

Noise-tolerant texture feature characterization through an improved CPLBP

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Abbreviated abstract: A new texture pattern descriptor based on the Circular Parts Local Binary Pattern (CPLBP) is presented. This approach considers, for each pixel of an image, a hierarchical system of circular regions. Then the median value of the gray level of the pixels of each circular sector is thresholded with the central pixel value, obtaining the binary coding which determines the LBP coded pattern. The proposed descriptor improves the performance of the CPLBP, in contaminated textures context.

Related publications:

- I. Al Saidi et.al, Image Anal Stereol, 40,105 -114, (2021).
- T. Ojala et.al, IEEE Trans. on Pattern Anal. and Mach. Intell., 24 (7),156 -160, (2002).



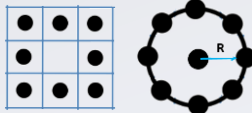
Previous Works

The original LBP

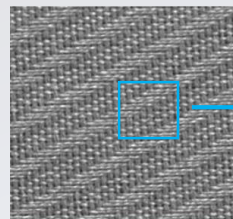
$$LBP_{R,P}(c) = \sum_{p=0}^{P-1} s(g_p - g_c) \cdot 2^p, \quad s(g) = \begin{cases} 1 & g \geq 0 \\ 0 & g < 0 \end{cases}$$

Where

- P : is the number of neighbours evenly distributed on a circle of radius R ; R y $P \in \mathbb{N}$,
- g_c : represent the gray level of the central pixel,
- $g_p, p = 1, \dots, P$: the gray level of the p -th neighbour pixel of the circle of radius R ,
- $s(\cdot)$: is binary thresholding function,
- 2^p : weight assigned to each result of the p -th thresholding.



Example. For each pixel of the image



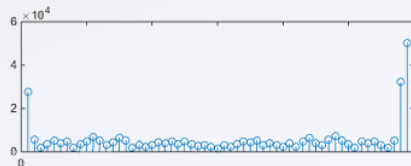
$$I = \begin{pmatrix} 72 & 78 & 95 \\ 58 & 75 & 71 \\ 65 & 70 & 74 \end{pmatrix}$$

$$\begin{pmatrix} s(72-75) & s(78-75) & s(95-75) \\ s(58-75) & & s(71-75) \\ s(65-75) & s(70-75) & s(74-75) \end{pmatrix}$$

Threshold	Weights
$\begin{pmatrix} 0 & 1 & 1 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$	$\begin{pmatrix} 2^3 & 2^2 & 2^1 \\ 2^4 & & 2^0 \\ 2^5 & 2^6 & 2^7 \end{pmatrix}$

LBP code
5

Vc = Feature vector of the texture image



Robust Circular Parts Local Binary Pattern (RCPLBP)

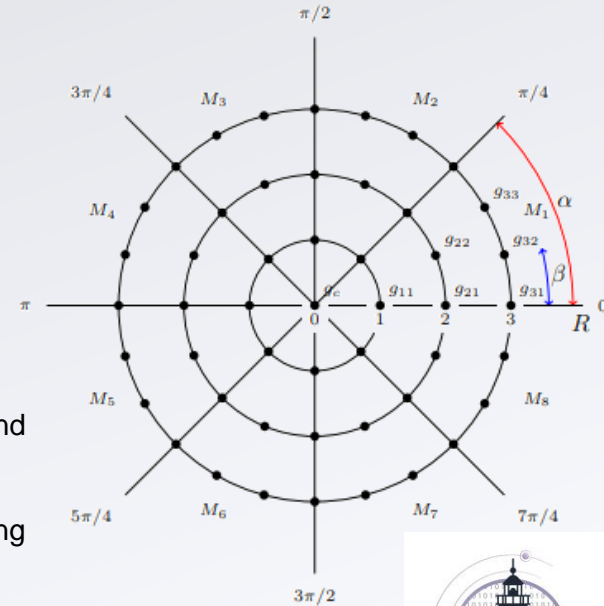
The novel LBP approach

$$RCPLBP_{R,P}(c) = \begin{cases} \sum_{p=0}^{P-1} s(M_p - g_c) & \text{if } U(LBP_{R,P}) \leq 2 \\ P + 1 & \text{otherwise} \end{cases}$$

Where

- R : is the special radius of the circular neighborhood,
- P : represent the number of neighbouring pixels on the circle of unit radius and also is the number of parts in which the circular neighborhood is divided,
- $M_p = \varphi(g_{ri}^p)_{\substack{1 \leq r \leq R, \\ 1 \leq i \leq r}}$ is the measure of the central tendency of the neighboring pixels gray values of the p-th circular part (our proposal: median),
- $U(LBP_{R,P})$: the uniformity measure.

Example. Circular neighbourhood: ($R=3$, $P=8$).



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Results and Conclusions

Database: Kylberg (28 classes of 160 gray-scale natural textures), **Contamination:** Three degrees of AWGN (low, medium and high), **Classifier:** 1-Nearest Neighbors (1-NN).

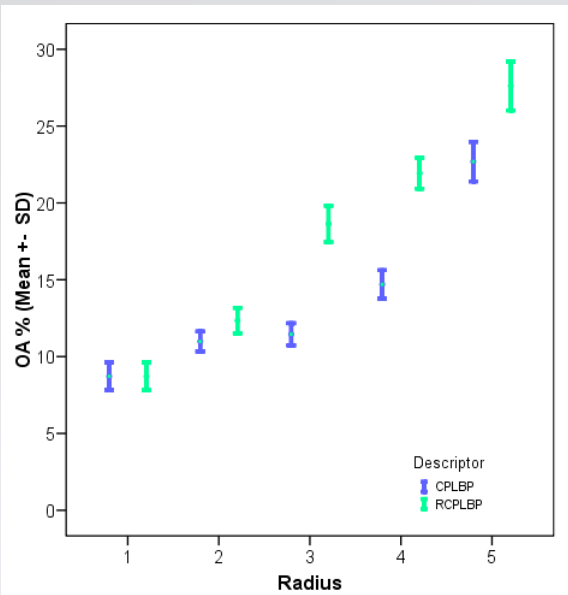


Figure 1. Overall Accuracy % (Mean \pm SD) according the CPLBP and RCPLBP, respectively, for $P=8$ and different radius values, in textures with high level of AWGN.

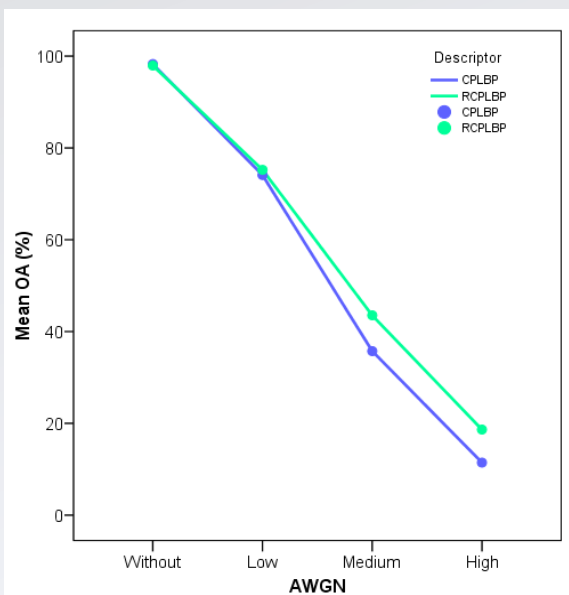


Figure 2. Mean Overall Accuracy (%) according the CPLBP and RCPLBP descriptors, in textures with different AWGN levels ($R=3$, $P=8$).

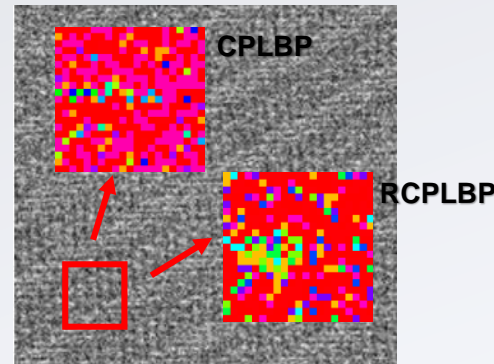


Figure 3. Visualization of micro-texture discrimination: CPLBP vs. RCPLBP, in a region of size 20x20 pixels, of a texture contaminated with a AWGN medium level ($R=3$, $P=8$).