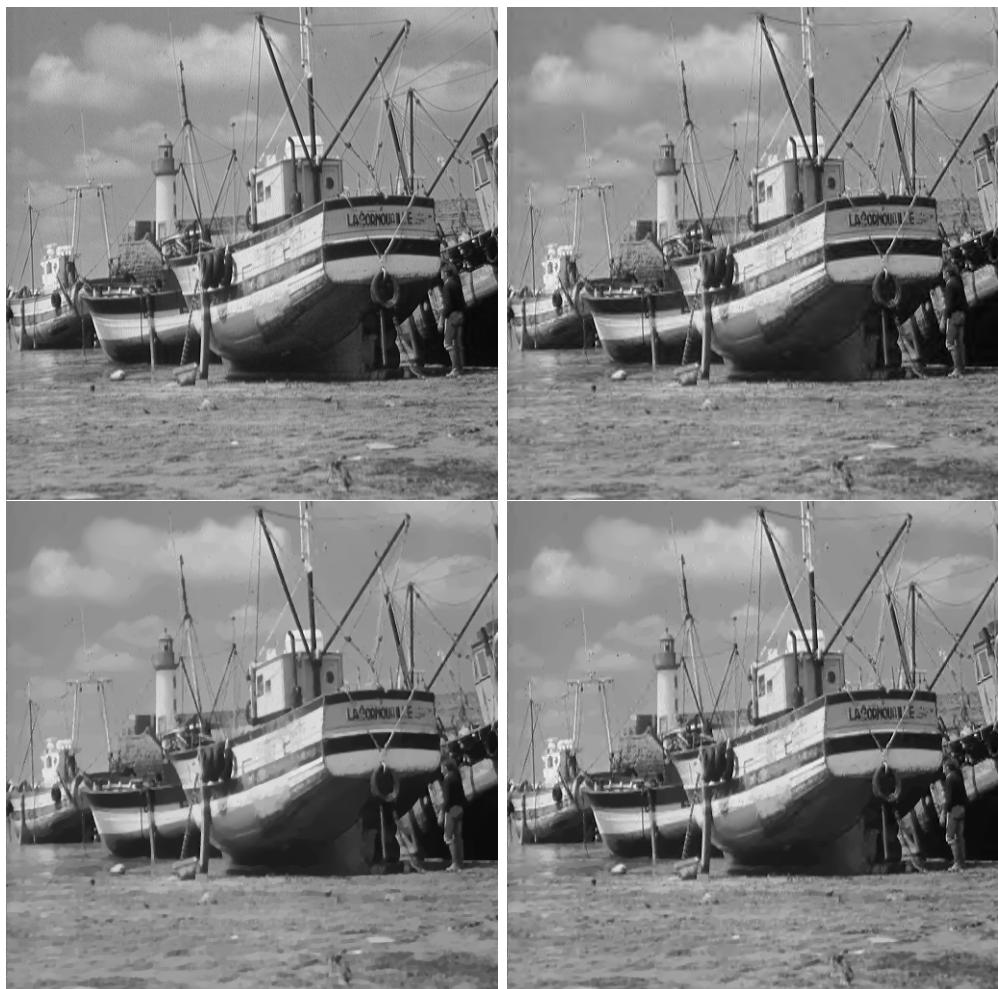


FIG. 14 – Image :boat.512 *** Bitrate :0.53 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	32.656	31.527	32.421
<i>SIM</i>	0.962	0.947	0.960
<i>NQM</i>	30.465	27.952	30.249



FIG. 15 – Image :boat.512 *** Bitrate :0.447 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	31.818	30.662	31.606
<i>SIM</i>	0.952	0.934	0.950
<i>NQM</i>	28.926	26.313	28.677

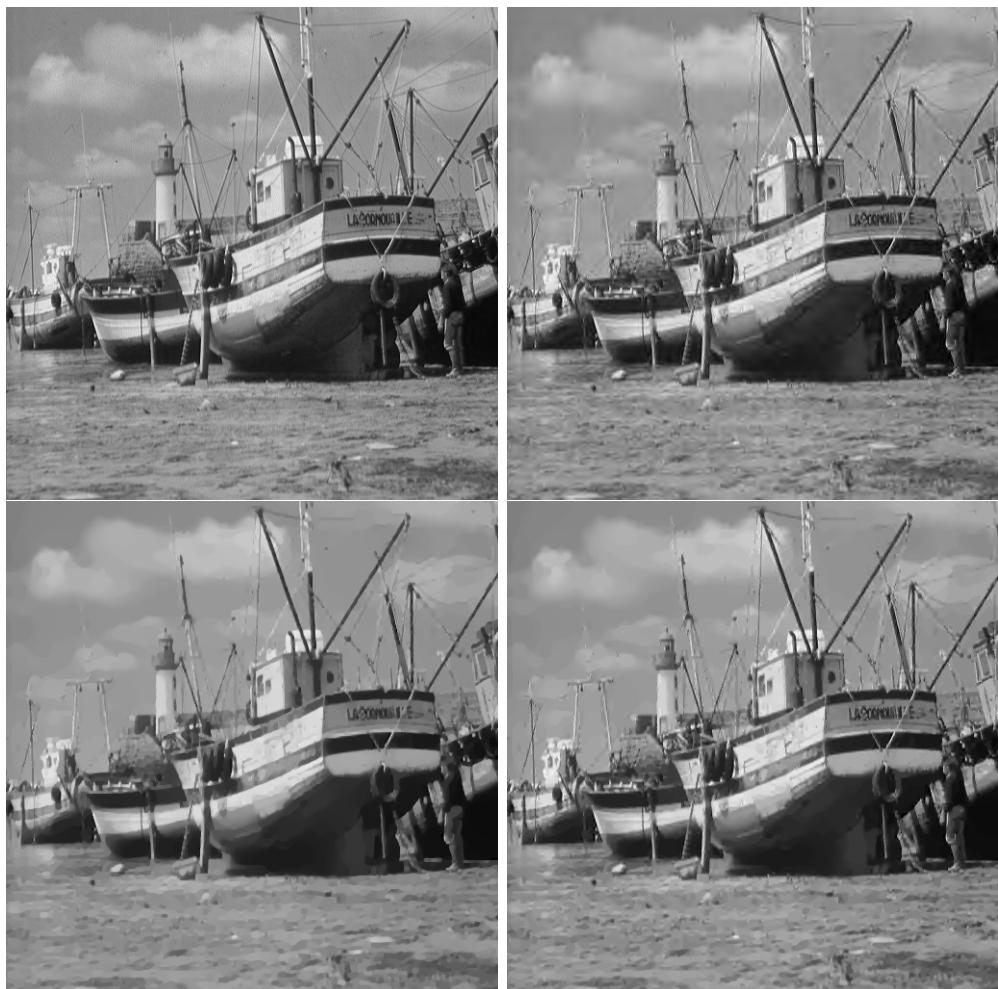


FIG. 16 – Image :boat.512 *** Bitrate :0.339 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	30.571	29.672	30.436
<i>SIM</i>	0.936	0.916	0.935
<i>NQM</i>	27.318	24.947	27.105



FIG. 17 – Image :boat.512 *** Bitrate :0.289 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	29.885	29.022	29.753
<i>SIM</i>	0.924	0.902	0.922
<i>NQM</i>	26.212	23.542	25.867

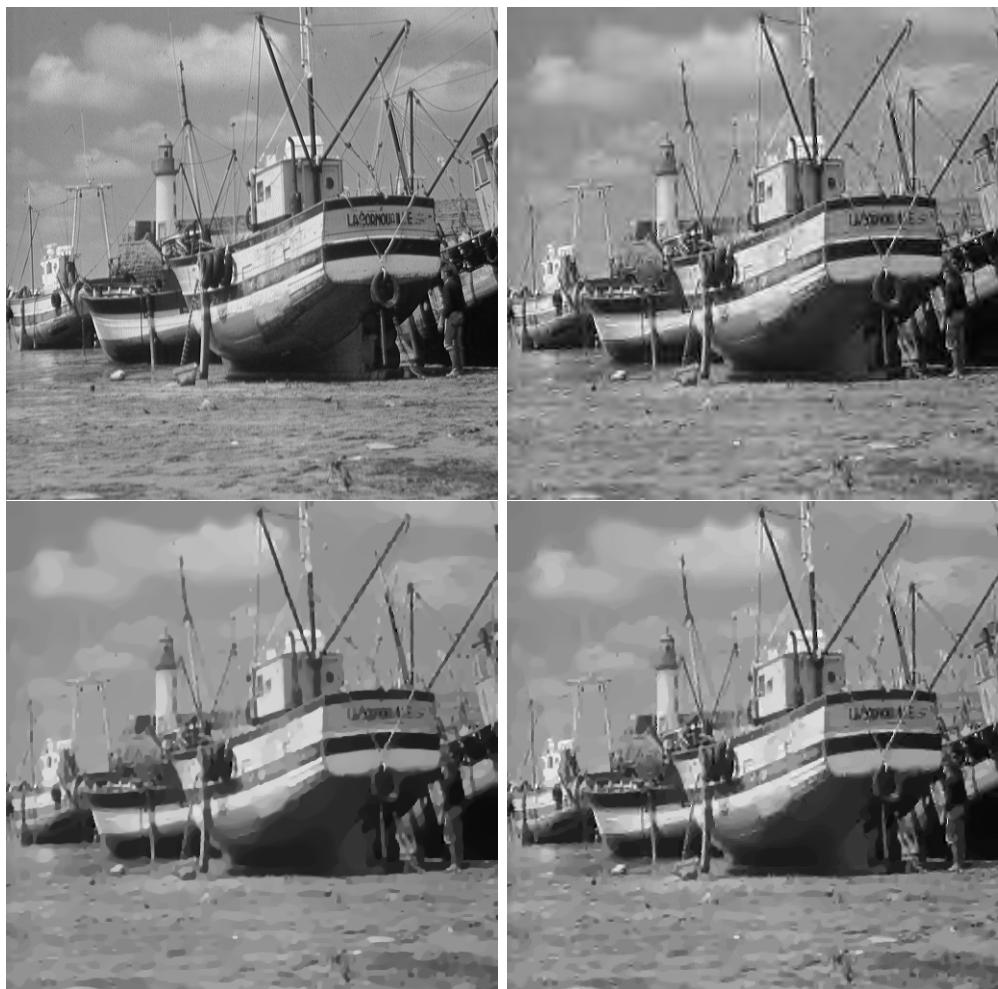


FIG. 18 – Image :boat.512 *** Bitrate :0.165 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	27.714	27.005	27.585
<i>SIM</i>	0.878	0.849	0.875
<i>NQM</i>	23.098	20.698	22.970



FIG. 19 – Image :boat.512 *** Bitrate :0.104 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	26.288	25.825	26.257
<i>SIM</i>	0.827	0.799	0.825
<i>NQM</i>	19.929	18.296	19.981



FIG. 20 – Image :boat.512 *** Bitrate :0.0724 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	25.320	24.933	25.380
<i>SIM</i>	0.777	0.749	0.777
<i>NQM</i>	17.225	15.988	17.413

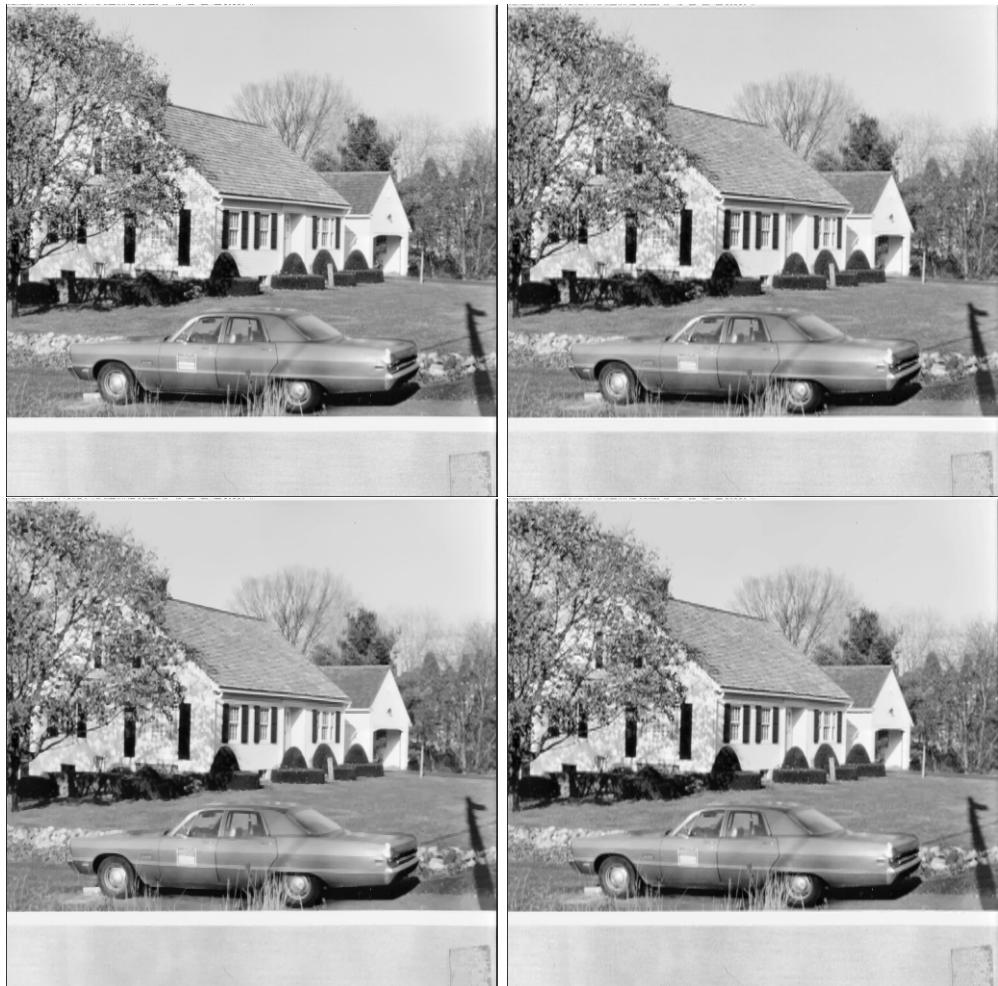


FIG. 21 – Image :house *** Bitrate :1.56 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	34.666	33.294	34.497
<i>SIM</i>	0.987	0.983	0.986
<i>NQM</i>	41.365	36.148	40.575



FIG. 22 – Image :house *** Bitrate :1.25 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	34.225	32.679	33.978
<i>SIM</i>	0.984	0.978	0.983
<i>NQM</i>	39.516	35.008	38.753



FIG. 23 – Image :house *** Bitrate :0.856 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	33.085	31.282	32.749
<i>SIM</i>	0.976	0.967	0.974
<i>NQM</i>	35.616	31.651	35.066

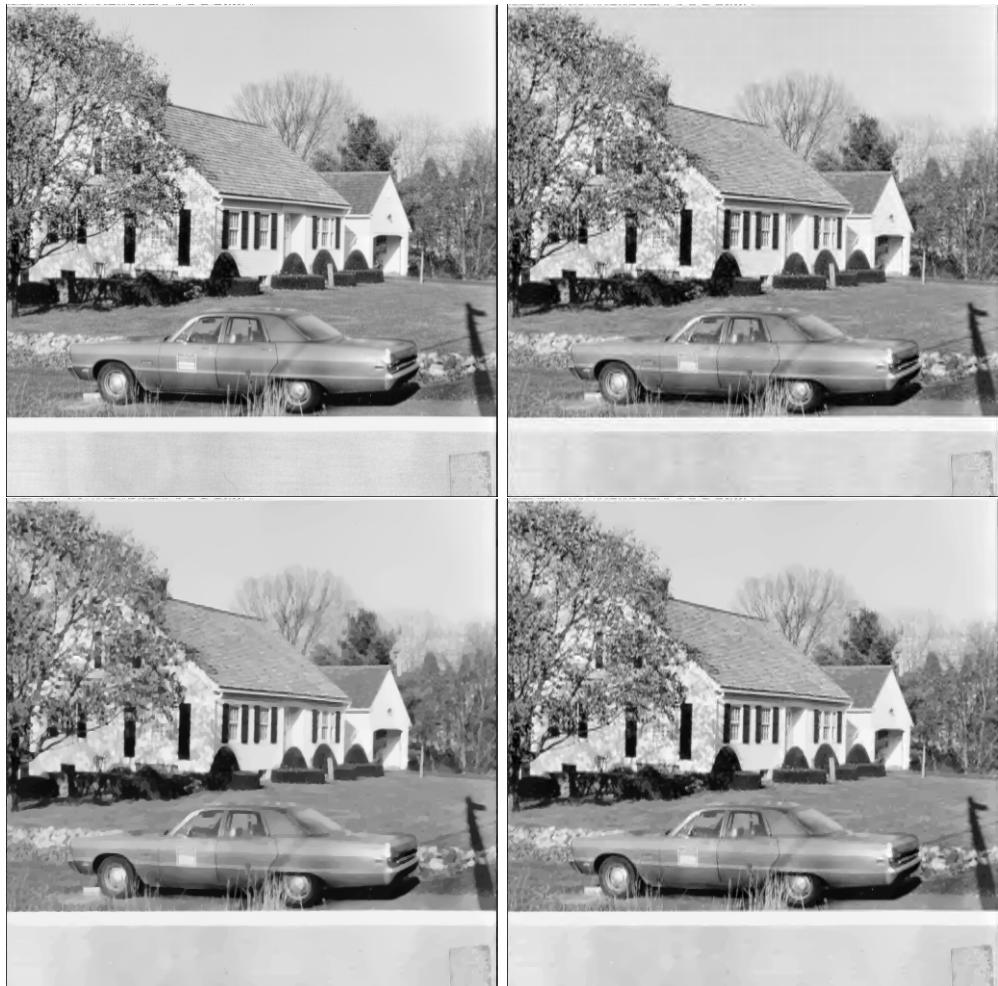


FIG. 24 – Image :house *** Bitrate :0.624 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	31.768	30.032	31.455
<i>SIM</i>	0.965	0.951	0.963
<i>NQM</i>	32.760	29.226	32.499

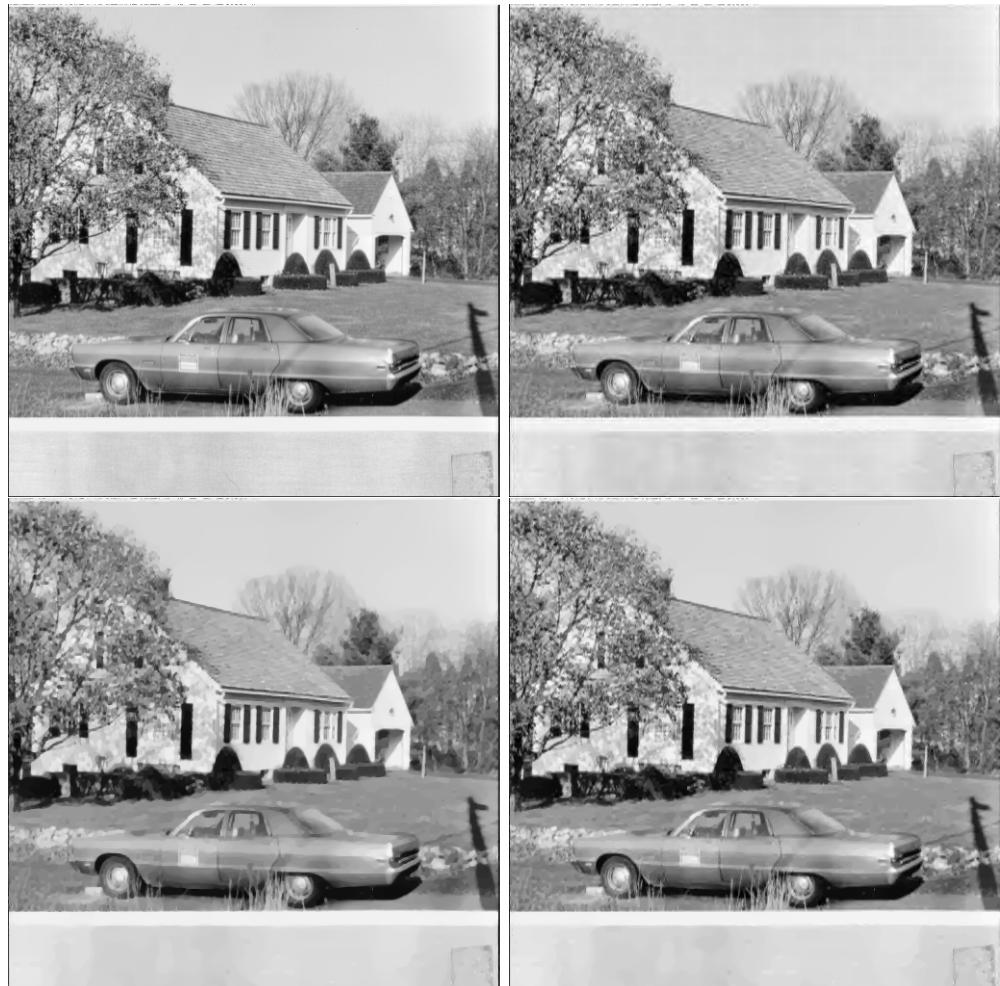


FIG. 25 – Image :house *** Bitrate :0.527 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	30.983	29.411	30.704
<i>SIM</i>	0.958	0.942	0.957
<i>NQM</i>	30.988	27.737	30.678

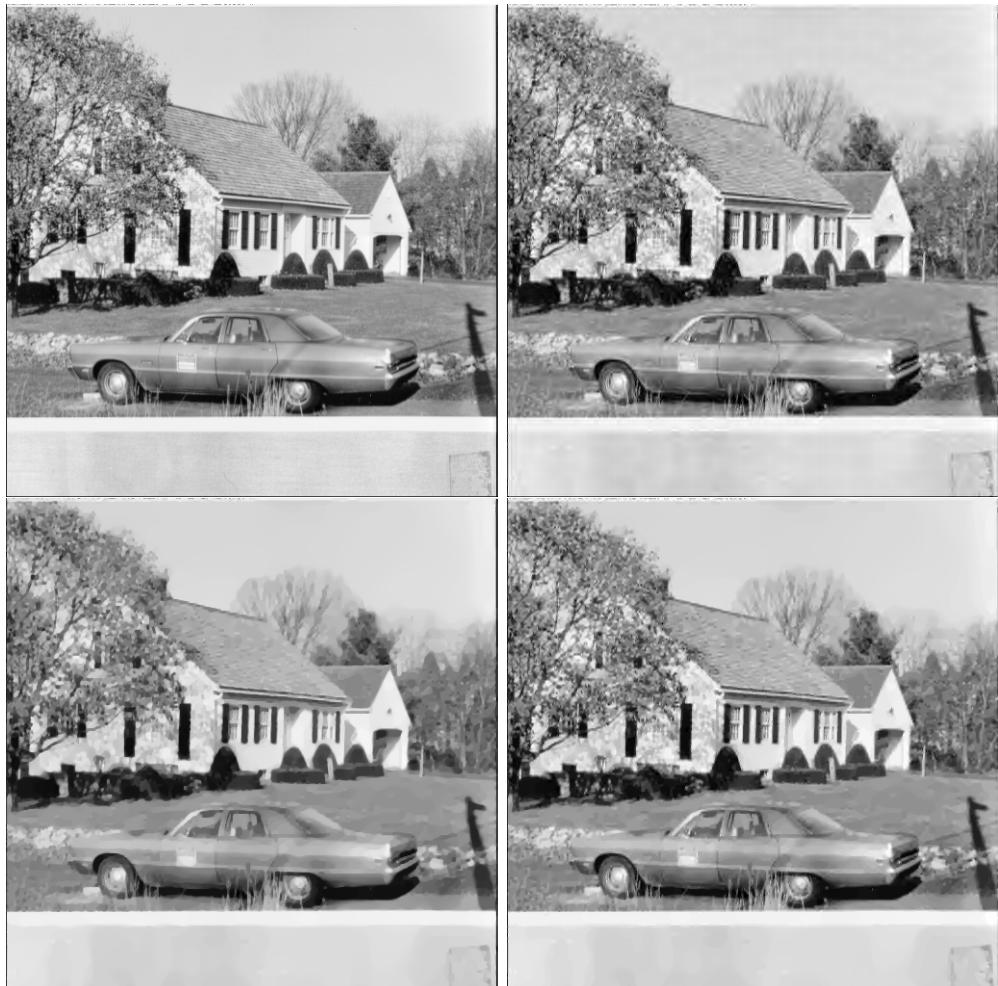


FIG. 26 – Image :house *** Bitrate :0.402 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	29.769	28.339	29.527
<i>SIM</i>	0.946	0.929	0.945
<i>NQM</i>	29.578	26.330	29.468

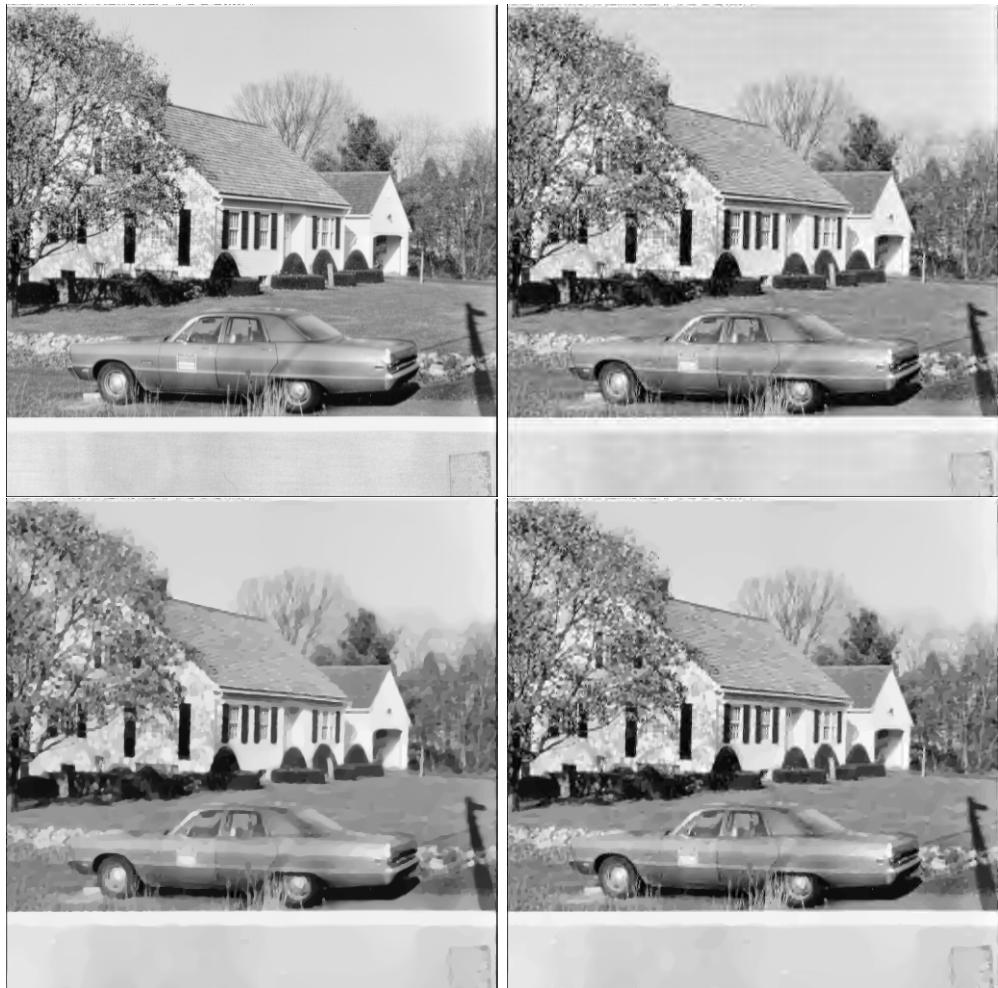


FIG. 27 – Image :house *** Bitrate :0.347 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	29.136	27.817	28.893
<i>SIM</i>	0.937	0.918	0.937
<i>NQM</i>	28.250	25.329	28.146

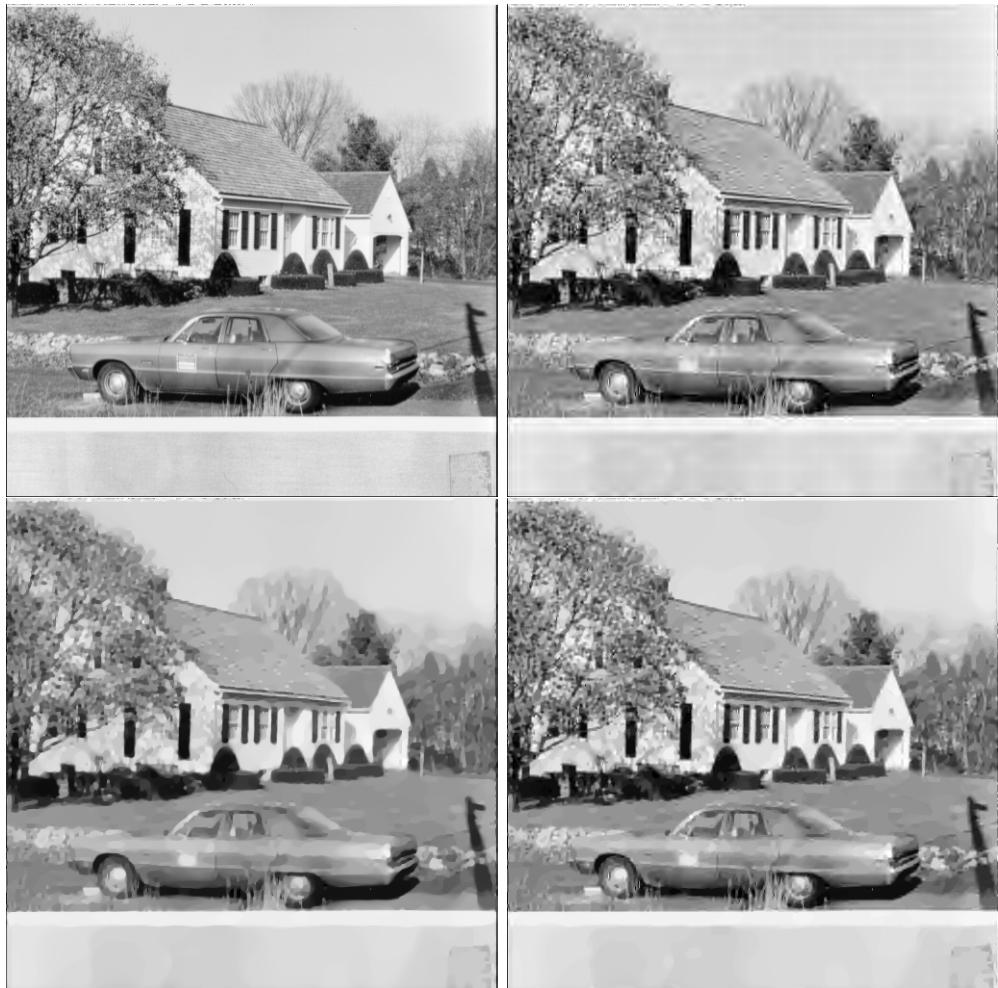


FIG. 28 – Image :house *** Bitrate :0.238 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	27.516	26.396	27.391
<i>SIM</i>	0.908	0.885	0.910
<i>NQM</i>	25.290	22.284	25.416

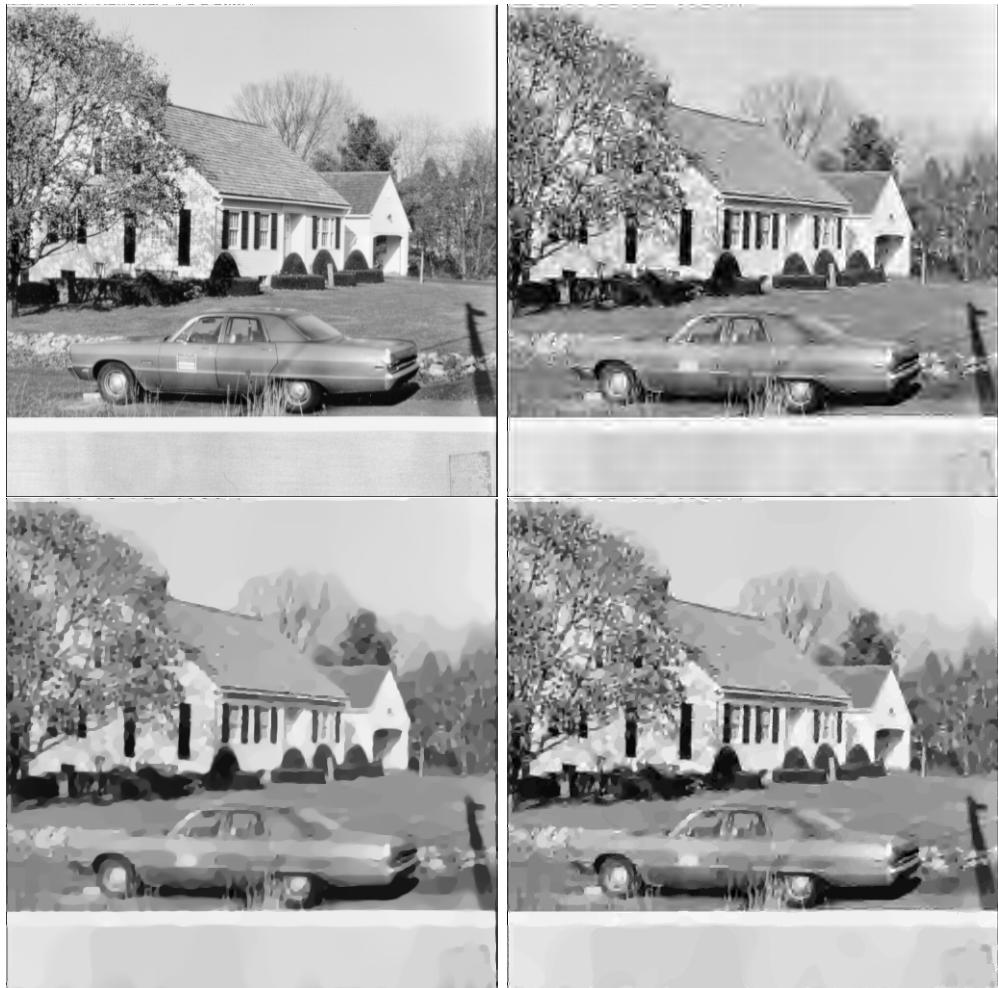


FIG. 29 – Image :house *** Bitrate :0.159 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	25.962	25.017	25.852
<i>SIM</i>	0.871	0.840	0.870
<i>NQM</i>	22.618	19.832	22.563

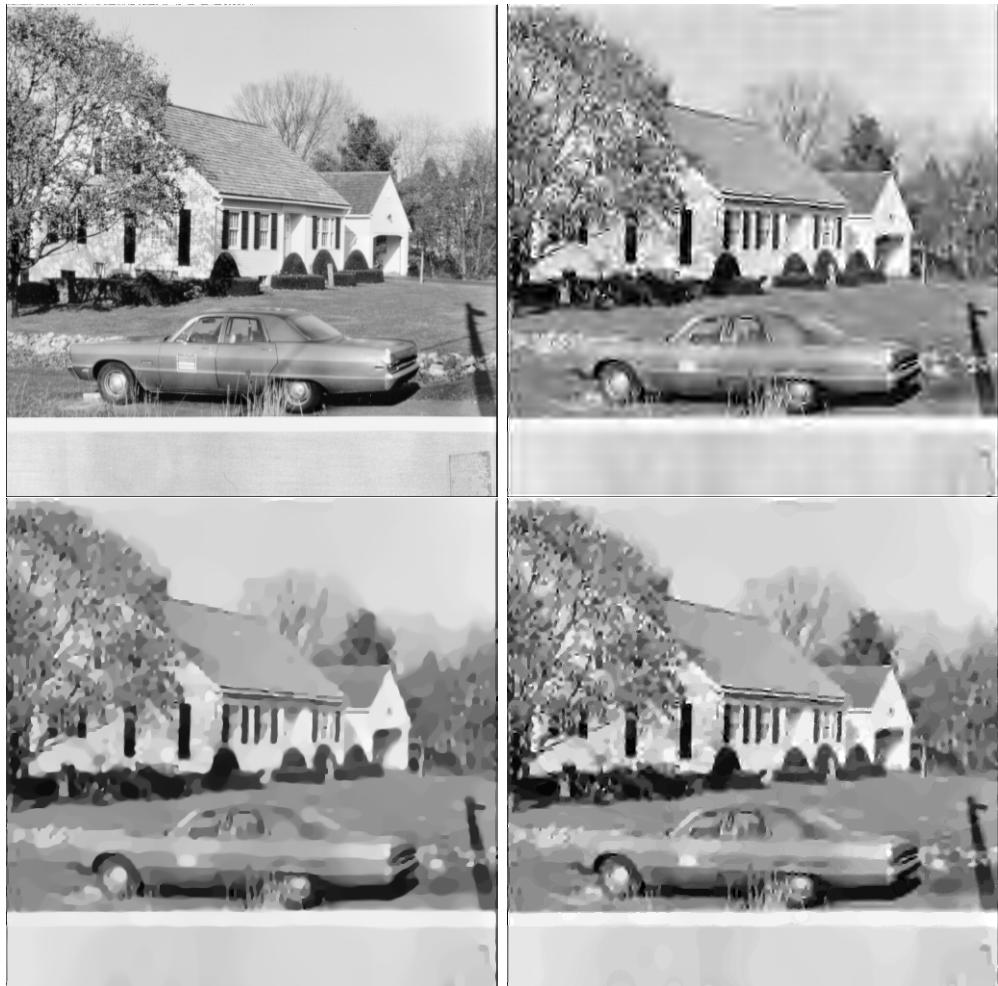


FIG. 30 – Image :house *** Bitrate :0.106 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	24.465	23.948	24.531
<i>SIM</i>	0.825	0.796	0.826
<i>NQM</i>	19.633	17.988	20.192

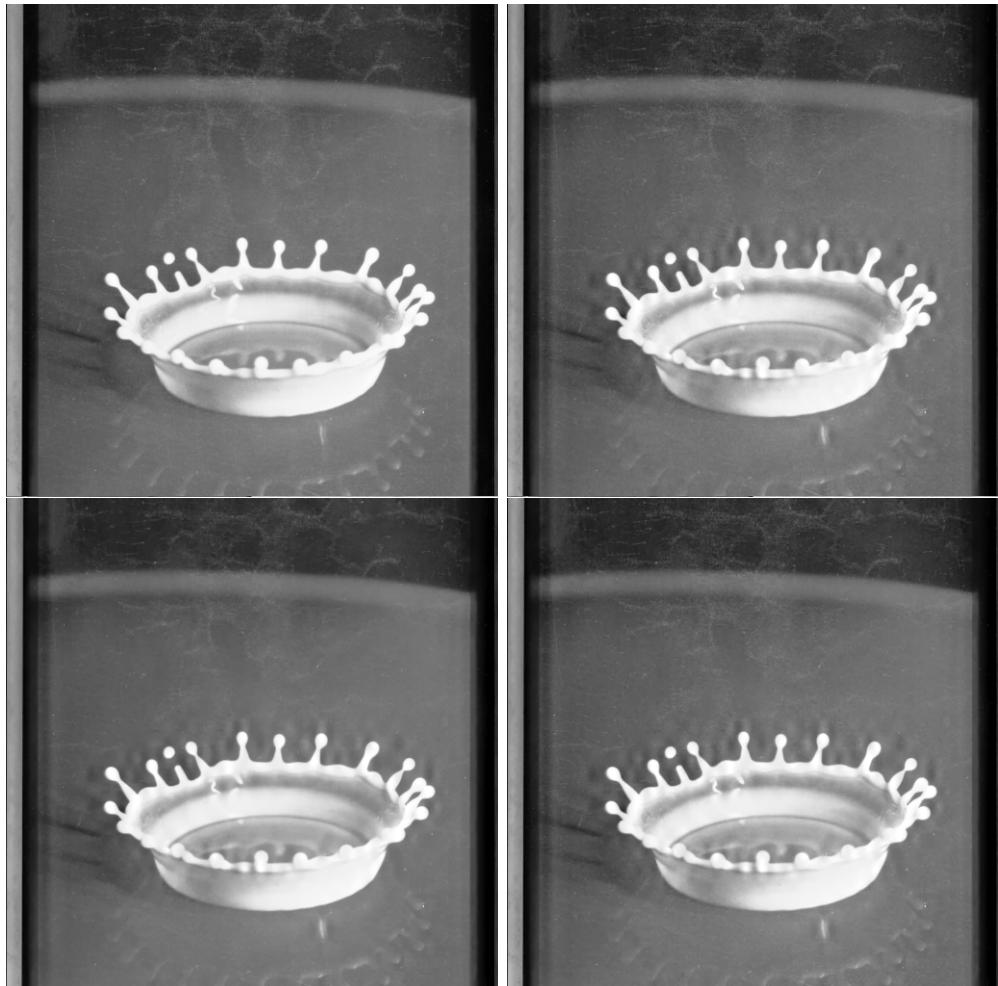


FIG. 31 – Image :4.2.01 *** Bitrate :0.897 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	33.852	34.550	34.313
<i>SIM</i>	0.949	0.954	0.952
<i>NQM</i>	19.383	20.733	20.399

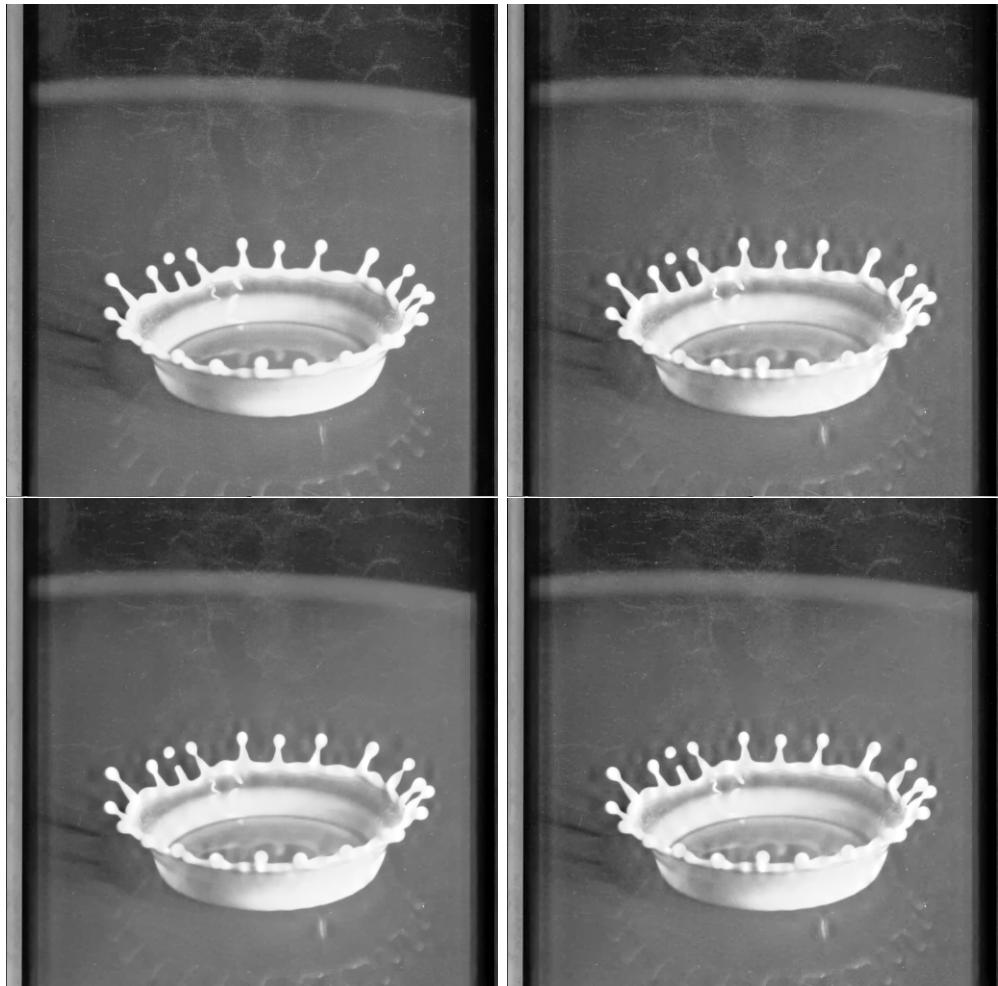


FIG. 32 – Image :4.2.01 *** Bitrate :0.577 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	33.491	34.353	33.956
<i>SIM</i>	0.941	0.949	0.945
<i>NQM</i>	19.371	21.029	20.438

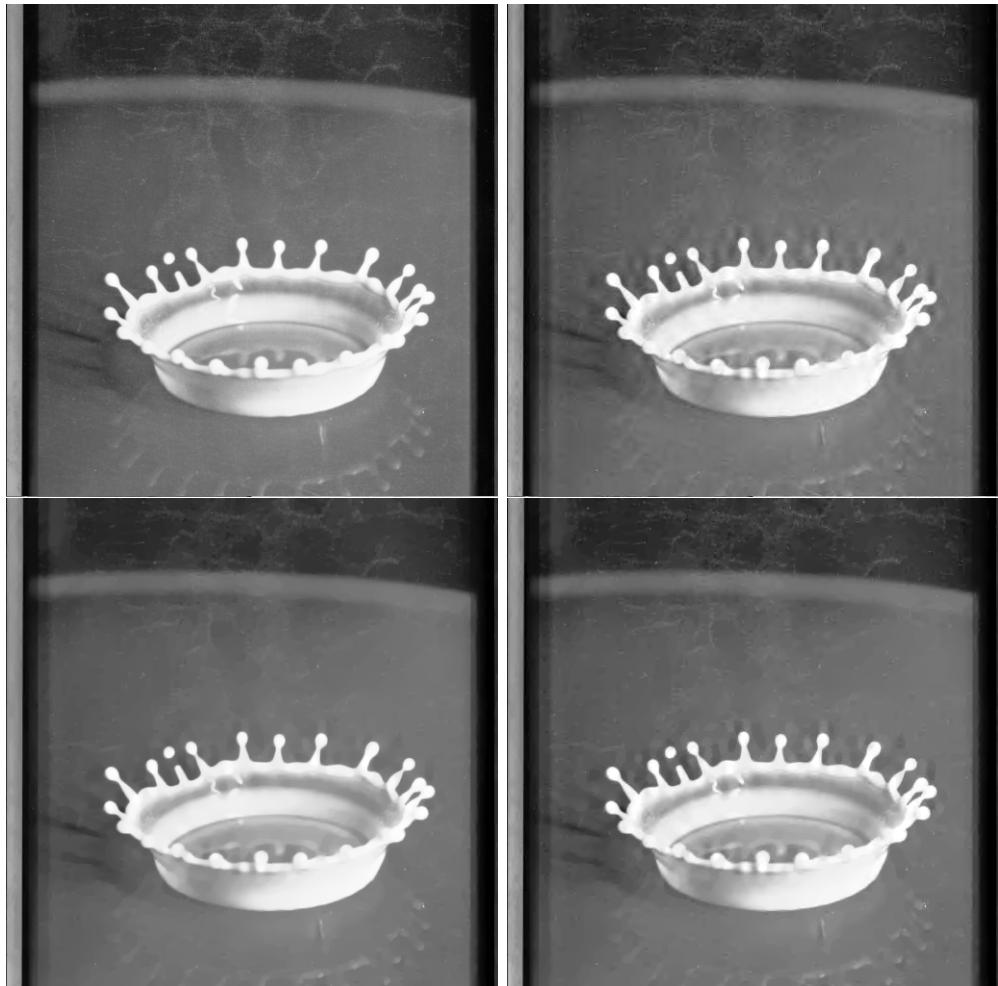


FIG. 33 – Image :4.2.01 *** Bitrate :0.293 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	32.815	34.017	33.396
<i>SIM</i>	0.921	0.936	0.929
<i>NQM</i>	19.268	21.759	20.624

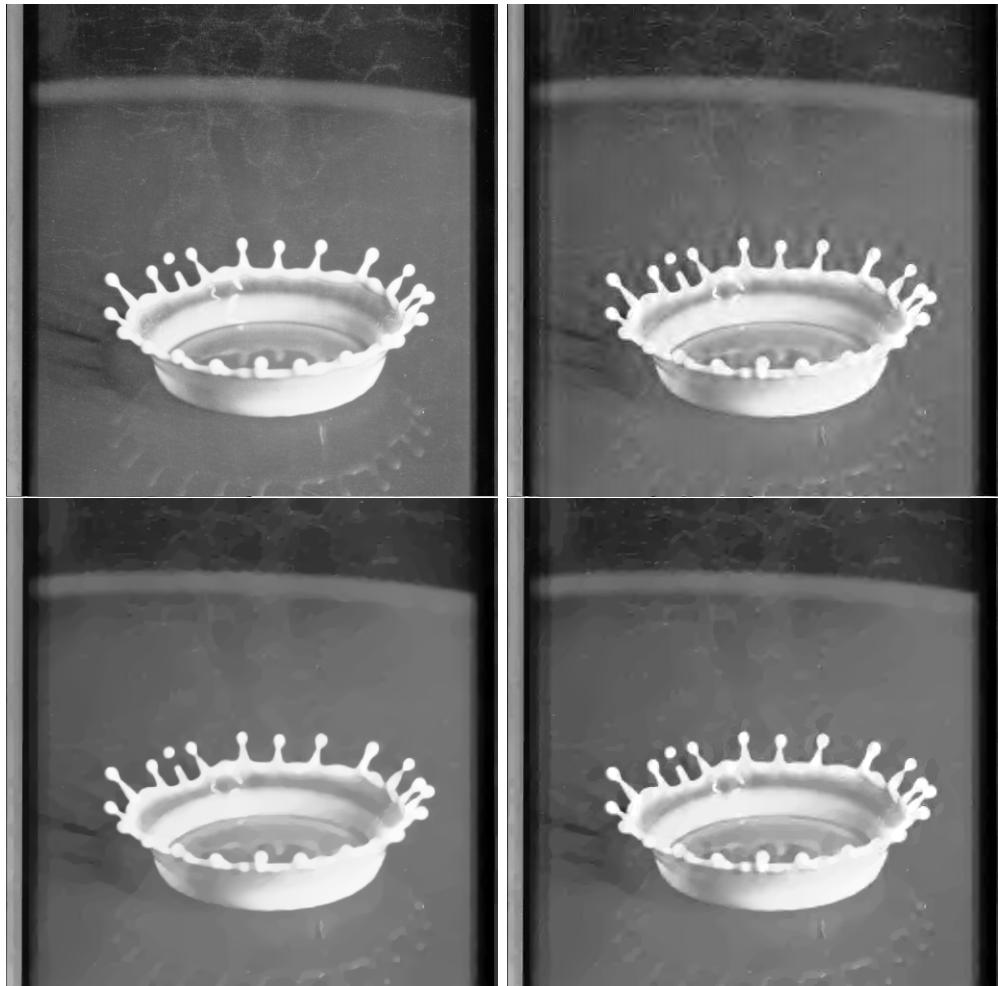


FIG. 34 – Image :4.2.01 *** Bitrate :0.172 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	32.044	33.122	32.813
<i>SIM</i>	0.905	0.922	0.916
<i>NQM</i>	19.148	21.916	20.904

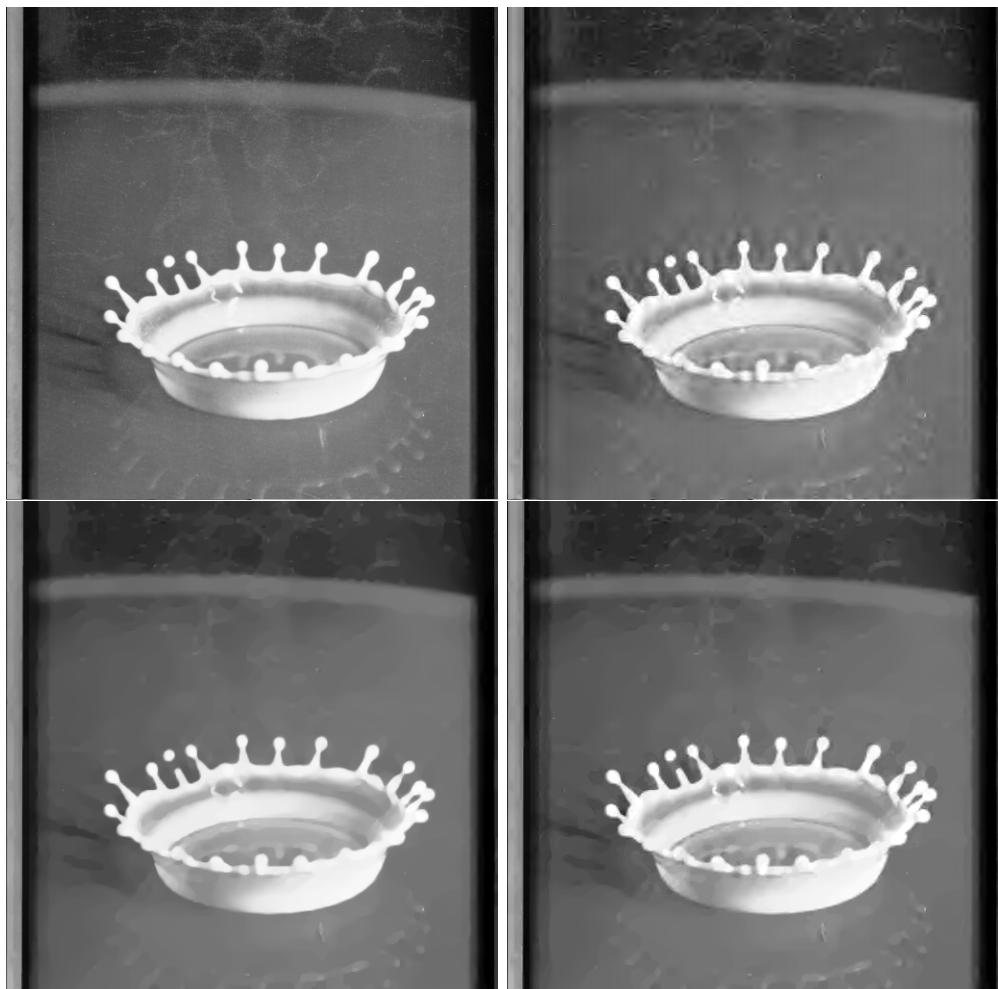


FIG. 35 – Image :4.2.01 *** Bitrate :0.154 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	31.867	32.915	32.644
<i>SIM</i>	0.898	0.916	0.911
<i>NQM</i>	19.038	21.552	20.731

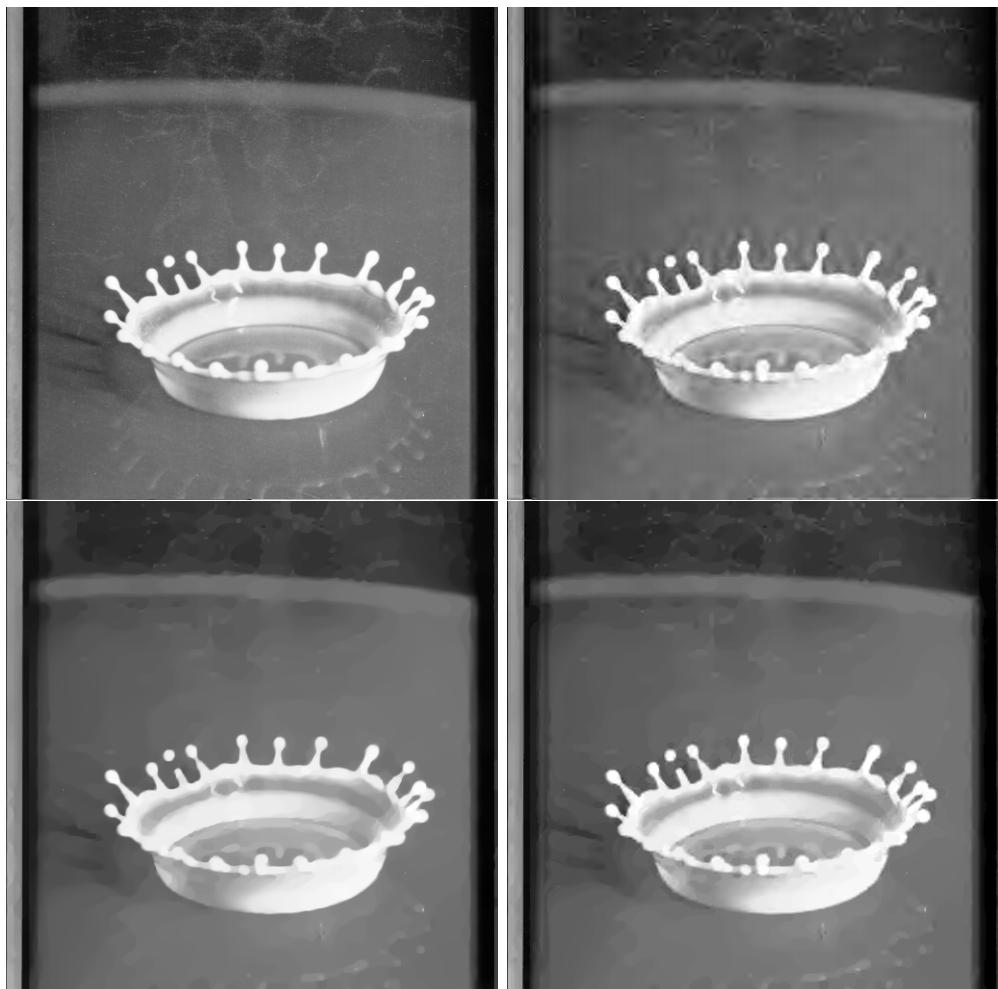


FIG. 36 – Image :4.2.01 *** Bitrate :0.131 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	31.447	32.273	32.189
<i>SIM</i>	0.893	0.911	0.905
<i>NQM</i>	18.877	21.323	20.647

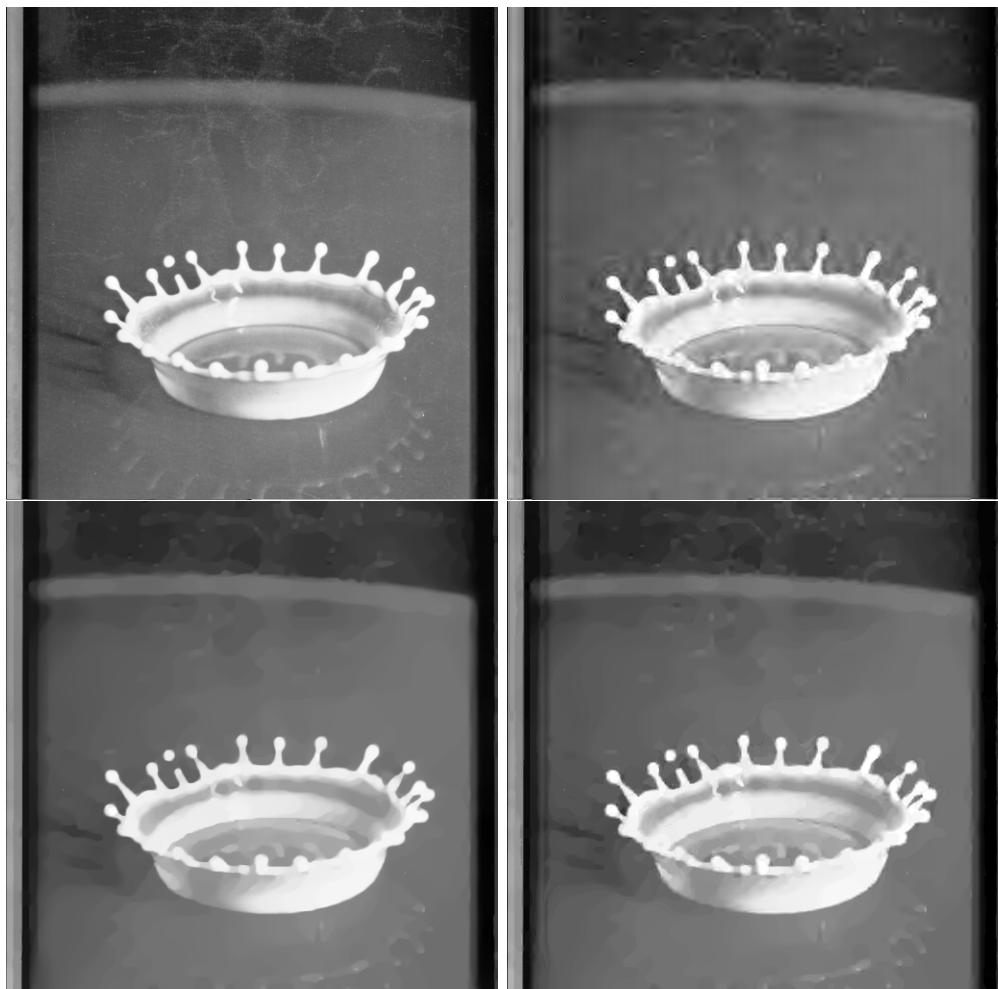


FIG. 37 – Image :4.2.01 *** Bitrate :0.111 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	31.072	31.454	31.897
<i>SIM</i>	0.886	0.904	0.898
<i>NQM</i>	18.803	20.504	20.545

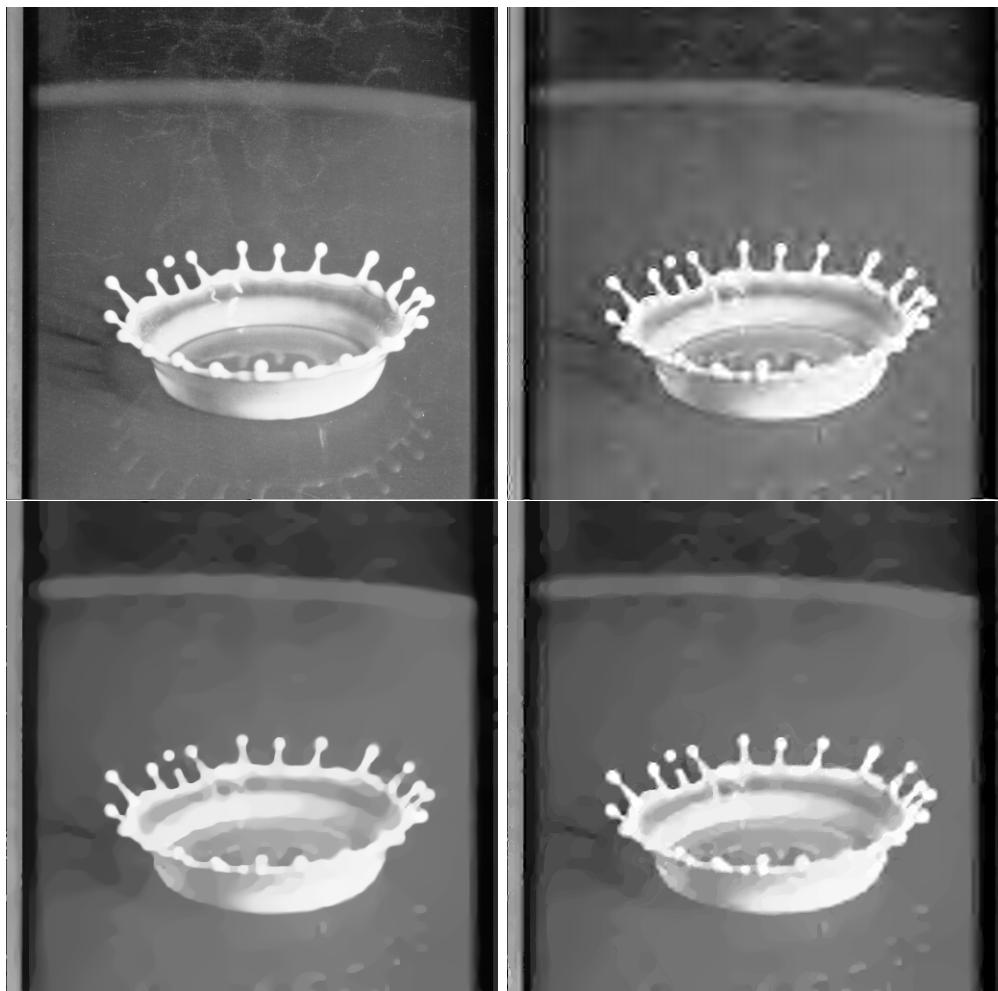


FIG. 38 – Image :4.2.01 *** Bitrate :0.063 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	28.846	30.332	29.924
<i>SIM</i>	0.863	0.889	0.882
<i>NQM</i>	18.136	19.375	19.369

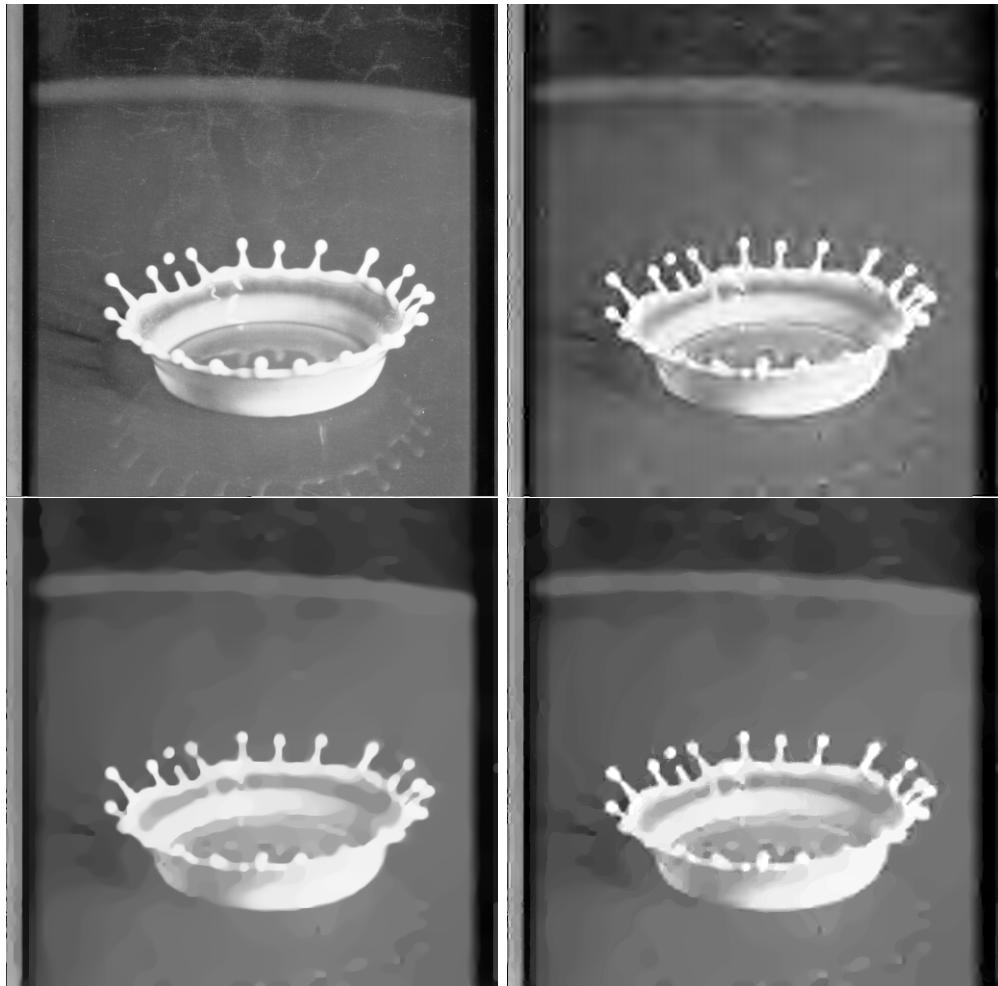


FIG. 39 – Image :4.2.01 *** Bitrate :0.0487 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	28.274	28.828	28.897
<i>SIM</i>	0.853	0.875	0.870
<i>NQM</i>	17.387	18.131	18.578

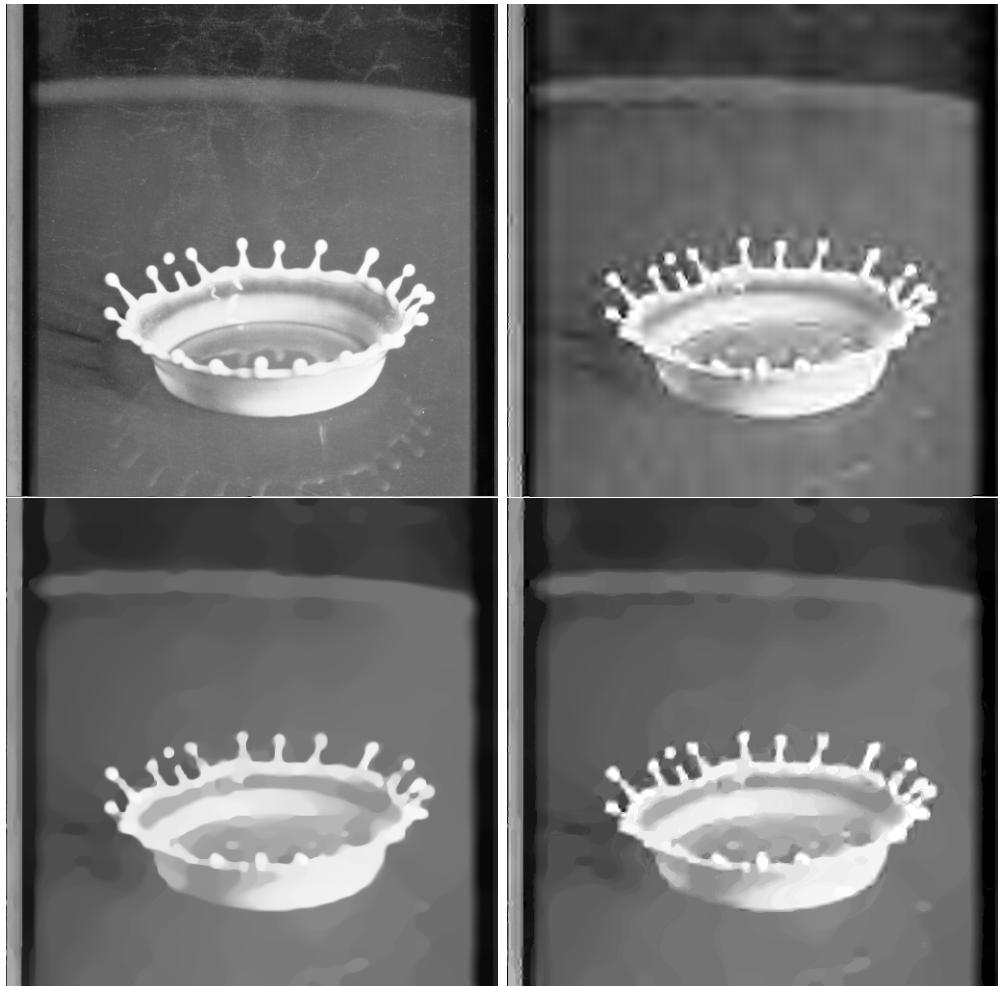


FIG. 40 – Image :4.2.01 *** Bitrate :0.0431 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	28.084	28.727	28.690
<i>SIM</i>	0.837	0.861	0.856
<i>NQM</i>	16.486	16.656	17.430



FIG. 41 – Image :4.2.02 *** Bitrate :0.995 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	39.434	36.944	39.202
<i>SIM</i>	0.989	0.984	0.988
<i>NQM</i>	32.339	27.926	31.481



FIG. 42 – Image :4.2.02 *** Bitrate :0.682 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	38.289	36.019	38.033
<i>SIM</i>	0.983	0.976	0.981
<i>NQM</i>	30.567	26.829	29.924



FIG. 43 – Image :4.2.02 *** Bitrate :0.35 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	36.156	34.313	35.895
<i>SIM</i>	0.969	0.958	0.966
<i>NQM</i>	27.043	23.794	26.533



FIG. 44 – Image :4.2.02 *** Bitrate :0.209 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	34.572	33.041	34.392
<i>SIM</i>	0.952	0.937	0.949
<i>NQM</i>	24.616	21.607	24.161



FIG. 45 – Image :4.2.02 *** Bitrate :0.145 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	33.506	32.010	33.245
<i>SIM</i>	0.940	0.923	0.936
<i>NQM</i>	23.364	20.251	22.862



FIG. 46 – Image :4.2.02 *** Bitrate :0.113 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	32.853	31.417	32.597
<i>SIM</i>	0.926	0.907	0.922
<i>NQM</i>	21.834	19.003	21.453



FIG. 47 – Image :4.2.02 *** Bitrate :0.0923 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	32.330	30.819	32.098
<i>SIM</i>	0.916	0.895	0.910
<i>NQM</i>	20.882	17.709	20.531



FIG. 48 – Image :4.2.02 *** Bitrate :0.062 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	31.189	29.932	30.998
<i>SIM</i>	0.887	0.864	0.880
<i>NQM</i>	18.272	15.719	18.227



FIG. 49 – Image :4.2.02 *** Bitrate :0.0393 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	29.907	28.868	29.747
<i>SIM</i>	0.852	0.825	0.844
<i>NQM</i>	15.665	13.716	15.679



FIG. 50 – Image :4.2.02 *** Bitrate :0.0244 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	28.385	27.788	28.312
<i>SIM</i>	0.809	0.784	0.798
<i>NQM</i>	12.291	11.243	12.535

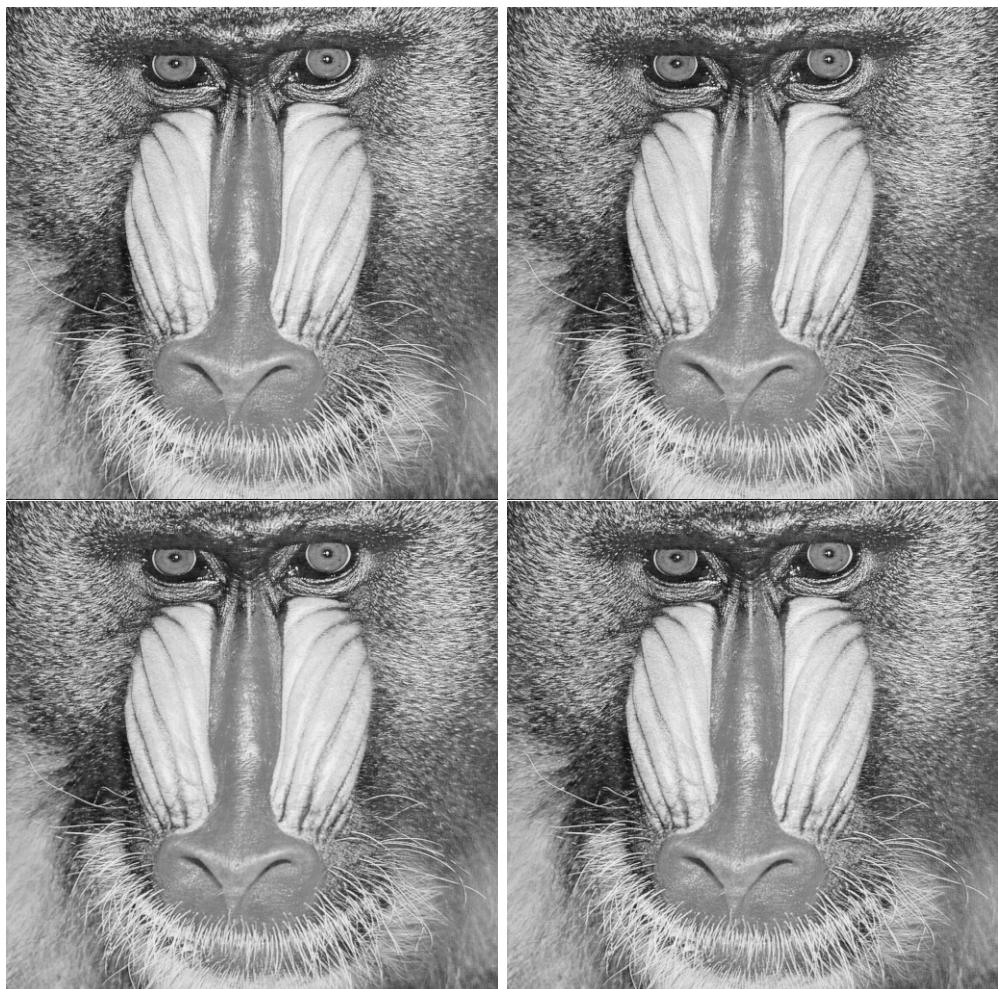


FIG. 51 – Image :4.2.03 *** Bitrate :3.59 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	42.624	40.609	42.426
<i>SIM</i>	0.998	0.997	0.998
<i>NQM</i>	41.597	41.378	41.570

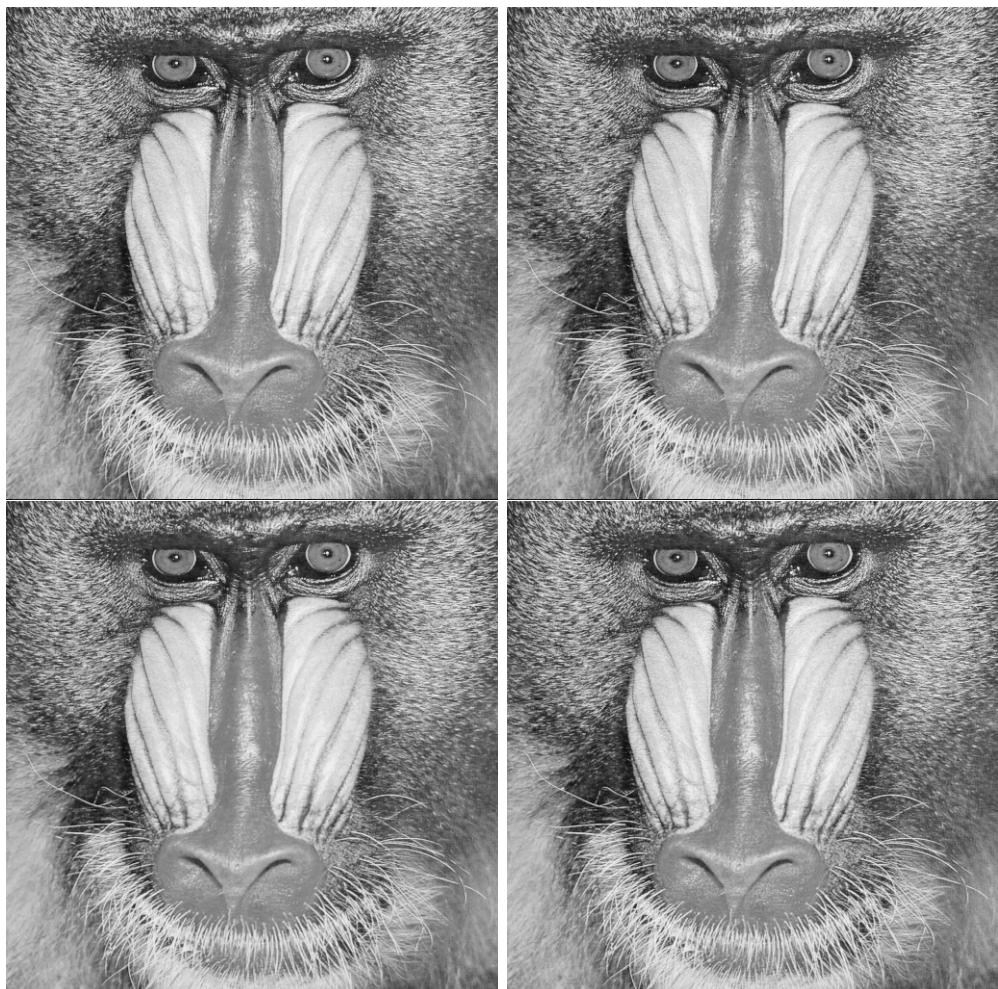


FIG. 52 – Image :4.2.03 *** Bitrate :3.1 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	39.588	37.833	39.434
<i>SIM</i>	0.996	0.994	0.996
<i>NQM</i>	38.759	38.487	38.732

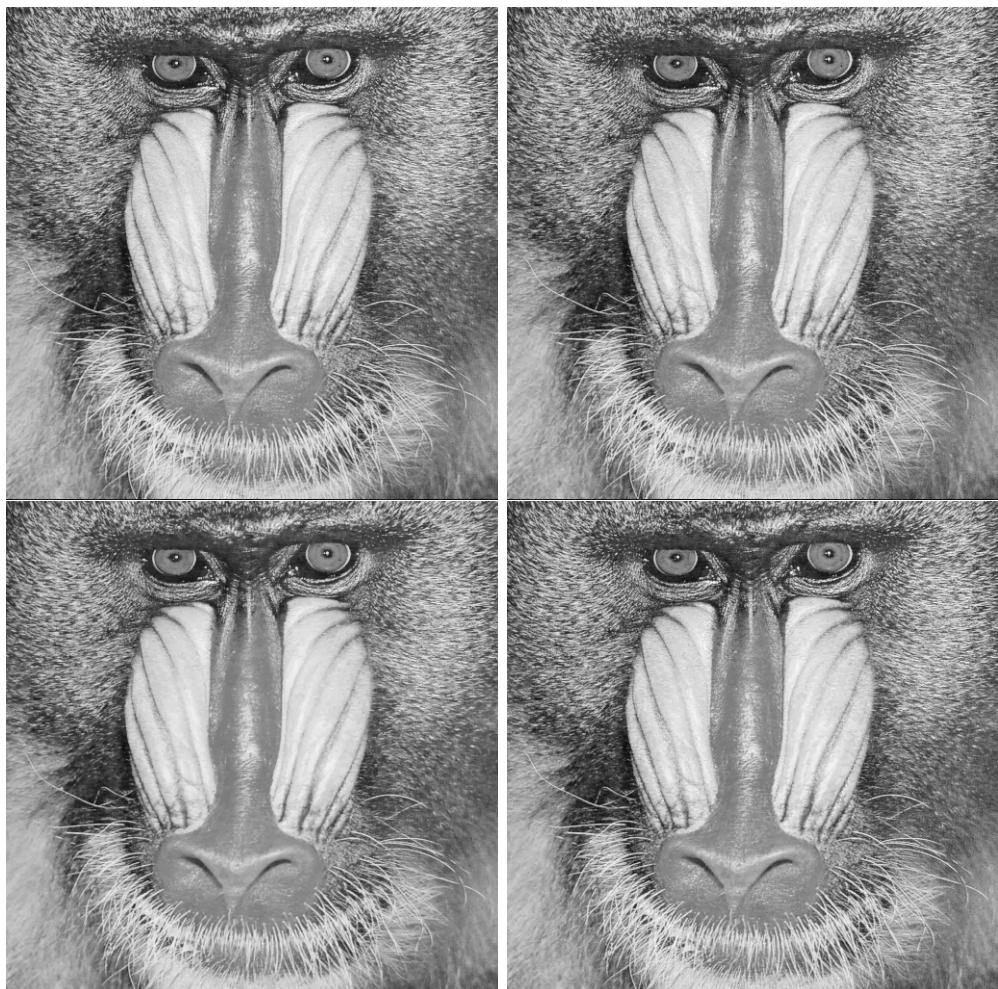


FIG. 53 – Image :4.2.03 *** Bitrate :2.27 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	34.627	33.178	34.506
<i>SIM</i>	0.988	0.984	0.988
<i>NQM</i>	34.677	34.144	34.636

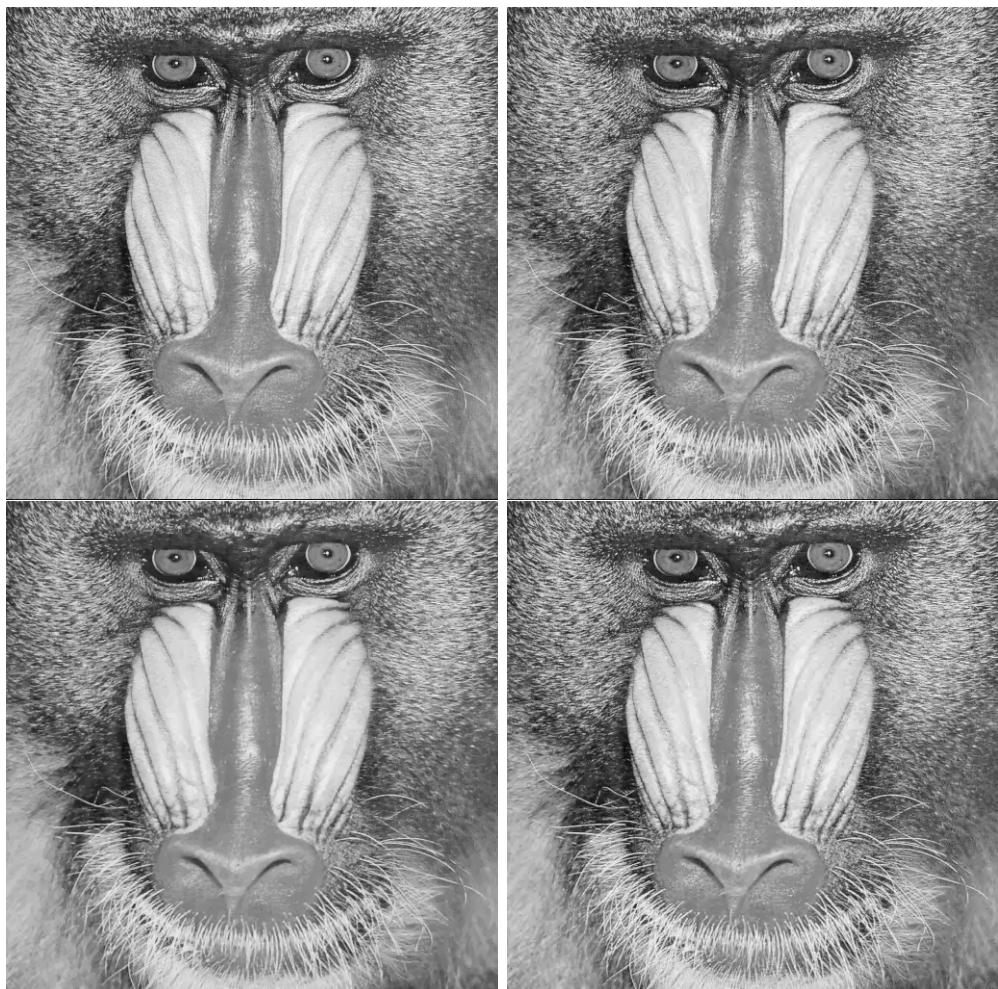


FIG. 54 – Image :4.2.03 *** Bitrate :1.6 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	30.788	29.454	30.656
<i>SIM</i>	0.973	0.962	0.972
<i>NQM</i>	31.378	30.390	31.289

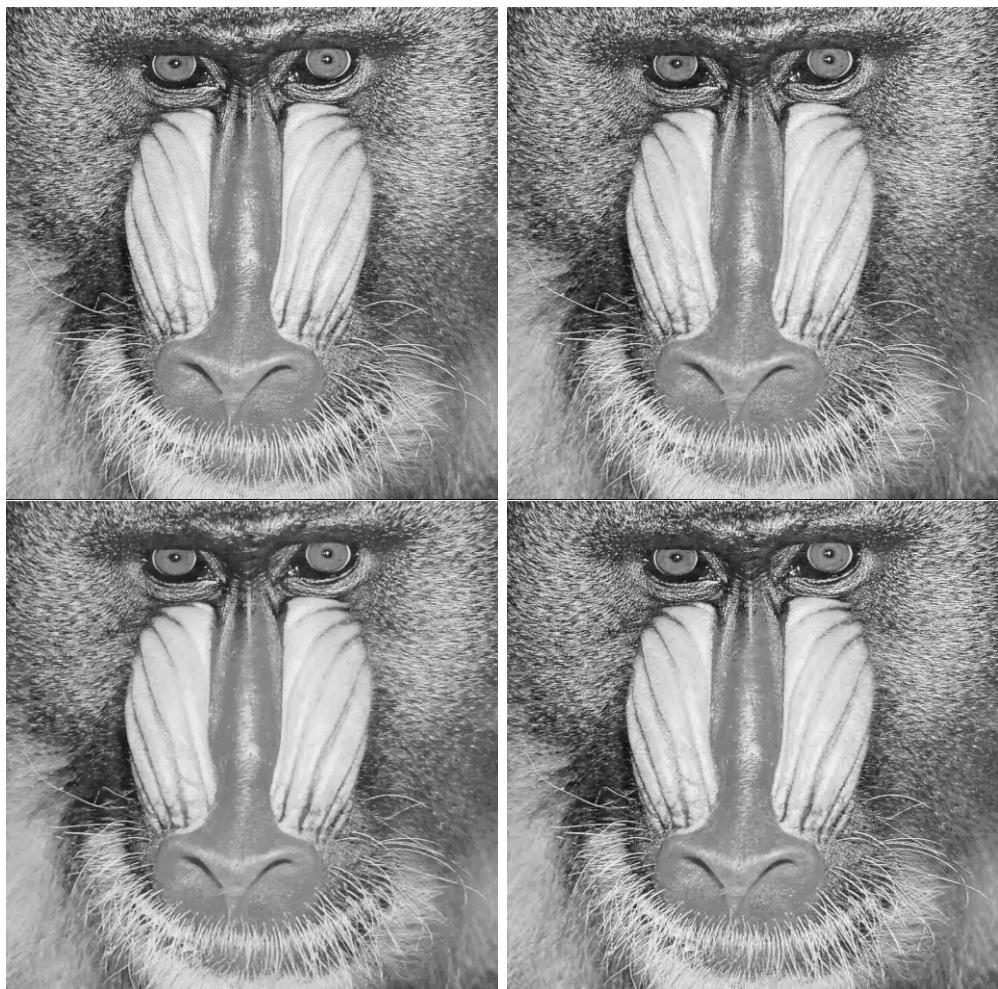


FIG. 55 – Image :4.2.03 *** Bitrate :1.32 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	29.203	27.908	29.048
<i>SIM</i>	0.963	0.944	0.961
<i>NQM</i>	29.552	28.196	29.438

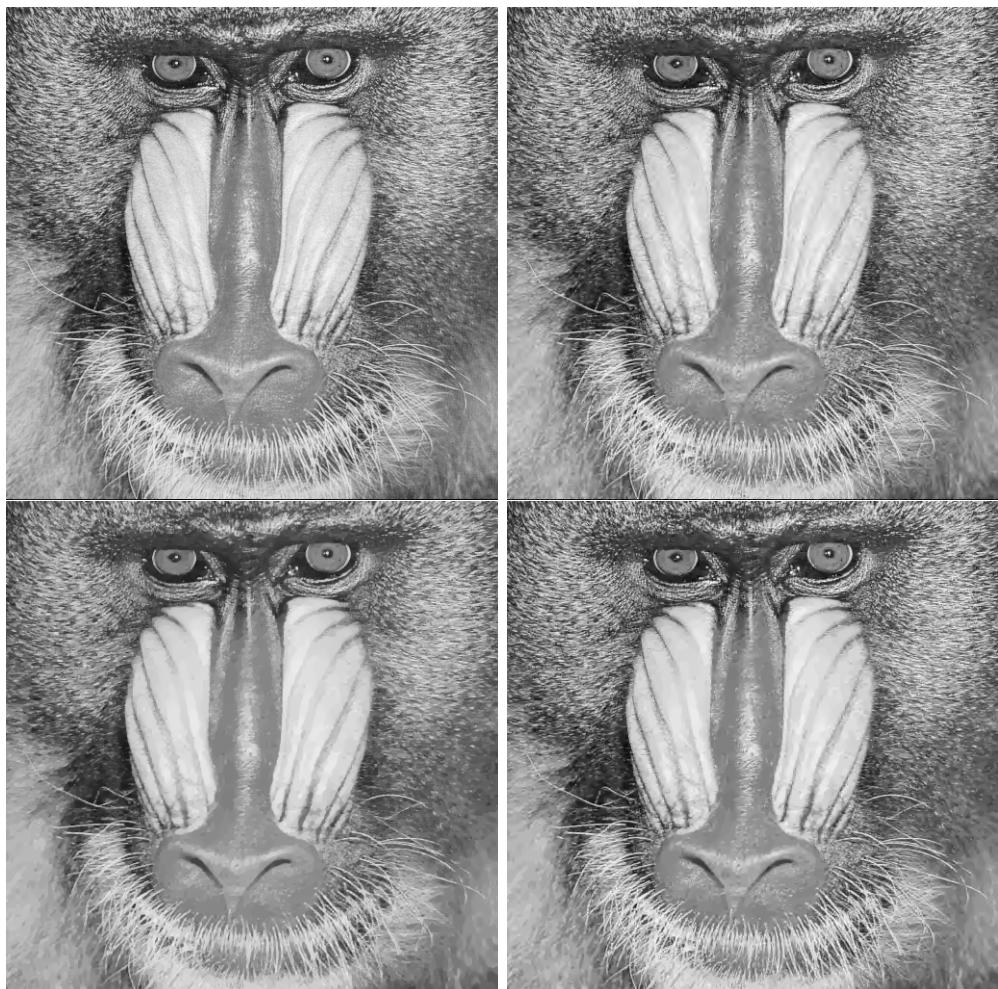


FIG. 56 – Image :4.2.03 *** Bitrate :1 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	27.323	25.810	27.035
<i>SIM</i>	0.948	0.914	0.944
<i>NQM</i>	27.888	25.198	27.704

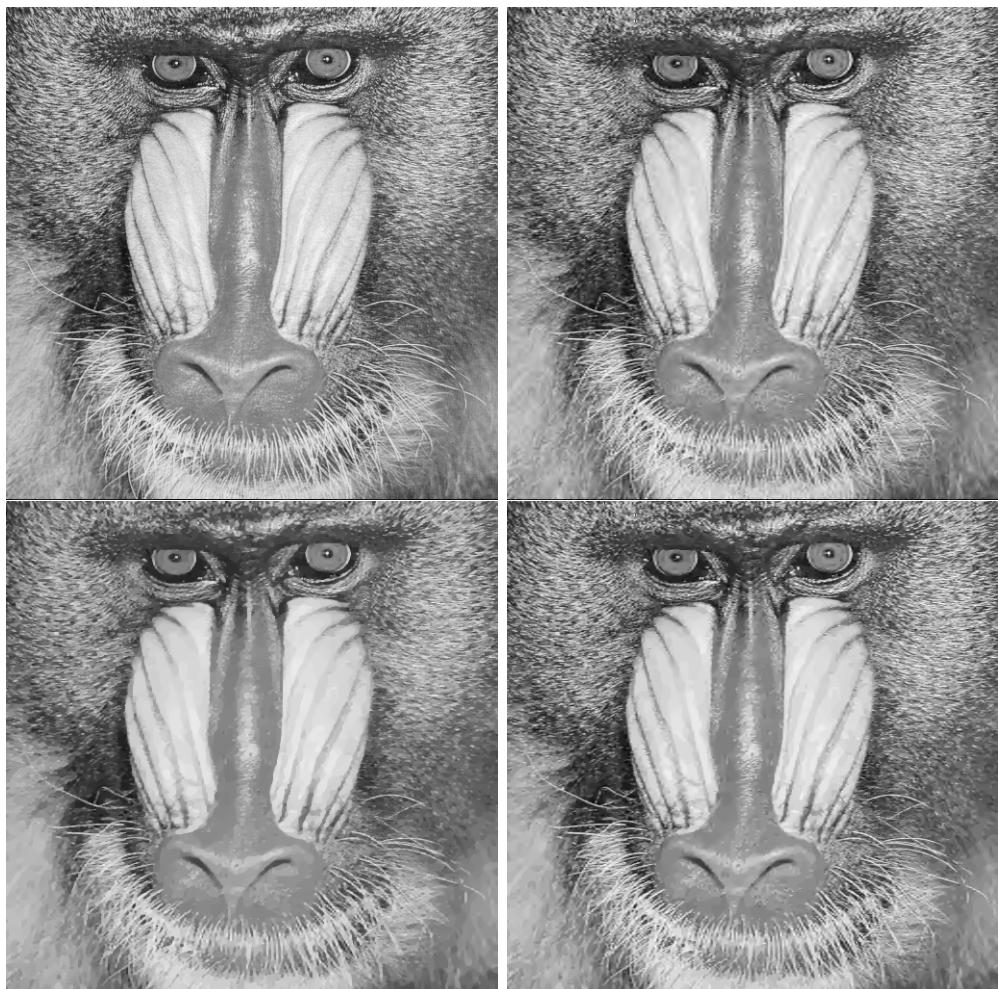


FIG. 57 – Image :4.2.03 *** Bitrate :0.758 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	25.594	24.297	25.275
<i>SIM</i>	0.928	0.883	0.922
<i>NQM</i>	26.887	23.298	26.571

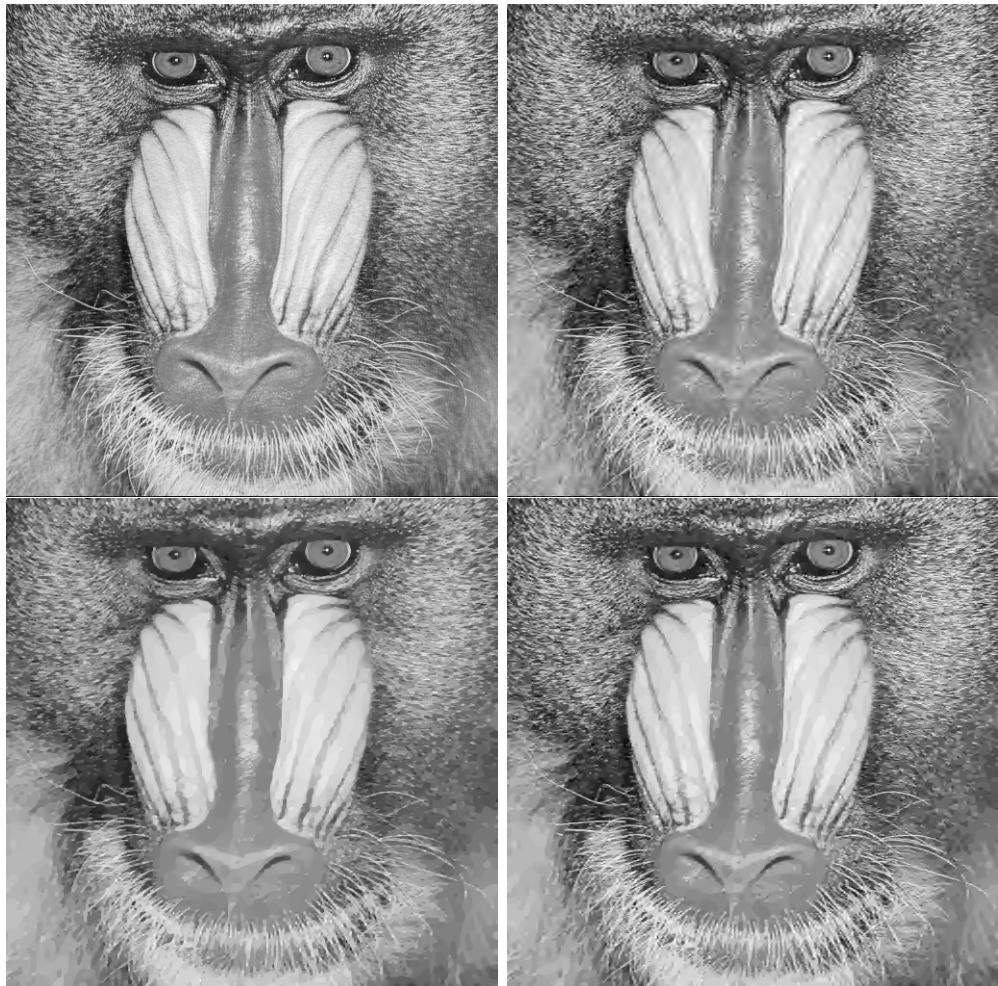


FIG. 58 – Image :4.2.03 *** Bitrate :0.531 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	24.220	23.132	23.918
<i>SIM</i>	0.890	0.826	0.879
<i>NQM</i>	23.497	20.077	23.173

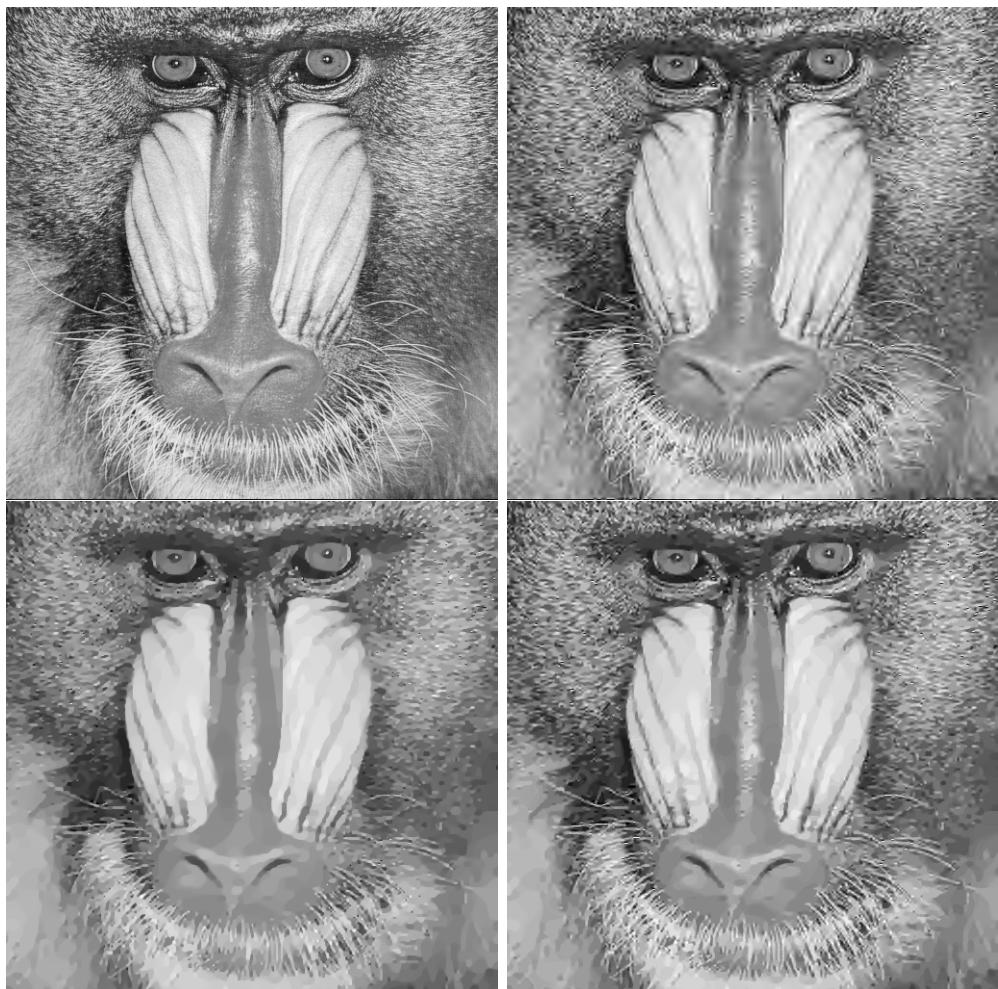


FIG. 59 – Image :4.2.03 *** Bitrate :0.234 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	21.771	21.158	21.593
<i>SIM</i>	0.808	0.728	0.792
<i>NQM</i>	20.606	17.818	20.302

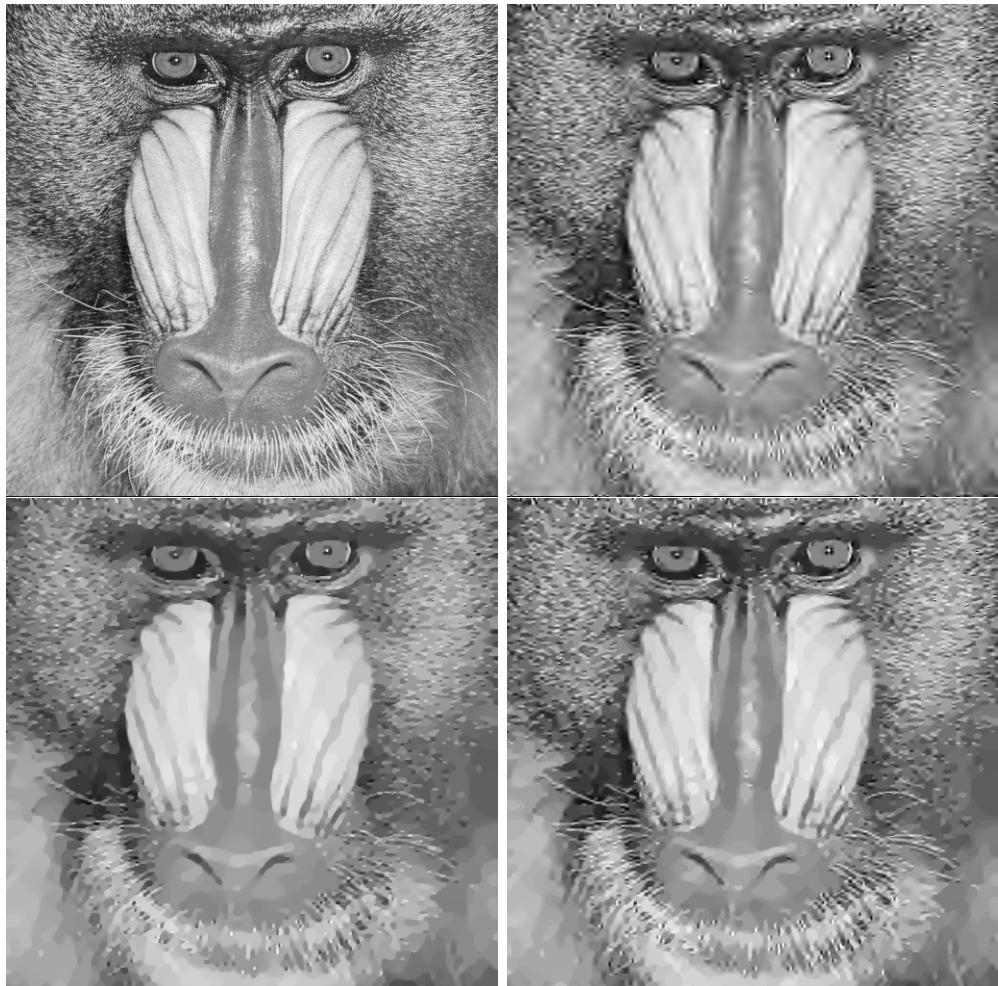


FIG. 60 – Image :4.2.03 *** Bitrate :0.133 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	20.689	20.302	20.552
<i>SIM</i>	0.718	0.629	0.694
<i>NQM</i>	17.564	15.532	17.217



FIG. 61 – Image :4.2.04 *** Bitrate :1.92 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	42.288	41.897	42.060
<i>SIM</i>	0.994	0.994	0.993
<i>NQM</i>	43.952	43.404	43.766



FIG. 62 – Image :4.2.04 *** Bitrate :1.19 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	38.550	38.299	38.420
<i>SIM</i>	0.987	0.986	0.986
<i>NQM</i>	41.652	40.404	41.484



FIG. 63 – Image :4.2.04 *** Bitrate :0.579 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	35.224	34.226	34.964
<i>SIM</i>	0.973	0.965	0.971
<i>NQM</i>	36.585	33.651	36.092



FIG. 64 – Image :4.2.04 *** Bitrate :0.374 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	33.402	32.316	33.126
<i>SIM</i>	0.959	0.948	0.957
<i>NQM</i>	33.744	30.512	33.142



FIG. 65 – Image :4.2.04 *** Bitrate :0.316 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	32.678	31.629	32.421
<i>SIM</i>	0.952	0.938	0.949
<i>NQM</i>	31.696	28.693	31.201



FIG. 66 – Image :4.2.04 *** Bitrate :0.227 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	31.224	30.227	31.005
<i>SIM</i>	0.941	0.923	0.937
<i>NQM</i>	30.273	26.996	29.796



FIG. 67 – Image :4.2.04 *** Bitrate :0.198 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	30.756	29.769	30.524
<i>SIM</i>	0.932	0.914	0.929
<i>NQM</i>	29.374	26.432	28.916



FIG. 68 – Image :4.2.04 *** Bitrate :0.132 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	29.250	28.505	29.157
<i>SIM</i>	0.906	0.887	0.904
<i>NQM</i>	26.212	23.457	25.946



FIG. 69 – Image :4.2.04 *** Bitrate :0.0894 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	27.787	27.298	27.803
<i>SIM</i>	0.870	0.852	0.871
<i>NQM</i>	22.965	20.930	23.097



FIG. 70 – Image :4.2.04 *** Bitrate :0.0569 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	26.295	26.000	26.366
<i>SIM</i>	0.831	0.812	0.833
<i>NQM</i>	20.767	18.907	20.883

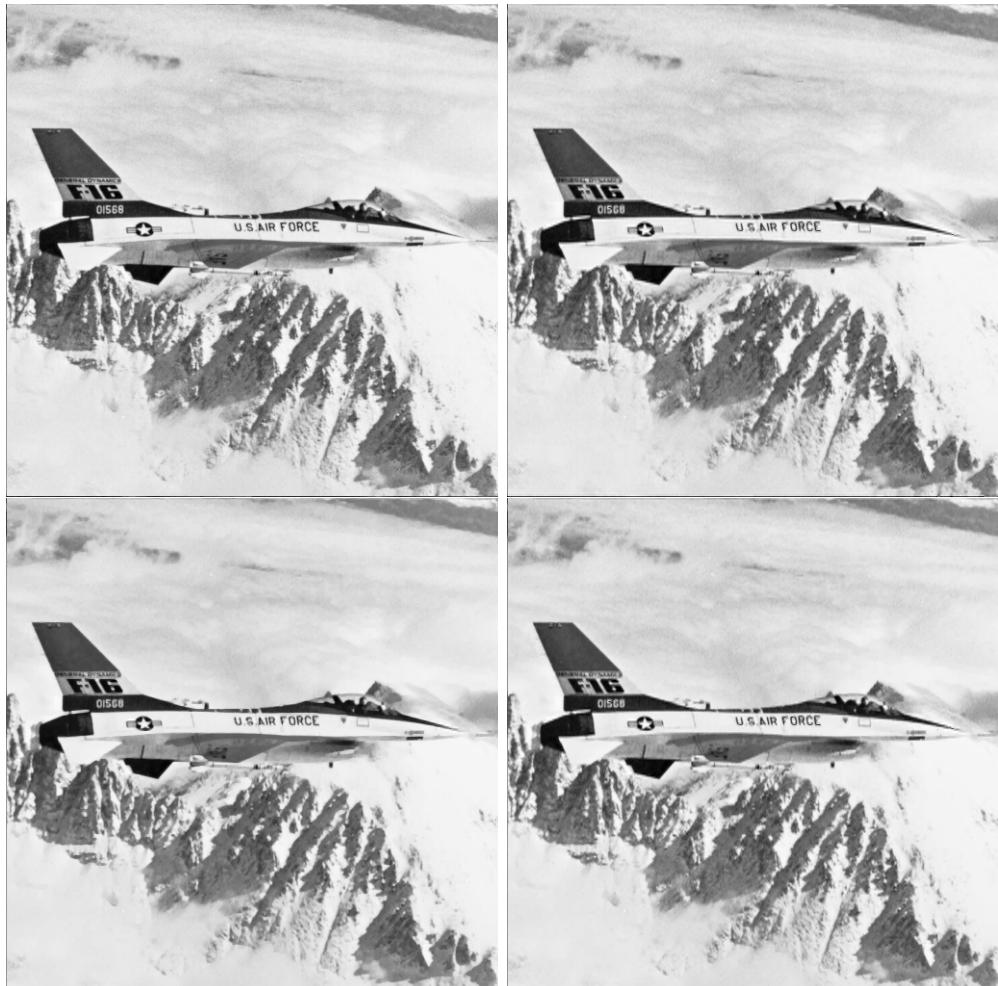


FIG. 71 – Image :4.2.05 *** Bitrate :1.29 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	35.246	34.428	35.248
<i>SIM</i>	0.990	0.987	0.989
<i>NQM</i>	38.616	34.094	38.201

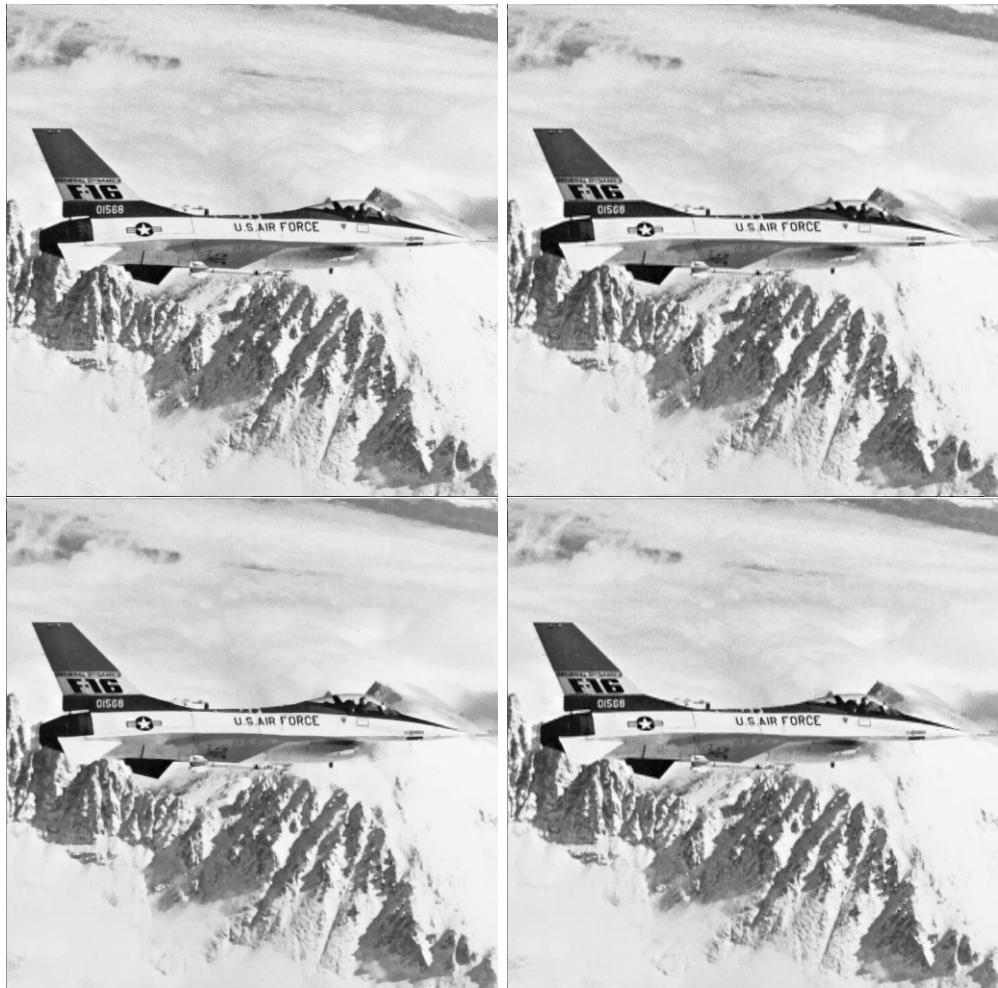


FIG. 72 – Image :4.2.05 *** Bitrate :0.965 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	34.728	33.733	34.673
<i>SIM</i>	0.986	0.981	0.984
<i>NQM</i>	37.360	33.140	36.765



FIG. 73 – Image :4.2.05 *** Bitrate :0.618 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	33.615	32.329	33.506
<i>SIM</i>	0.974	0.966	0.971
<i>NQM</i>	33.983	30.336	33.540



FIG. 74 – Image :4.2.05 *** Bitrate :0.439 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	32.419	31.067	32.327
<i>SIM</i>	0.961	0.952	0.960
<i>NQM</i>	31.188	28.122	30.856



FIG. 75 – Image :4.2.05 *** Bitrate :0.376 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	31.784	30.386	31.683
<i>SIM</i>	0.954	0.944	0.953
<i>NQM</i>	30.097	26.772	29.716



FIG. 76 – Image :4.2.05 *** Bitrate :0.312 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	30.966	29.685	30.935
<i>SIM</i>	0.944	0.934	0.944
<i>NQM</i>	28.347	25.441	28.021



FIG. 77 – Image :4.2.05 *** Bitrate :0.247 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	29.849	28.676	29.723
<i>SIM</i>	0.935	0.923	0.935
<i>NQM</i>	27.393	24.411	27.035



FIG. 78 – Image :4.2.05 *** Bitrate :0.187 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	28.718	27.482	28.729
<i>SIM</i>	0.915	0.902	0.917
<i>NQM</i>	25.033	21.995	25.215



FIG. 79 – Image :4.2.05 *** Bitrate :0.14 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	27.422	26.571	27.527
<i>SIM</i>	0.885	0.876	0.891
<i>NQM</i>	22.388	20.192	22.509



FIG. 80 – Image :4.2.05 *** Bitrate :0.0742 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	24.693	24.561	24.928
<i>SIM</i>	0.833	0.829	0.842
<i>NQM</i>	19.228	17.937	19.864



FIG. 81 – Image :4.2.06 *** Bitrate :2.53 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	42.644	41.389	42.287
<i>SIM</i>	0.995	0.995	0.995
<i>NQM</i>	44.645	44.118	44.498



FIG. 82 – Image :4.2.06 *** Bitrate :2.05 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	39.677	38.907	39.414
<i>SIM</i>	0.991	0.991	0.990
<i>NQM</i>	42.018	41.491	41.843



FIG. 83 – Image :4.2.06 *** Bitrate :1.03 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	34.060	33.104	33.930
<i>SIM</i>	0.978	0.972	0.977
<i>NQM</i>	37.724	35.080	37.356



FIG. 84 – Image :4.2.06 *** Bitrate :0.651 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	31.771	30.973	31.728
<i>SIM</i>	0.963	0.954	0.963
<i>NQM</i>	34.081	31.424	33.917



FIG. 85 – Image :4.2.06 *** Bitrate :0.53 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	30.822	30.082	30.794
<i>SIM</i>	0.955	0.944	0.955
<i>NQM</i>	32.880	29.932	32.721



FIG. 86 – Image :4.2.06 *** Bitrate :0.399 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	29.605	28.921	29.590
<i>SIM</i>	0.943	0.931	0.944
<i>NQM</i>	30.932	28.240	30.840



FIG. 87 – Image :4.2.06 *** Bitrate :0.327 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	28.853	28.123	28.817
<i>SIM</i>	0.933	0.920	0.935
<i>NQM</i>	29.824	26.959	29.819



FIG. 88 – Image :4.2.06 *** Bitrate :0.21 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	27.239	26.404	27.152
<i>SIM</i>	0.902	0.885	0.906
<i>NQM</i>	26.785	23.970	26.844



FIG. 89 – Image :4.2.06 *** Bitrate :0.148 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	26.028	25.365	26.053
<i>SIM</i>	0.867	0.850	0.875
<i>NQM</i>	23.834	21.438	24.123



FIG. 90 – Image :4.2.06 *** Bitrate :0.0835 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	24.157	23.829	24.224
<i>SIM</i>	0.814	0.800	0.826
<i>NQM</i>	21.100	19.243	21.528

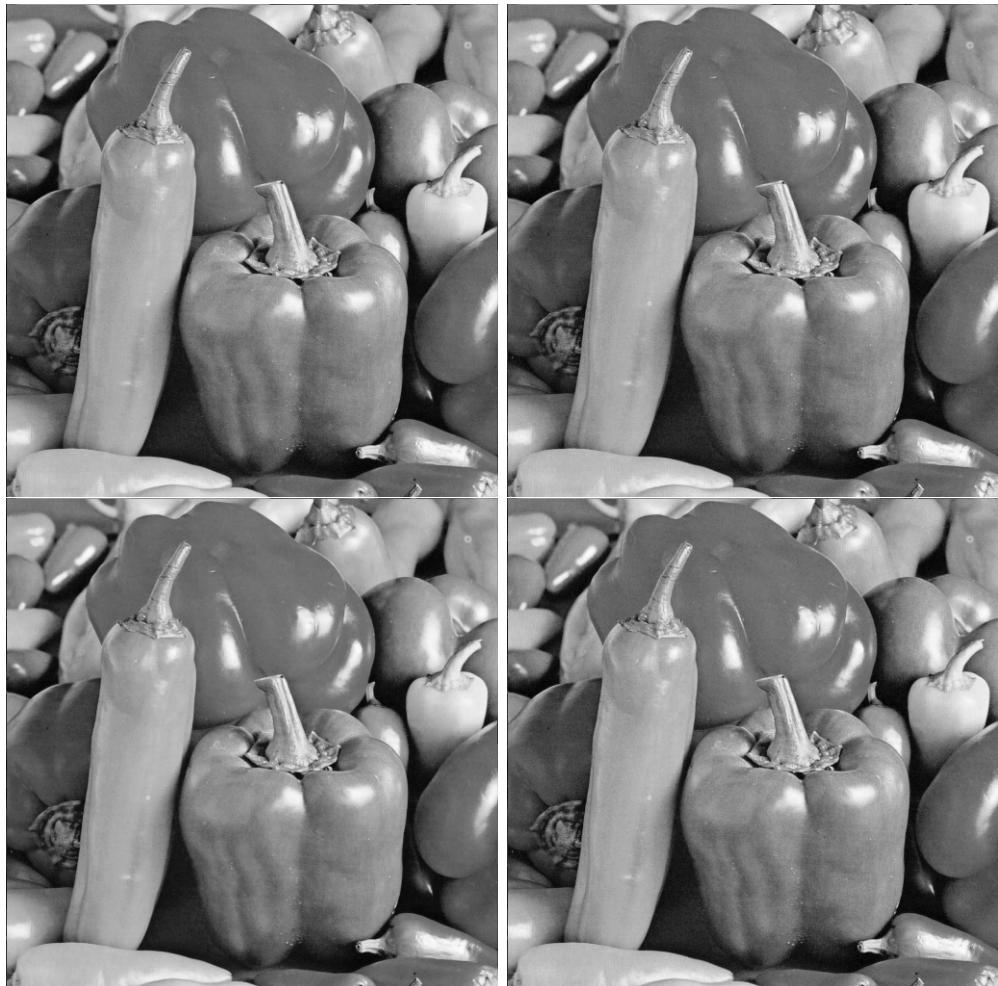


FIG. 91 – Image :4.2.07 *** Bitrate :2.08 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	42.751	42.004	42.342
<i>SIM</i>	0.994	0.994	0.993
<i>NQM</i>	44.136	43.756	43.984

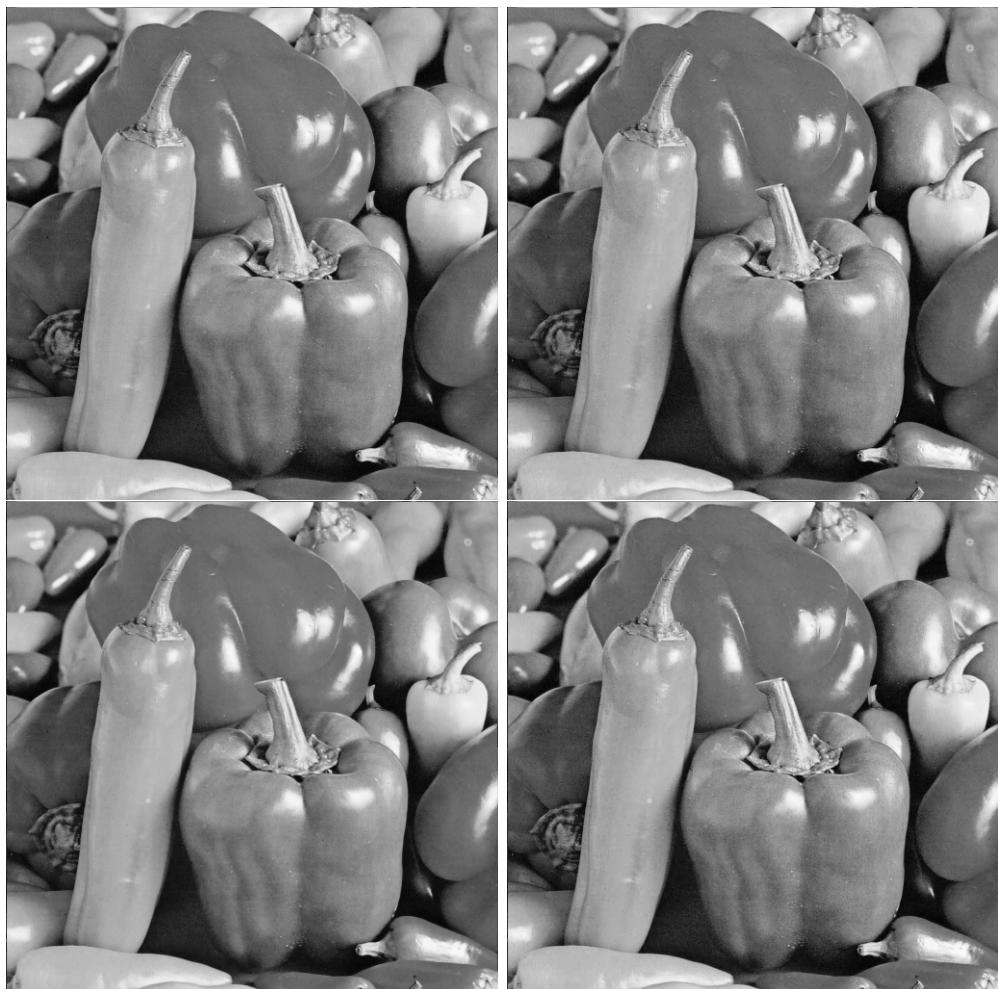


FIG. 92 – Image :4.2.07 *** Bitrate :1.42 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	38.854	38.775	38.644
<i>SIM</i>	0.987	0.987	0.986
<i>NQM</i>	41.284	40.535	41.088

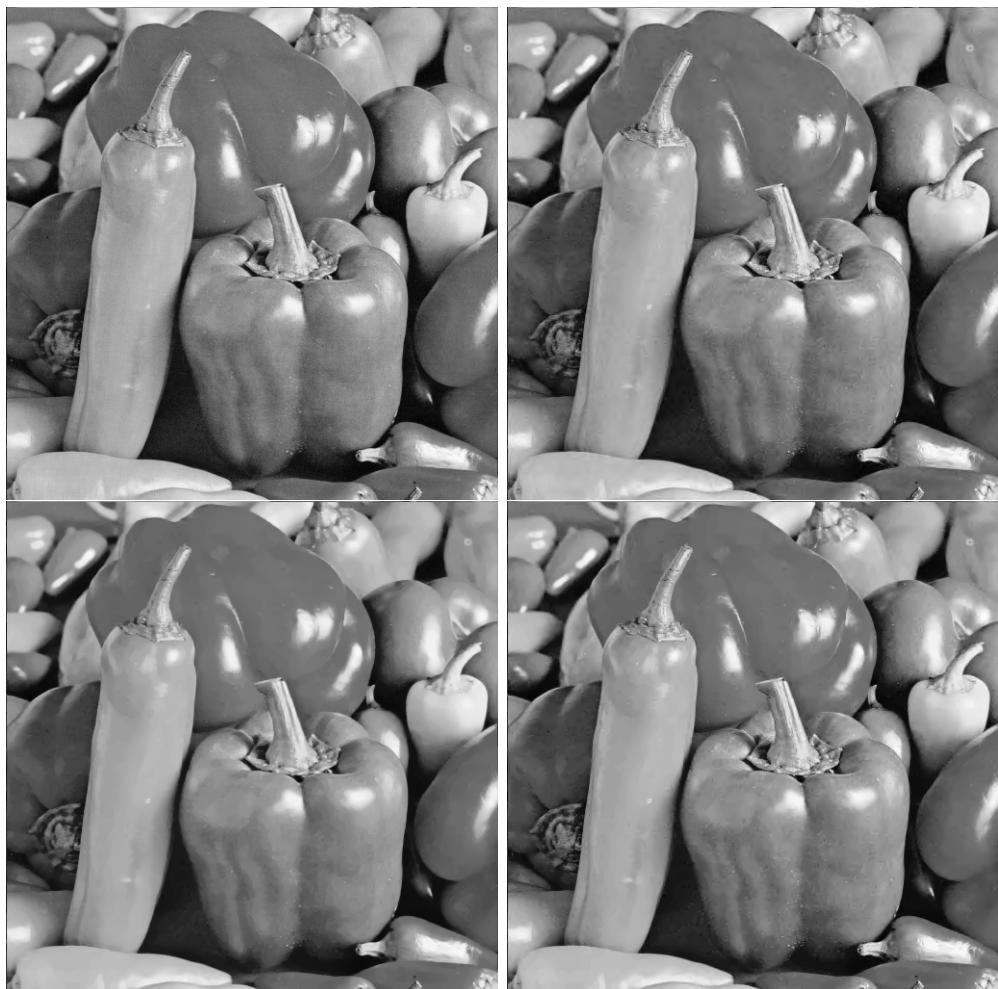


FIG. 93 – Image :4.2.07 *** Bitrate :0.51 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	34.771	34.501	34.746
<i>SIM</i>	0.971	0.966	0.970
<i>NQM</i>	37.053	34.636	36.668



FIG. 94 – Image :4.2.07 *** Bitrate :0.329 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	33.289	32.785	33.280
<i>SIM</i>	0.957	0.949	0.956
<i>NQM</i>	33.505	30.611	33.161

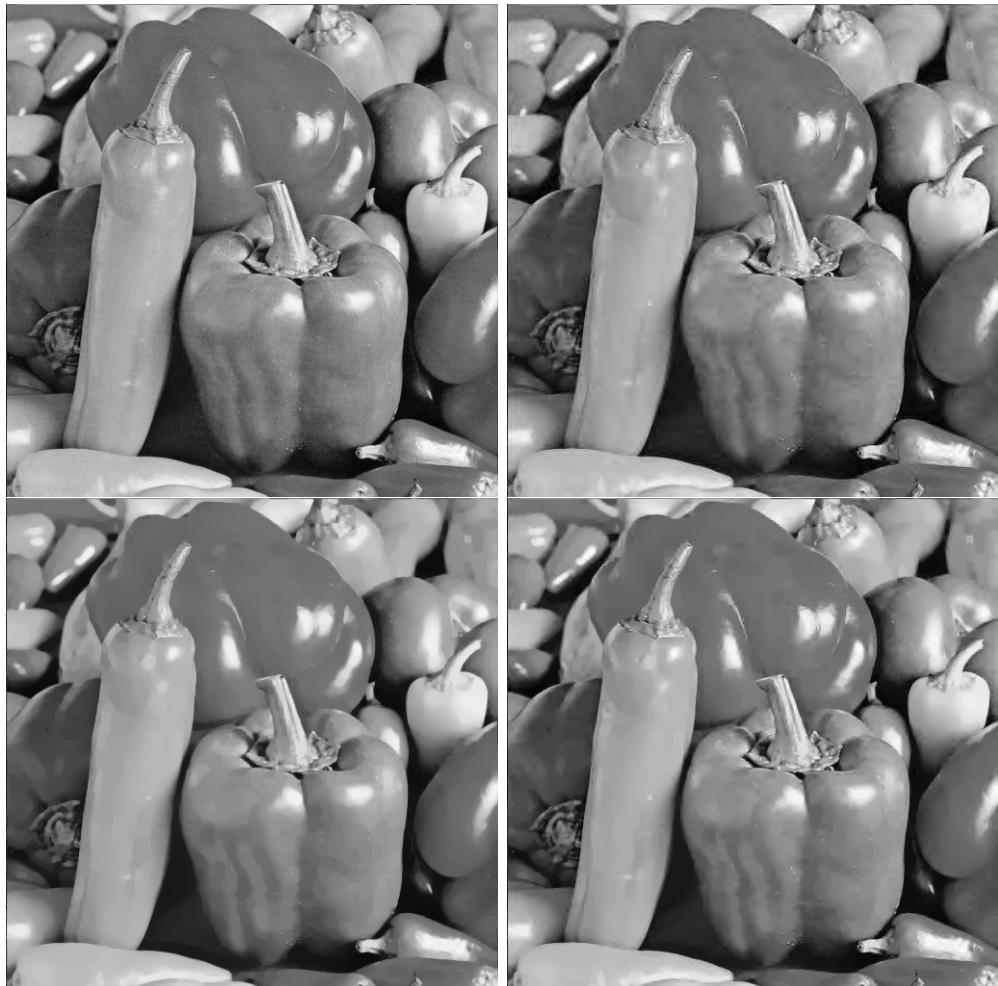


FIG. 95 – Image :4.2.07 *** Bitrate :0.274 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	32.621	32.220	32.668
<i>SIM</i>	0.951	0.942	0.950
<i>NQM</i>	32.141	29.324	31.891

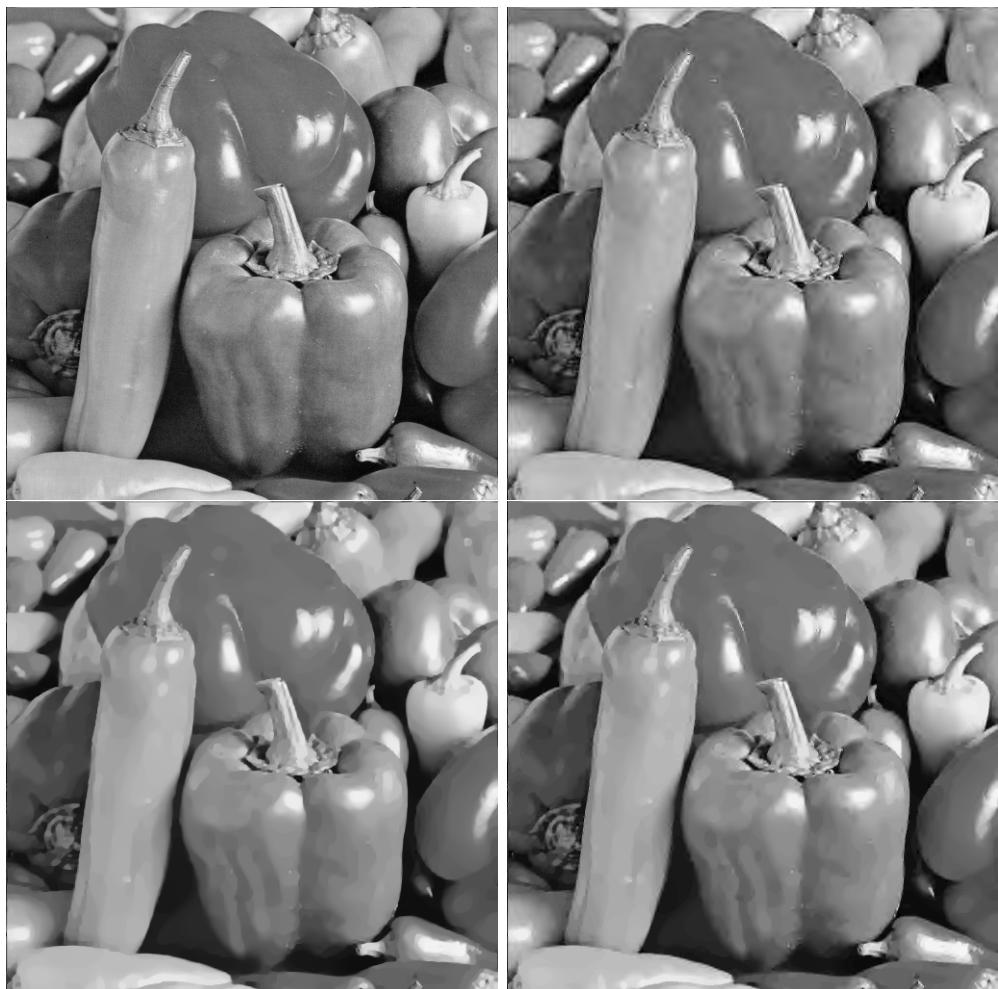


FIG. 96 – Image :4.2.07 *** Bitrate :0.198 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	31.344	30.800	31.350
<i>SIM</i>	0.939	0.927	0.937
<i>NQM</i>	30.120	27.096	29.744

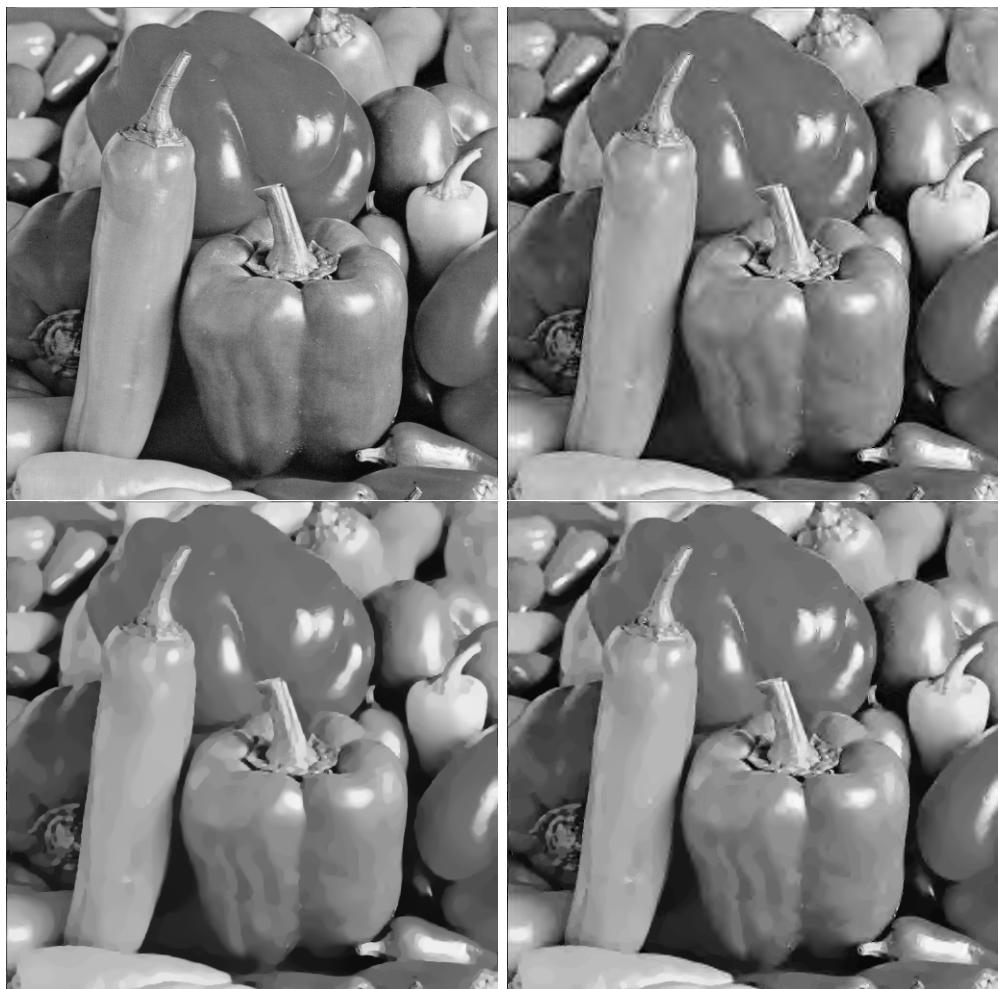


FIG. 97 – Image :4.2.07 *** Bitrate :0.174 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	30.934	30.320	30.950
<i>SIM</i>	0.933	0.920	0.931
<i>NQM</i>	28.788	25.720	28.525



FIG. 98 – Image :4.2.07 *** Bitrate :0.123 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	29.720	29.060	29.756
<i>SIM</i>	0.911	0.898	0.912
<i>NQM</i>	25.939	23.163	25.855

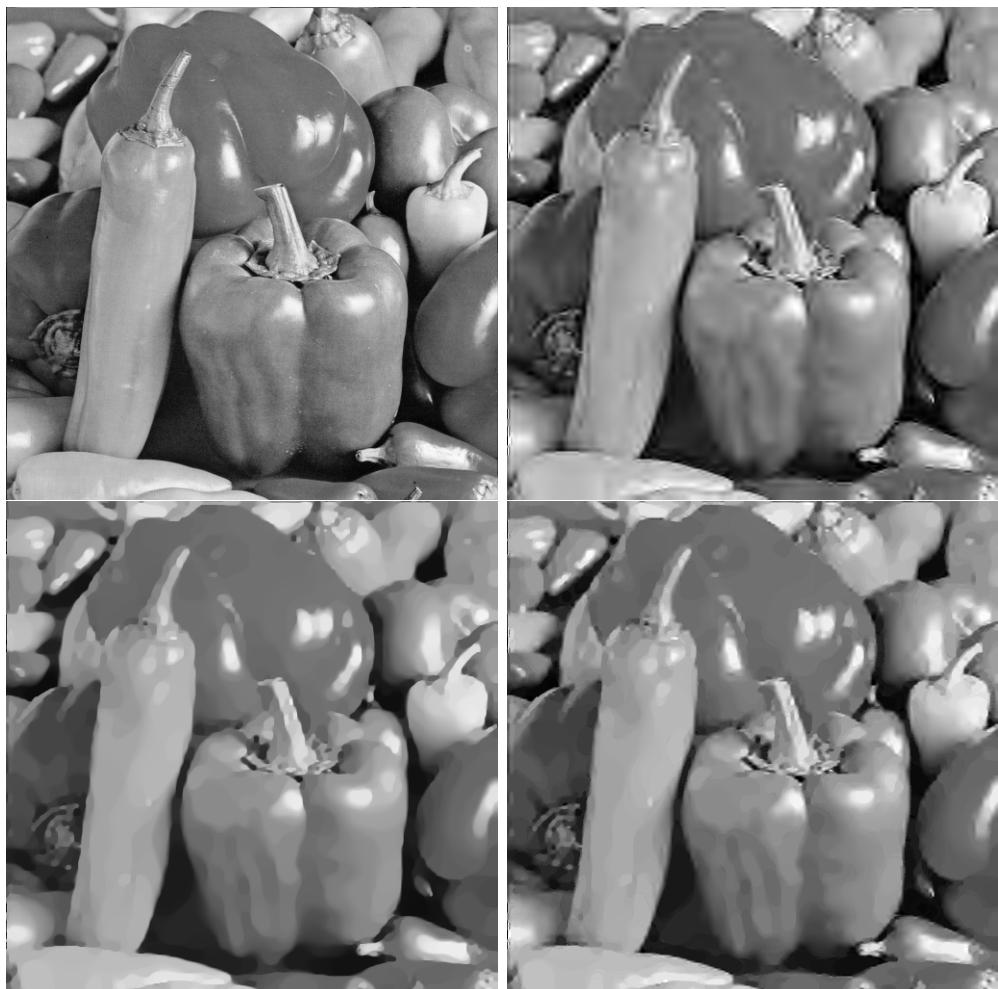


FIG. 99 – Image :4.2.07 *** Bitrate :0.0788 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	27.909	27.604	28.084
<i>SIM</i>	0.881	0.869	0.884
<i>NQM</i>	23.126	20.828	23.091



FIG. 100 – Image :4.2.07 *** Bitrate :0.0529 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	26.711	26.374	26.867
<i>SIM</i>	0.846	0.839	0.855
<i>NQM</i>	20.555	18.591	20.839

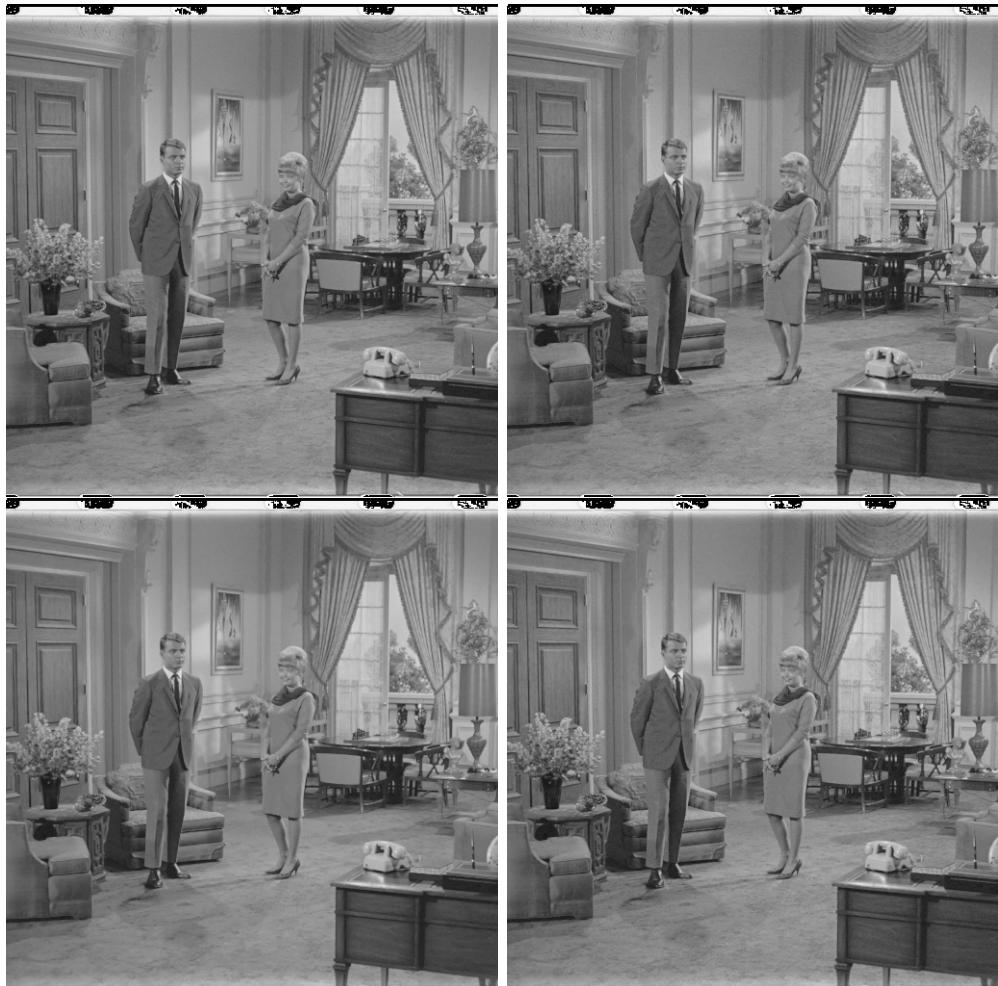


FIG. 101 – Image :5.2.08 *** Bitrate :1.89 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	42.010	41.424	41.879
<i>SIM</i>	0.995	0.994	0.995
<i>NQM</i>	40.022	39.487	39.784

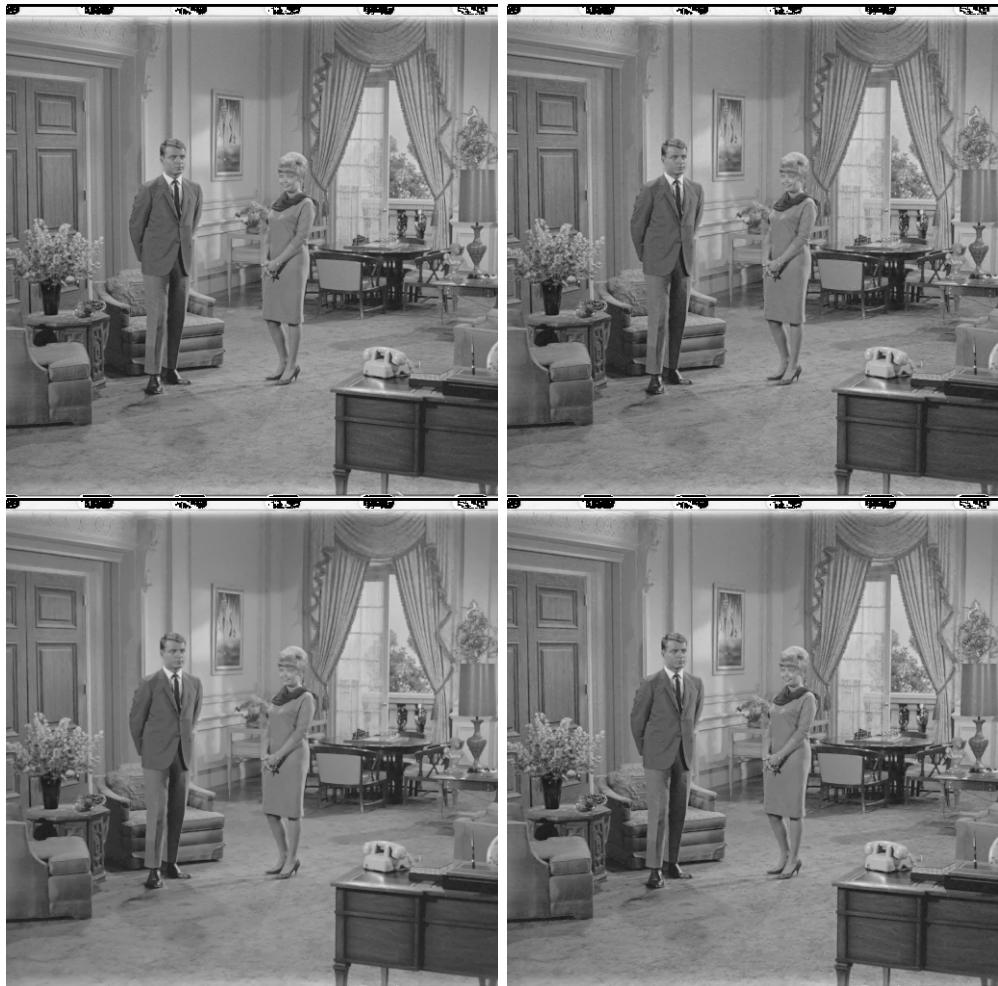


FIG. 102 – Image :5.2.08 *** Bitrate :1.4 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	39.286	38.786	39.290
<i>SIM</i>	0.990	0.988	0.990
<i>NQM</i>	37.046	36.369	36.943

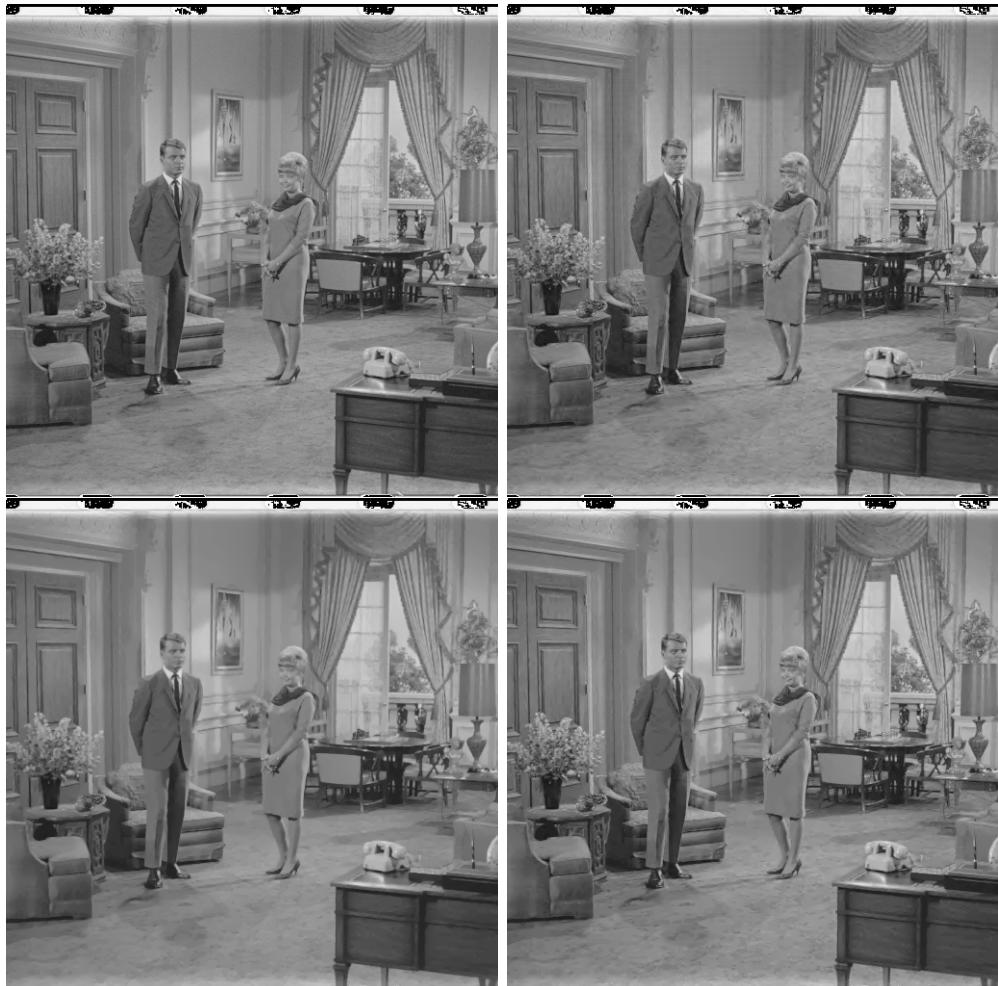


FIG. 103 – Image :5.2.08 *** Bitrate :0.854 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	35.711	34.959	35.729
<i>SIM</i>	0.977	0.969	0.976
<i>NQM</i>	32.987	31.184	32.733

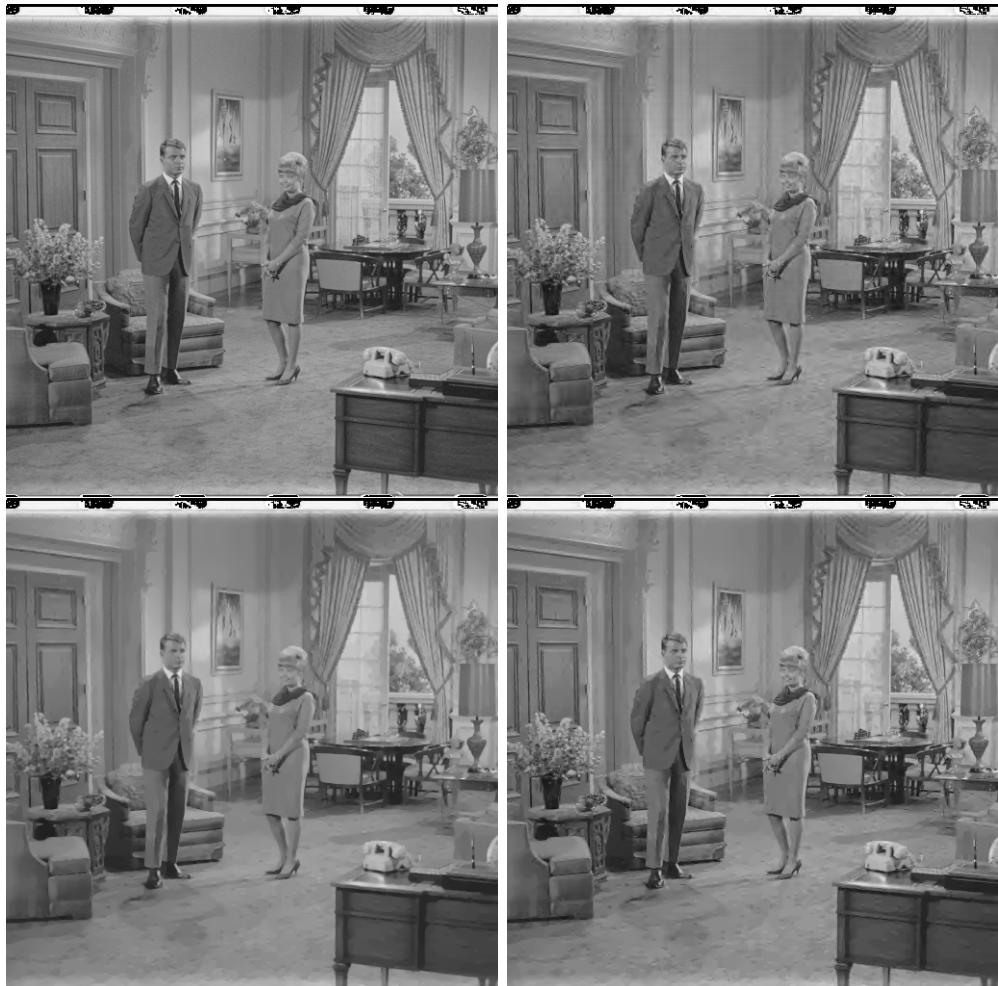


FIG. 104 – Image :5.2.08 *** Bitrate :0.577 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	33.226	32.736	33.314
<i>SIM</i>	0.957	0.947	0.957
<i>NQM</i>	29.634	27.934	29.453

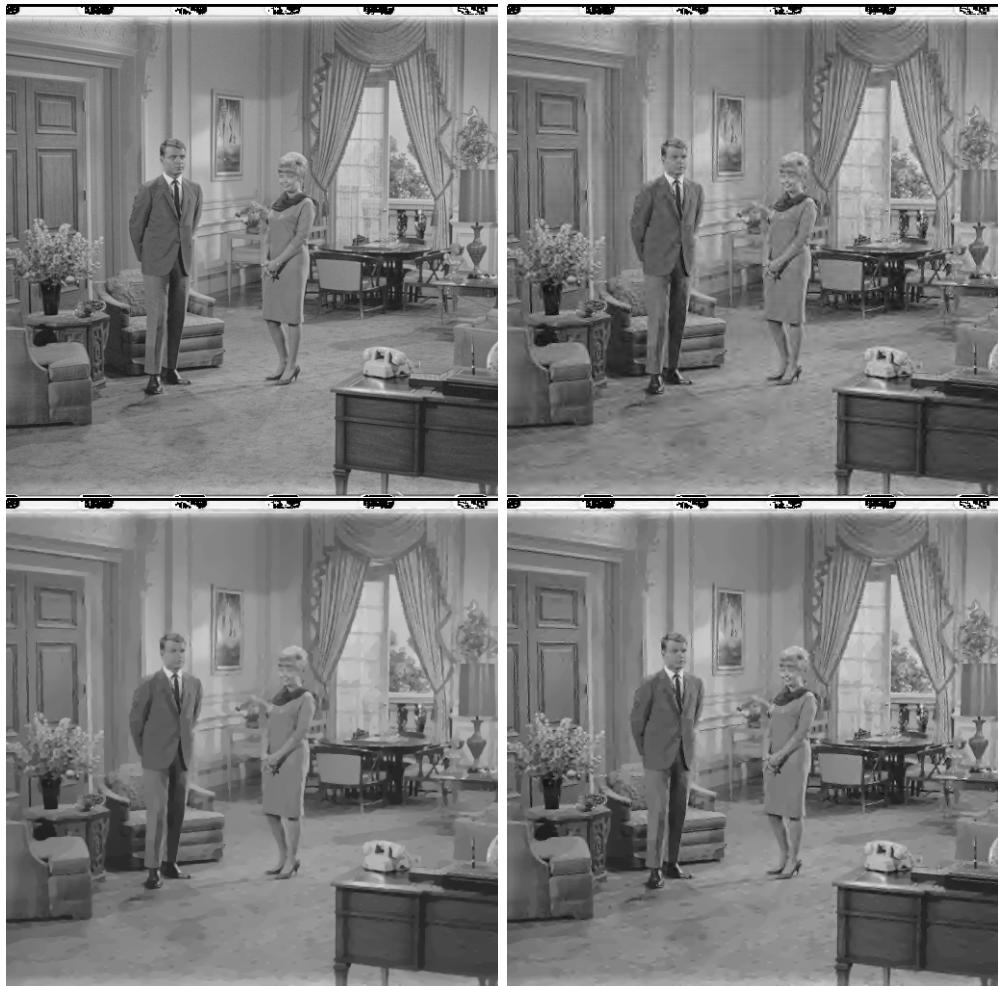


FIG. 105 – Image :5.2.08 *** Bitrate :0.422 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	31.560	31.059	31.612
<i>SIM</i>	0.942	0.929	0.943
<i>NQM</i>	27.950	25.826	27.790



FIG. 106 – Image :5.2.08 *** Bitrate :0.32 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	30.332	29.432	30.246
<i>SIM</i>	0.924	0.903	0.922
<i>NQM</i>	26.351	23.754	26.144



FIG. 107 – Image :5.2.08 *** Bitrate :0.279 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	29.781	28.890	29.713
<i>SIM</i>	0.912	0.890	0.910
<i>NQM</i>	25.220	22.714	25.021

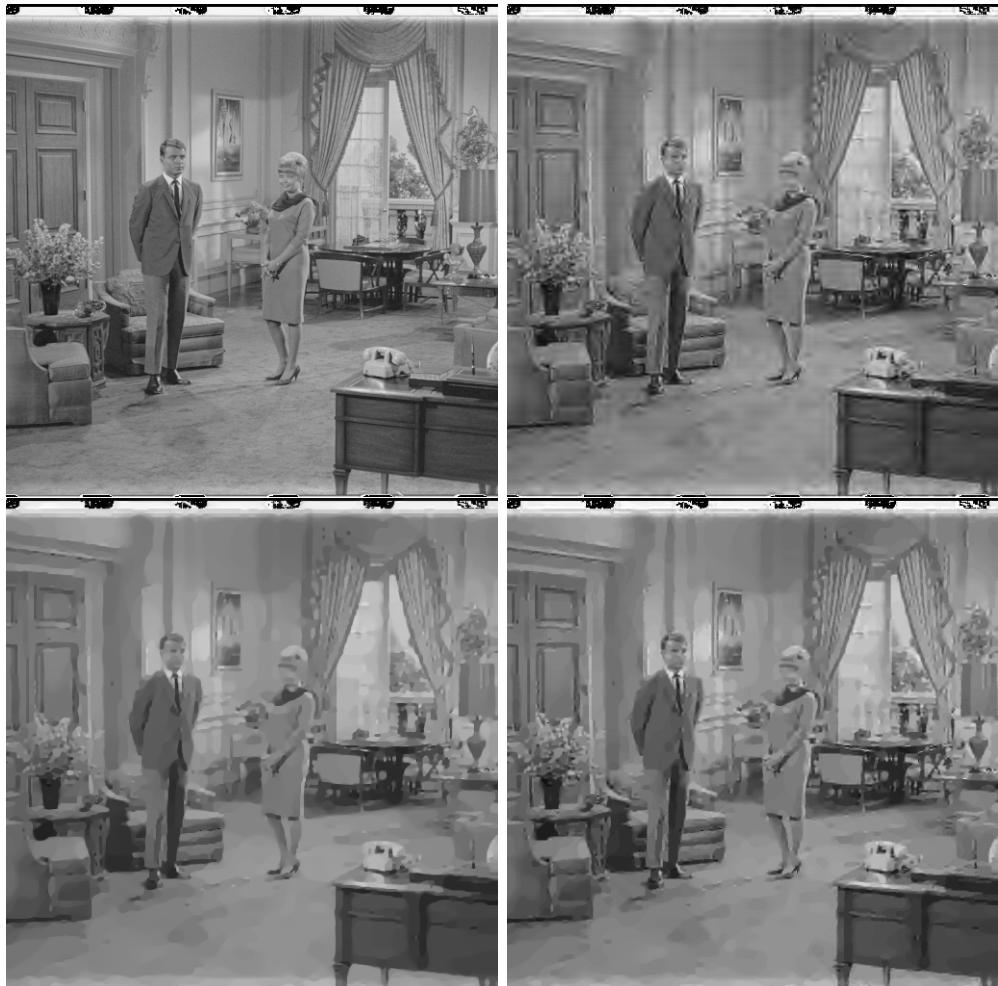


FIG. 108 – Image :5.2.08 *** Bitrate :0.199 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	28.444	27.613	28.406
<i>SIM</i>	0.871	0.839	0.866
<i>NQM</i>	22.017	19.559	21.889



FIG. 109 – Image :5.2.08 *** Bitrate :0.124 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	26.643	26.100	26.669
<i>SIM</i>	0.816	0.779	0.808
<i>NQM</i>	19.291	16.907	18.982



FIG. 110 – Image :5.2.08 *** Bitrate :0.078 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	24.821	24.567	24.950
<i>SIM</i>	0.715	0.686	0.710
<i>NQM</i>	14.824	13.747	14.956



FIG. 111 – Image :5.2.09 *** Bitrate :2.64 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	42.462	41.532	42.429
<i>SIM</i>	0.998	0.997	0.997
<i>NQM</i>	38.082	37.758	37.928



FIG. 112 – Image :5.2.09 *** Bitrate :2.16 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	39.577	38.756	39.595
<i>SIM</i>	0.995	0.994	0.995
<i>NQM</i>	35.919	35.319	35.793



FIG. 113 – Image :5.2.09 *** Bitrate :1.44 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	34.989	34.230	35.054
<i>SIM</i>	0.988	0.984	0.988
<i>NQM</i>	31.931	30.945	31.829



FIG. 114 – Image :5.2.09 *** Bitrate :0.98 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	31.833	30.566	31.790
<i>SIM</i>	0.976	0.963	0.976
<i>NQM</i>	29.132	26.911	28.979



FIG. 115 – Image :5.2.09 *** Bitrate :0.815 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	30.556	29.265	30.479
<i>SIM</i>	0.967	0.950	0.967
<i>NQM</i>	27.846	25.078	27.615



FIG. 116 – Image :5.2.09 *** Bitrate :0.63 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	28.991	27.897	28.937
<i>SIM</i>	0.954	0.932	0.955
<i>NQM</i>	26.045	23.163	25.912



FIG. 117 – Image :5.2.09 *** Bitrate :0.514 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	27.913	26.814	27.819
<i>SIM</i>	0.942	0.915	0.942
<i>NQM</i>	24.917	21.792	24.779



FIG. 118 – Image :5.2.09 *** Bitrate :0.348 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	26.170	25.246	26.117
<i>SIM</i>	0.908	0.873	0.909
<i>NQM</i>	22.238	19.271	22.082



FIG. 119 – Image :5.2.09 *** Bitrate :0.204 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	24.090	23.416	24.050
<i>SIM</i>	0.847	0.802	0.847
<i>NQM</i>	18.926	16.355	18.974



FIG. 120 – Image :5.2.09 *** Bitrate :0.133 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	22.778	22.383	22.813
<i>SIM</i>	0.780	0.728	0.778
<i>NQM</i>	16.655	14.555	16.693



FIG. 121 – Image :5.2.10 *** Bitrate :3.06 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	42.461	40.855	42.320
<i>SIM</i>	0.998	0.997	0.998
<i>NQM</i>	43.687	43.333	43.792



FIG. 122 – Image :5.2.10 *** Bitrate :2.56 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	39.467	38.052	39.359
<i>SIM</i>	0.996	0.994	0.996
<i>NQM</i>	40.994	40.361	40.924



FIG. 123 – Image :5.2.10 *** Bitrate :1.77 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	34.660	33.584	34.568
<i>SIM</i>	0.988	0.983	0.988
<i>NQM</i>	36.274	35.480	36.225



FIG. 124 – Image :5.2.10 *** Bitrate :1.11 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	30.613	29.223	30.336
<i>SIM</i>	0.974	0.953	0.972
<i>NQM</i>	33.103	29.861	32.908



FIG. 125 – Image :5.2.10 *** Bitrate :0.906 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	29.451	28.241	29.199
<i>SIM</i>	0.964	0.936	0.961
<i>NQM</i>	31.088	27.806	30.931



FIG. 126 – Image :5.2.10 *** Bitrate :0.68 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	28.013	27.153	27.807
<i>SIM</i>	0.949	0.916	0.944
<i>NQM</i>	29.520	26.257	29.296



FIG. 127 – Image :5.2.10 *** Bitrate :0.532 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	27.004	26.309	26.837
<i>SIM</i>	0.933	0.895	0.928
<i>NQM</i>	28.035	24.838	27.882



FIG. 128 – Image :5.2.10 *** Bitrate :0.274 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	25.017	24.404	24.835
<i>SIM</i>	0.883	0.831	0.873
<i>NQM</i>	25.202	21.973	24.888



FIG. 129 – Image :5.2.10 *** Bitrate :0.14 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	23.455	23.040	23.347
<i>SIM</i>	0.791	0.724	0.774
<i>NQM</i>	21.812	19.147	21.566



FIG. 130 – Image :5.2.10 *** Bitrate :0.0894 bpp

	<i>Compressed</i>	<i>Denoised</i>	<i>Denoised + Enhanced</i>
<i>PSNR</i>	22.597	22.271	22.553
<i>SIM</i>	0.719	0.648	0.700
<i>NQM</i>	18.778	16.727	18.692