A Psychovisual Optimization of Wavelet Foveation-Based Image Coding and Quality Assessment Based on Human Quality Criterions

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A B S T R A C T
In the present article, we introduce a foveation-based optimized embedded and its optimized version image coders thereafter called VOEFIC/MOEFIC and its related foveation wavelet visible difference predictor FWVDP coding quality metric. It advances a visually advanced foveal weighting mask that regulates the wavelet-based image spectrum before its encoding by the SPIHT encoder. It intends to arrive at a destined compression rate with a significant quality improvement for a disposed of binary budget, witnessing separation, and a foveal locale that locates the object in the zone of concern ROI. The coder embodies a couple of masking achieves build on the human psycho-visual quality criteria. Hence, the coder administers the foveal model to weigh the source wavelets samples, reshapes its spectrum content, adapts its shape, discards or somewhat shrinks the redundant excess and finally enhances the visual quality. The foveal weighting mask is computed indoors wavelet sub-bands as come after. First, it administers the foveal wavelet-based filter depending on the intention point so that it removes or at least reduces the imperceptible frequencies around the zone of concern. Next, it augments the picture contrast according to wavelet JND thresholds to manage brightening and nice the contrast above the distortion just notable. Once refined, the weighted wavelet spectrum will be embedded coded using the standard SPIHT to reach a desired binary bit budget. The manuscript also advances a foveation-based objective quality evaluator that embodies a psycho-visual quality criterion identified with the visual cortex framework. This investigator furnishes a foveal score FPS having the power of detecting probable errors and measuring objectively the compression quality. Keep in mind that the foveal coder VOEFIC and its visually upgraded variant MOEFIC, have similar complexity as their reference SPIHT. In contrast, their gathered data highlight the visual coding advancement and the boost ratio purchased in its quality gain.

1. Introduction

In multi-channel wavelet picture coding [1], psycho-visual investigations show that spatially, the goals, or examining thickness, has the most noteworthy incentive at the purpose of the fovea and descends quickly aside from that seeing point depending on the glancing angle. Therefore, when a spectator eyewitness glances at a zone in a natural picture, the locale encompassing the purpose of obsession is anticipated toward his fovea. At that point, examined with the most noteworthy thickness and thusly saw with the most elevated differentiation affectability. Overall, the viewing thickness and contrast susceptibility diminishes significantly with expanding the glancing angle regarding the gazed point. The inspiration driving the foveal compression is that there exists significant high-recurrence data excess in the fringe districts.

In the vision, an image can capably be addressed by discarding or somewhat shrinking the redundant excess, considering the foveal point (s) and the watching space. The foveal masking plans to filter a constant resolution picture, with the end goal that when the spectator glances at his interested zone, he could not recognize...
the likeness among the source picture and its foveal variant around the locale of intrigue. As illustrated in Figure 1, we administer the foveal mask to the BARBARA test picture and subjectively compare its quality to its original version. As a result, when we center our attention on a gazed zone, both pictures grant the likewise appearance. However, in peripheral regions, the disparities are significant. On the other hand, the foveal quality becomes acceptable, but its reference still distorted. In addition, the foveal coder is practiced adopting three vital parameters, the viewing distance (V=4), the bit rate (0.15bpp), and the regarded zone (the face middle) which specify the region of intrigue ROI.

In the literature, various strategies inexact the ideal foveal channel. In [2], a pyramid architecture is prescribed to focus pictures. In [2-5], the foveal channel comprises a set of low-pass bands with different cutoff frequencies. In [3], the configuration of the foveal mask relies upon the Laplacian pyramidal design. In [2-5], the foveal masking strategy implements a non-uniform arranging design [6-9] that lacks the integration of psycho-visual properties. Lately, incredible achievement has been furnished by a couple of wavelet picture coders that are based zones of concern (ROI), like the coders implemented in [4-9], their psychovisual variant accurate in [10-12] and the norm JPEG2000 cited in [14].

The previous solution doesn’t fuse the Watson’s psycho-visual compression approach that is founded on the quality criterions examinations of the wavelets filter 9/7 [13-14] to aggregate the clarity of its coefficients distortion limits [14-16], then to quantify them visually and finally to furnish an enhanced lossless squeezing. In the last plan, the merge of psychovisual aspect isn’t appropriated, similar to luminance and contrast hiding or edge rise [17-20], whose specific characteristics is to spatially refine these picture features and also to reform every single conceal recurrence to the observer’s visual cortex. Abusing this reality, we adjust the picture technical aspect (luminance acclimating and difference hiding), to fine-tune conceal frequencies as indicated by the JND limits [15] and to still quantize proficiently the picture spectrum among the zones of concern ROI.

Once a picture is coded, the gained quality needs to be evaluated. To attain this objective, one may find in the literature a series of “Image Fidelity Assessor” (IFA) [21-24]. Based on the “Visible Difference Predictor” VDP [25] and its wavelet-based variant WVDP [26-35], we suggest a psycho-visual assessor that integrates the “Human Visual System HVS” quality criterions [31-33]. Our foveal metric named thereafater FWVDP adapts the original wavelet coefficients, provides a foveal score FPS aiming to predict the probability of detecting the coder introduced errors.

This manuscript includes the following section: first, it advances the flow diagram of the foveal coder. After, it explains, in the second section, how to implement, the wavelet-based foveal masking. Then, it highlights in the third section, how to compute and implement the visual threshold elevation model integrating the wavelet-based edges (JND) entitled “Just Noticeable Differences”. This way, it improves the content of the weighted wavelet spectrum and subsequently optimizes coding. Then it details, in the fourth section, how to evaluate the foveal coding quality based on the foveation wavelet-based visible distortion predictor model to conclude our visual encoder performances. Finally, it emotionally and neutrally discards, in the last section, the results gathered depending on the viewing distance, the bit rate, and the regarded zone which specify the region of intrigue ROI.

2. Foveation Wavelet-Based Visual Image Coding Diagram

We advance in Figures 2 and 3, the flow process of the VOEFIC coder “Visually Optimized Embedded Foveation Image Coder” [12] and its upgraded variant MOEFIC the “Modified Optimization Embedded Foveation Image Coder”. The two coders comprise five successive stages itemized as come after. In the initial trail, it transforms the source picture utilizing a discrete wavelet DWT that play out a cortical-like decay [1] exploiting a 9/7 biorthogonal filter [13-14] which, in view of its extraordinary mathematic criterions [15] guarantees an ideal reproduction as prescribed by the standard coder JPEG2000 [12-13].

![Figure 2: Foveation Wavelet-Based Visual Embedded Image Coding and Decoding flow diagrams based together on a Psycho-Visual Upgrading Tools.](image)

In the following trail, related to the fixation point and its related observation distance we compute the wavelet-based foveal filter [2-5]. Its main aim is to eliminate or reduce invisible frequencies in the peripheral regions of the zone of concern ROI (section III). Then in the subsequent trail, according to the wavelet notable difference edges, we figure the contrast veiling known as limits height [14-16]. Its task starts first on computing the luminance concealing identified with the foveation wavelet coefficients. At that point, it uses the perceptual JND [15] edges required for contrast redress. This activity shadows undetectable differentiation parts and lifts above JNDs limits every single noticeable one concerning the degree of wavelet edges (Section IV).

![Figure 3: Visually Optimized Wavelet Weighting Process](image)

The primary reason for our upgraded visually based masking layout and exclusively furnished to the MOEFIC coder (VOEFIC coder upgraded variant) [10-12] is its capacity of regulating none directly the picture spectral contents regarding the visioning
conditions. This parameter, as it develops from a lower to higher values, the spectral form plans to cover the significant frequencies. For low separations, the obtained channel spread significantly lower spectrum contents. Oppositely, for higher length, the mask removes, this time, substantially higher image spectral frequencies.

In the last advance, we administer a progressive coder to salable code with different compression rates our visually ballasted wavelet samples till arriving at destined goal identified with a disposed of binary budget. For this scope, we have opted for the use of the SPIHT progressive encoder, which is itself an advanced variant that appertains to the clan of “Embedded Zero Tree Wavelet EZW” Coder commenced early by Shapiro [36] and heightens alongside by A. Said and W. A. Pearlman [37-39].

3. Conceiving and Configuring a Wavelet Foveal Filter

In the guise of the observer framework, the HVS is profoundly space-variation in testing, encoding, preparing, and understanding, and in light of the fact that the spatial goals of the visual cortex is most noteworthy all over the gazed region, and diminishes quickly with the working up of the eccentricity, we register the foveation channel [2-5]. By misusing its preferences, it is conceivable to decrease or evacuate impressive high frequencies and unfortunate data from the fringe districts and still perceptually reproduce with a brilliant nature of the decoded picture. To reach this aim; we apply the upcoming process shown in Figure 5. First, we locate the fixation point and calculate the distortion for all pixels with respect to this point. Then, we convert these distortions to eccentricities e given cycle/degree. Next, we compute the cut-off frequency, \( f_c \) (cycle/degree) beyond which, all higher frequencies become invisible (eq. 1) which limits the visible frequencies with no aliasing display in the human visual cortex. Moreover, based on the half display resolution, \( f_d \) (eq. 2) (cycle/degree), we obtain the minimum frequency (cycle/degree) so known to us as the Nyquist frequency, \( f_m \) (eq. 3) which determinates the visible spectrum.

\[
f_c = \frac{e_0 \ln \left( \frac{1}{C T_0} \right)}{\alpha (e + e_0)} \quad (1), \quad f_d = \frac{r}{2} = \frac{\pi N v}{360} \quad (2), \quad f_m(x) = \min(f_c, f_d)(3)
\]

Here \( f \) refers to the spatial recurrence (cycles/degree), \( e_0 = 2.3 \), \( \alpha = 0.106 \), \( C T_0 = 1/64 \), \( e = \tan \left( \frac{d(x)}{N v} \right) \) eccentricity (degree), \( x \) point in image, \( d \) distortion, \( v \) distance, \( N \) image resolution.

The best filter parameters can be obtained in [2-5,31,35]. Finally, from the contrast threshold \( CT \) we reach the error sensitivity \( S_f \) that can be expressed as follow:

\[
CT(f, e) = CT_0 \exp \left( \alpha \frac{e + e_0}{e_1} \right) \\
S_f(v, f, x) = \begin{cases} 
\frac{CS(f, e(v, x))}{CS(f, 0)} = \exp(-0.0461 f e(v, x)) & \text{pour } f \leq f_m(x) \\
0 & \text{pour } f > f_m(x)
\end{cases}
\]

The foveation channel alters the picture range contingent upon the survey perception separation. Its shape wipes out logically higher frequencies with expanding perception separation. Therefore, the onlooker is continuously unfit to recognize high frequencies when the distance increments [2-5] Figure 4.

Figure 4. Foveation wavelet-based models designed according to the following survey distance \( V = 1, 3, 6 \) and 10. With increasing observation distances, the shadowed regions increase and the foveal filter sensitivity value decrease.
To start with, the procedure breaks down the first picture to give wavelet coefficients - initial step-. At that point figures their relating perceptual edges JND - second step-. These limits depend upon both to Daubechies linear phase channel. It registers next, the foveal filter FOV to foveate the wavelet areas of intrigue ROI and reshape their range [2-10]–third step-. From that point forward, it adjusts the picture relating luminance [17-20] - fourth step-and raises the complexity as per perceptual limits [14-16]. At last, - in the fifth step-., it administers the planned channel to load the wavelet samples and scalable encodes them as indicated by SPIHT described coding reasoning [36-37].

We advance in Figure 6, the masking process conceived specially for the LENA test picture at a granted review separation V=4. This task explains how we restyle the picture wavelet spectrum regarding our visual loads and explains how the channel influences the wavelet dispersion across sub-bands. It impressively reshapes medium and low frequencies that comprise normally the fundamental image substance. Keep in mind that, we can regulate the shape conditionally to a changeable perception separation.
5. Foveation-based Unbiased Quality Investigator

To quantize the strategies of image coding quality, we contrast dependably the measures concurring with abstractly to the opinion averaged notes (MOS). The utilization of scientific models, like, the “average squared distortion” (MSE) and its streamlined variant the “Peak Signal to Noise Ratio” (PSNR) are straightforward and spatially processed. Notwithstanding, these measurements correspond ineffectively to the MOS averaged notes that rely upon favorable conditions ensuring the cortical quality criteria [33].

Right now, we have built up another cortical-like picture quality measurement; labeled “Foveation Wavelet-based Visible Difference Predictor FWVDP” that appeared in Figure 7. It is a foveal form of its native variant WVDP [25-30]. It sums noticeable blunders exercising the “Minkowski Aggregation” to arrive at the obvious contrast guide and yields, obviously [25-30], the foveal mark FPS employing a “Psychometric Activity” [23]. The foveal metric regulates both the source and degraded picture utilizing the advanced arranging mask we conveyed in sections 3 and 4. Along these lines, it disposes of all imperceptible data and looks at just the significant ones. At that point, it moves these blunders to the “Minkowski Addition” [23] entity to arrive at the obvious distortions map and their foveal factor FPS utilizing the “Psychometric Activity”. Therefore, it supplies productively to psycho-visual coders planning to upgrade their exhibition. It communicates the capacity to see noticeable blunders inside wavelet channels. Its recognition likelihood recipe is as come after:

\[
P(\lambda, \theta, i, j) = 1 - \exp\left(-\frac{D_{\text{FOV}}(\lambda, \theta, i, j)}{D_{\text{SPIHT}}(\lambda, \theta, i, j)}\right)
\]

Here, the term \(D(\lambda, \theta, i, j)\) means degradations at the area \((\lambda, \theta, i, j)\), \(JND(\lambda, \theta, i, j)\) refers to the visual edge, \(\alpha\) and \(\beta\) are refining constants, \(P\) the error probability. Propelled from the Minkowski Summation, and exercised indoors image wavelet spectrum, the probability summation furnishes the aimed mark as come after:

\[
FPS = \exp\left(-\frac{1}{M\cdot N}\sum_{i,j}P(\lambda, \theta, i, j)\right) \quad : M, N \text{ denote the image size}
\]

Keep in mind that with increasing values of the FPS mark approaching the unit the degraded image reaches its excellent quality. Oppositely, the degraded image attend its poor quality.

6. Gathered Results Analysis

In the vision, all coders are completely subject to their quality measurement which hypothetically and effectively corresponds well with its subjective reference issued from the opinion averaged note MOS. Right now, we experimented with foveal coder MOEFIC and its native variant VOEFIC engaging 8 bits gray scale pictures. We also surveyed their quality exercising the FWVDP foveal wavelet metric for the former and its streamlined variant FVDP for the later. For such reason, we study the MOEFIC and VOEFIC coding quality coding to their reference, separately with VOEFIC for the former and to SPIHT for the later. To arrive at this point, we conveyed three assessment manners that act objectively, subjectively and quantitatively, as a function of the bit binary budget spending and survey conditions.

The main methodology counts completely upon the scores FPS acquired from the coding quality assessment afforded by the coders SPIHT, and its visually revised variants VOEFIC, and MOEFIC experienced together on standard test grayscale pictures. As appeared in figures 8, 9, 10, 11 and 12, the outcomes are done for expanding squeezing rates changing from 256:1 constraining to 0.0039bpp till 2:1 corresponding to 0.5bpp and a viewing separation constant grabbing its value in the set: \(1, 3, 6, 10\). Accordingly, all methodologies support that exceptionally for low spending plan (below 0.0625bpp), numerous spatial blunders are noticeable in the SPIHT coder picture, while visual coders MOEFIC and VOEFIC display substantially more fascinating data with regards to the locales of concern. So also, at the intermediate squeezing rate (beneath 0.125bpp), the SPIHT coder despite everything giving obscured pictures, while the foveal variants coders show a huge quality over the entire picture. Then again, for a higher compression rate (above 0.25bpp), the foveal coders’ quality remains constantly better than its reference one. At long
last, when the compression rate arrives at a high piece pace, all the
mentioning coders approache a uniform appearance and their
afforded images become indistinguishable at the entire images.

The qualitative manner affords the average scores of the
advanced coders and of their reference. As exhibited in Figures 8-
9, we emotionally highlight the MOEFIC, VOEFIC, and SPIHT
coder images. We inspect the approach on the “BARBARA” test
picture for spending compression rate and fixed perception length
V. This experience affirms the abstract quality documentation to
the target esteems identified with its corresponding property score
FPS. It affirms that, at a lower compression rate, the candidate
coders MOEFIC and VOEFIC results keep up significant-quality
over the entire picture. So also, for the intermediate spending plan,
the witnessed images zones are pitifully unmistakable in the
reference coder pictures. However, those areas are emphatically
recognizable to the visual coders' images that emphasize
significantly the whole picture contents. For higher compression
rates and survey distances, the visual coders behave superbly well
at the whole analyzed image, as well as the images offered by the
SPIHT encoder become significant.

In the QUANTITATIVE methodology, we contrast the visual
quality boost ratio against its reference SPIHT as come after:

\[
\text{FPS}_\text{MOEFIC} = \frac{100 \times (\text{FPS}_\text{MOEFIC} - \text{FPS}_\text{SPIHT})}{\text{FPS}_\text{SPIHT}}
\]

We can finish up as filled in tables 1, 2 and 3, with expanding
parallel spending compression rate and also perception conditions
the quality addition develops continuously up. This establishes our
coder/assessor upgrading aim in terms of additional enhancement.

Figure 8: The foveal coder visually optimized VOEFIC (left column) contrast its
Reference SPIHT coder (right column) with accompanied FPS values granted by
the Quality Metric FWVDP experienced for BARBARA test picture, for
changeable binary budget and fixed survey distance. The former has its values in
the set: a. 0.0156bpp, b. 0.0313bpp, c. 0.0625bpp, d. 0.125bpp, and e. 0.25bpp
and the latter has its value set to V = 4.

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a. FPS\text{MOEFIC} = 0.1886, FPS\text{SPIHT} = 0.2182, Bit Rate=0.0156bpp, V=4
b. FPS\text{MOEFIC} = 0.4521, FPS\text{SPIHT} = 0.3958, Bit Rate=0.0313bpp, V=4
c. FPS\text{MOEFIC} = 0.7296, FPS\text{SPIHT} = 0.6536, Bit Rate=0.0625bpp, V=4
d. \( F_{\text{MOEFIC}} = 0.8271, F_{\text{MOEFIC}} = 0.7899, \text{Bit Rate}=0.125\text{bpp}, V=4 \)

e. \( F_{\text{MOEFIC}} = 0.9526, F_{\text{MOEFIC}} = 0.8904, \text{Bit Rate}=0.25\text{bpp}, V=4 \)

Figure 9: The foveal coder visually optimized MOEFIC (left column) contrast its legacy version VOEFIC coder (right column) with accompanied FPS values granted by the Quality Metric FWVDP experienced for BARBARA test picture, for changeable binary budget and fixed survey distance. The former has its values in the set: a. 0.0156bpp, b. 0.0313bpp, c. 0.0625bpp, d. 0.125bpp, and e. 0.25bpp and the latter has its value set to \( V = 4 \).

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Figure 10: Foveal coder VOEFIC contrasts the standard SPIHT Coder with accompanied FPS scores granted by the FWVDP Metric experienced for BARBARA and GOLDHIL test pictures, for changing binary rate in the set \{a. 0.0156bpp, b. 0.0313bpp, c. 0.0625bpp, d. 0.125bpp, and e. 0.25bpp\} and fixed survey distance taking its value in the set \{1, 3, 6, 10\}.

Figure 11: Foveal Coder MOEFIC contrasts the VOEFIC Foveal Coder with accompanied scores FPS, granted by the FWVDP Metric experienced for BARBARA and MANDRILL test pictures, for a changing binary rate in the set \{a. 0.0156bpp, b. 0.0313bpp, c. 0.0625bpp, d. 0.125bpp, and e. 0.25bpp\} and fixed survey distance taking its value in the set \{1, 3, 6, 10\}.

Figure 12: Foveal Coder MOEFIC contrasts the VOEFIC Foveal Coder with accompanied scores FPS, granted by the FWVDP Metric experienced for LENA and BOAT test pictures, for a changing binary rate in the set \{a. 0.0156bpp, b. 0.0313bpp, c. 0.0625bpp, d. 0.125bpp, and e. 0.25bpp\} and fixed survey distance taking its value in the set \{1, 3, 6, 10\}.
Table 1: VOEIFIC vs SPIHT quality boost ratio based on the FVDP Quality Metric experienced for the test pictures: BOAT, MANDRILL, BARBARA, and LENA for changing survey distances and still binary budget.

| Targeted Binary Budget | Quality boost ratio (%) |
|------------------------|-------------------------|
|                        | LENA | BARBARA | MANDRILL | BOAT |
| BPP = 0.0625           | 8.9922 | 4.4205 | 5.1243 | 6.9512 |
| BPP = 0.25             | 26.3367 | 34.5819 | 22.4297 | 16.6942 |
| BPP = 1                | 94.2398 | 74.7420 | 53.1172 | 58.8734 |

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Table 2: VOEIFIC vs SPIHT quality benefits granted by FVDP Quality Metric experienced for the test pictures: BOAT, MANDRILL, BARBARA, and LENA for changeable binary compression rates and still survey separation.

| Viewing Separation | Quality boost ratio (%) |
|--------------------|-------------------------|
|                    | LENA | BARBARA | MANDRILL | BOAT |
| V = 1              | 29.8790 | 50.2645 | 91.4849 | 64.2214 |
| V = 3              | 22.6332 | 35.6187 | 64.7933 | 45.1057 |
| V = 6              | 13.6161 | 22.5175 | 39.6148 | 38.8212 |
| V = 10             | 16.5556 | 23.0739 | 26.2814 | 26.3661 |

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Table 3: MOEFIC vs VOEIFIC quality boost ratio based on the FWVDP metric experienced for the test pictures: BOAT, MANDRILL, BARBARA, and LENA for changeable binary compression rates and still survey separation.

| Viewing Separation | Quality boost ratio (%) |
|--------------------|-------------------------|
|                    | LENA | BARBARA | MANDRILL | BOAT |
| V = 1              | 22.8005 | 47.6810 | 14.0676 | 11.6146 |
| V = 3              | 28.3076 | 77.9034 | 3.7920 | 26.2814 |
| V = 6              | 26.8725 | 66.7592 | 3.3685 | 26.3661 |
| V = 10             | 5.1945 | 0.9735 | 14.0159 | 6.6470 |

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7. Biased and Unbiased Quality Correlation Factor

Right now, we will present the subjective quality assessor. This abstract methodology computes a quality scale named MOS (Mean Opinion Score) which midpoints the emotional estimates applied on pictures coded by our coders for various squeezing rates. First, the measures are gathered dependent on an investigation built up by a gathering of eyewitnesses of alternate class, age, and sex on an abstract scale differing from exceptionally poor to a particular quality. Then, a MOS factor calculation is established to approve the utilization of the MOEFIC and VOEIFIC visual coders over the standard coder SPIHT and to validate our FWVDP foveal metric.

Table 4: Necessary conditions to experience Subjective Evaluation

| Experienced Pictures | Standard Pictures |
|----------------------|-------------------|
| Environment          | Environment of Normal Desk |
| Viewing Separation V  | This choice belongs to the spectator |
| Perceiving Time      | Limitless |
| Observers Number     | Between 15 and 39 |
| Score Range          | Between 0 and 1 |

7.1. Requirements for an Abstract Quality Assessors

The instinctive aspect assessment is standardized according to CCIR suggestions [10, 31–33], initially intended for TV pictures. We plan to assess the identified differences among a candidate and reference pictures and embrace instinctive measures. We expect the utilization of Fränti conditions [40–41] required for this assessment experimentation, as suggested in the CCIR recommendation detailed in [42–43] and summarized in Table. 4. Assuming that these conditions are regarded, we standardize the assessment range to evade extra blunders environment dependent.

7.2. MOS Quality Factor Experimentation

To satisfy the relationship among the unbiased measures (vector X) and the biased measures (vector Y), we administer the matching coefficient evolved as come after:

\[ \rho(X, Y) = \frac{\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \bar{X})^2} \sqrt{\sum_{i=1}^{n}(Y_i - \bar{Y})^2}} \]

Where \( X_i \) and \( Y_i \), \( i, n \) refer separately the array elements of X and Y, \( n \) refers to the total of elements. \( \bar{X} \) and \( \bar{Y} \) mean, individually, the mean of the arrays X and Y values, according to the accompanying equation:

\[ \bar{X} = \frac{1}{n} \sum_{i=1}^{n} X_i \]

and decides the inconstancy note, as follow:

\[ \text{Var}(X) = \frac{1}{n} \sum_{i=1}^{n} (X_i - \bar{X})^2 \]

7.3. Results of subjective quality assessment

To explore the MOS figuring, refer to [10, 31–33], to fit the conditions to be respected before launching the subjective assessment. As shown in figure 13, the subjective score experienced by the MOS metric is compared to its objective scores FPS provided by the FWVDP assessor and deployed to highly textured test images and distorted at different bit rates by the JPEG2000 coder. This is to demonstrate a superior relationship between the objective and the subjective measures. This is highlighted in figure 13. This correlation is approved for the visual coders MOEFIC and VOEIFIC (with a significant improvement for the former), however, it is disapproved for the SPIHT coder.
Modify Optimized Embedded Foveation Image Coder MOEFIC

![Graph](image)

Figure 13: Opinion Averaged Notes using MOS vs FPS scores using FWVDP foveal metric experienced to “GOLDHILL” and “MANDRILL” images under MOEFIC/VOEFIC/SPHT coders as indicated by the accompanying arrangement: resolution 512x512 degraded pictures, JPEG2000 reference coding, number of spectators=24, Degraded pictures versions=24, .Separation=4.

8. Conclusion

In this manuscript, we submitted a novel picture coder MOEFIC, that is labeled “Modified Optimization Embedded Foveation Image Coding”, It takes its advantages from its adapted variant VOEFIC, that is baptized "Visually Optimized Embedded Foveation Image Coder” and largely explained in [10]. We have conceived these coders regarding their forerunner EVIC [11], MEVIC [12], POEZIC [38], as well as their foveal variant POEFIC that was elaborated in [39]. We additionally presented the quality evaluator FWVDP, that is entitled “Foveation Wavelet Visible Difference Predictor” [32-33]. The pair of the referenced frameworks manages precise cortical properties by the integration of the human psychophysical weighting models. They consolidate progressively the foveation channel (FOV), the wavelet visible distortions edges (JND), the contrast elevation above those JND limits dependent on luminance adaptation and contrast correction.

The ultimate model, when is applied to the wavelet-based picture spectrum, will reshape its range. Therefore, it will keep its significant data situated in the looked locale of intrigue and disposes of all subtle and repetitive ones. Thusly, we encoded and assessed the valuable data, which as indicated by the obsession point, using a paired spending squeezing rate and a perception separation. Consequently, we arrived at an increasingly upgraded picture quality contrasted with the reference form that has processed straightforwardly the initial wavelet-based picture spectrum. The foveal coder and its corresponding foveal assessor register together psychovisual-like transform, which regardless of its recurrence sub-bands constraint upgrades the picture transformation, limits perceptually increasingly pertinent blunders, arrives at the purpose binary rate and advances the ocular aspect contrasted with that provided by the mentioning SPIHT [37]. It likewise directly refine the picture spectrum shape contingent upon the coding aspect and the survey conditions. Indeed, when the perception separation increases taken away lower level to the greatest values, the picture adapted spectrum shape will spread the significant wavelet channels that, naturally, are the zones of interest located in low and medium frequency bands.

Besides, we highlighted in this manuscript three evaluation approaches aiming to validate the suggested coders. We meant here, the objective validation based on foveal score FPS that is provided by the mentioned assessor (FWVDP). The subjective validation, which is based on averaged spectator's notes (MOS). The quantitative and qualitative approaches that are based on the boost ratio for the former and the interaction factor between the objectives scores and the subjective notes for the later. This validation process was administered to the visually advanced coder MOEFIC, to its adapted variant VOEFIC, and to their mentioning coder SPIHT. As highly discussed above, all gathered fruits from obtained results approve our perceptual coders in terms of quality improvement and binary budget optimization.

To finish our unobtrusive work, note that we assembled, talked about and contrasted the got outcomes and distinctive assessment techniques we implied unbiased, biased, qualitative and quantifiable ways to deal with endorse and approve our work.

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