Supplementary Materials: Determining the Entropic Index q of Tsallis Entropy in Images through Redundancy

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Algorithms S1–S4 summarize the pseudocode of all algorithms applied in our image processing.

Algorithm S1: Procedure index q of an image.

input : A digital grayscale image I_1 of 8 bits and size $M \times N$.
output: q-index of I_1
begin

1. Let I_1 be the input image.
2. Calculate the histogram.
3. Normalize this histogram to obtain the probability distribution, where $0 \geq p_i \geq 255$. If $p_i = 0$, remove it from the distribution.
4. For each $= -2 + 0.01 \times i$, for $i = 0$ until $i = 1200$, calculate S_T and $S_{T\max}$ according to Equations (2) and (4) with $k = 1$.
5. Plot R_T versus q and find the maximum.
6. Index $q \in [-2, 10]$ associated with the previous maximum is the characteristic entropic index of the image I_1.

end

Algorithm S2: Procedure Shannon and Tsallis entropy of an image.

input : A digital grayscale image I_1 of 8 bits and size $M \times N$ and index q.
output: Shannon and Tsallis entropy of I_1.
begin

1. Let I_1 be the input image.
2. Calculate the histogram.
3. Normalizing the histogram to obtain the probability distribution, where $0 \geq p_i \geq 255$. If $p_i = 0$, remove it from the distribution.
4. For the q index, calculate S_S and S_T according to Equations (4) and (9) with $k = 1$.

end

Algorithm S3: Procedure image segmentation using Tsallis entropy.

input : A digital grayscale image I_1 of 8 bits and size $M \times N$ and index q.
output: A digital binarized image I_2 of size $M \times N$.
begin

1. Let I_1 be the input image.
2. Calculate the histogram.
3. Normalizing the histogram to obtain the probability distribution, where $0 \geq p_i \geq 255$.
4. For each $t \in \{0, 1, \ldots 255\}$
   (a) Calculate P_A and P_B, and normalize to obtain p_A and p_B.
   (b) Calculate $t^*(q) = \arg\max_{t \in G} \left[S_T^A(t) + S_T^B(t) \right]$.
5. Thresholding the image I_1 with t^* to obtain I_2, it is a binarized image by thresholding of size $M \times N$.

end

Algorithm S4: Procedure edge detection.

input : A digital binarized image I_2 of size $M \times N$.
output: A digital binarized image with edge I_3 of size $M \times N$.
begin

1. Let I_2 be the input image.
2. Convolve I_2 with Sobel filter to obtain I_3.
3. Calculate the complement of I_3; it is the image of detected edges of size $M \times N$.

end

Note: the last two algorithms were also used, but the Shannon entropy $S_S(q = 1)$, in order to show the Tsallis entropy advantages.