

# RSURF – THE EFFICIENT TEXTURE-BASED DESCRIPTOR FOR FLUORESCENCE MICROSCOPY IMAGES

## Abstract

Our work relates to the problem of classification of Human Epithelial (HEp-2) cells.

We introduce a **new efficient texture-based image descriptor** for HEp-2 images and compare it with LBP, Haralick features (GLCM statistics) and Tamura features using the public MIVIA HEp-2 Images Dataset.

Proposed descriptor **outperforms** all previously mentioned approaches and the kNN classifier based solely on this descriptor achieve the accuracy as high as 91.1%.

## 1. Motivation

➤ The Human Epithelial (HEp-2) cells ... used in the Indirect Immunofluorescence (IIF) tests to **detect autoimmune diseases**.

The evaluation of IIF tests

- ✓ **looking for specific** fluorescent staining **patterns** in the cells,
- ✓ **done by humans**,
- ✓ **subjective method** too dependent on the experience of the physician.

➤ The patterns ... a **set of pixels with different distribution**.

We introduce ... a **novel texture-based descriptor**

- ✓ very efficient in particular problem of HEp-2 cells images recognition,
- ✓ **outperform** the current **state-of-the-art approaches**.

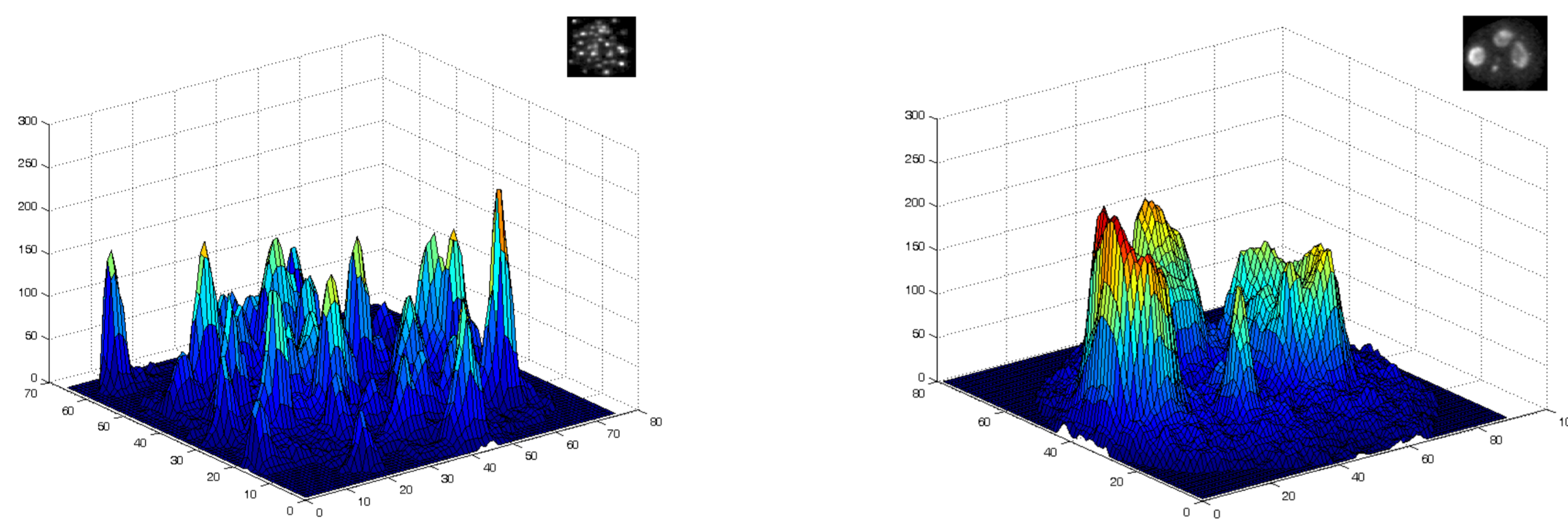


Figure 1: Examples of the surface images for centromere cell (left image) and nucleolar cell (right image).

## 2. Surface descriptor

- 2D greyscale image as a **topographic surface**.
- The intensity value  $I(x, y)$  ... the **elevation** of the surface at the point  $(x, y)$  (see Figure 1).
- Every leg between two neighbouring local extremes forms the slope (see Figure 2).

The main idea ... **compute the properties** such as

- ✓ length,
  - ✓ height,
  - ✓ integral,
- of each slope and **derive the statistics** of them.

## 3. Idea of slope processing

- Extract **all slopes** from **all collinear lines** for a particular direction.
- $S$  ... a **union of all slopes** of all considered directions  $d$
- $\Phi$  ... the function mapping the set of all slopes  $S$  to the real numbers.

Examples of **slope characteristic functions**:

- ✓  $\Phi_1(s_i) = n$  ... computes the length of the slope,
- ✓  $\Phi_2(s_i) = |I(p_1) - I(p_n)|$  ... computes the height difference between the highest and the lowest point of the slope.

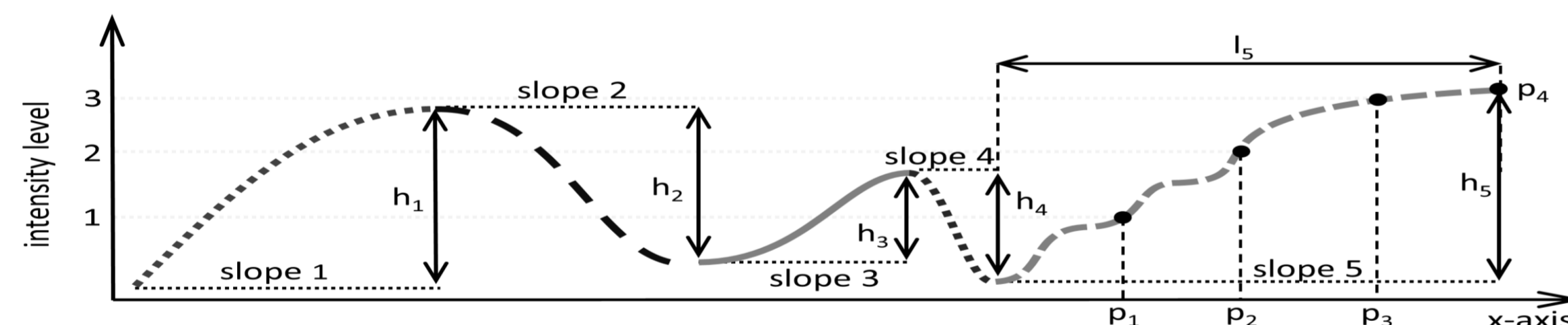


Figure 2: The illustration of continuous 1D signal obtained by traversing the image along the straight line. Each leg between local extreme is denoted as slope and is depicted with different line style.  $h_1, \dots, h_5$  denote values of some property for slopes 1, ..., 5 respectively. In this case, the height of the slope is computed.

## 4. Dataset and evaluation

➤ All the experiments on the **HEp-2 dataset** [1], which contains 1455 cell images of **6 classes** (see Figure 3).

➤ We used **k-NN classifier** implemented using **MESSIF framework** [2].

- ✓ **Leave-one-out cross-validation**.
- ✓ **L1 metric** as a distance function.

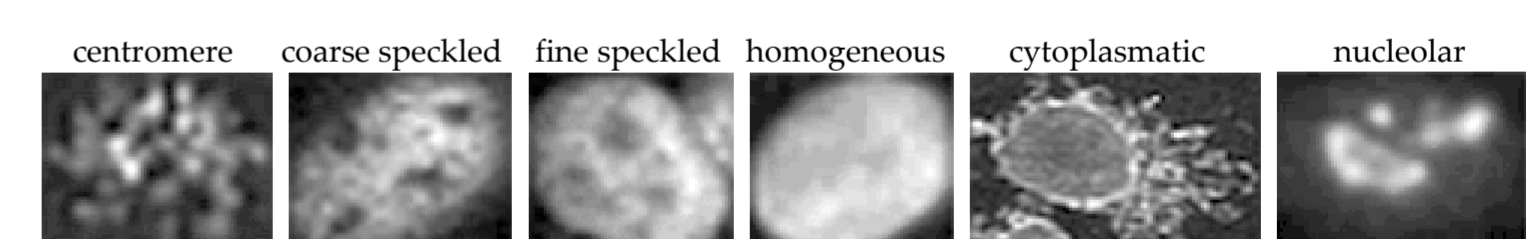


Figure 3: Examples of examined HEp-2 cell classes.

## 5. Results

The performance of proposed descriptor compared with the state-of-the-art descriptors, namely:

- ✓ **LBP**,
- ✓ **Haralick features**,
- ✓ **Tamura features**.

➤ **Table 1** ... the **classification accuracy** for different numbers of NN.

➤ **Figure 4** ... the differences caused by the rotation are **significantly smaller** than differences between cells of the same class.

Method	FVL	k = 1 (%)	k = 4 (%)	k = 8 (%)	k = 16 (%)	k = 24 (%)
<b>Our approach</b>	<b>64</b>	<b>89.6</b>	<b>91.1</b>	<b>91.1</b>	<b>88.8</b>	<b>88.0</b>
Original LBP [3]	256	71.5	73.5	72.4	71.8	70.8
LBP <sub>R=1,3,5</sub> [4]	768	79.4	81.6	82.4	81.5	80.5
Haralick <sub>D=1</sub> [5]	14	64.7	67.4	67.0	66.7	66.1
Haralick <sub>D=3</sub> [5]	42	70.8	72.9	73.1	72.3	71.8
Tamura [6]	3	48.9	50.0	51.3	51.8	52.4

Table 1: Performance of the k-NN classification of HEp-2 cells based on different descriptors and for different number of neighbours ( $k$ ). In the table, FVL indicates the feature vector length.

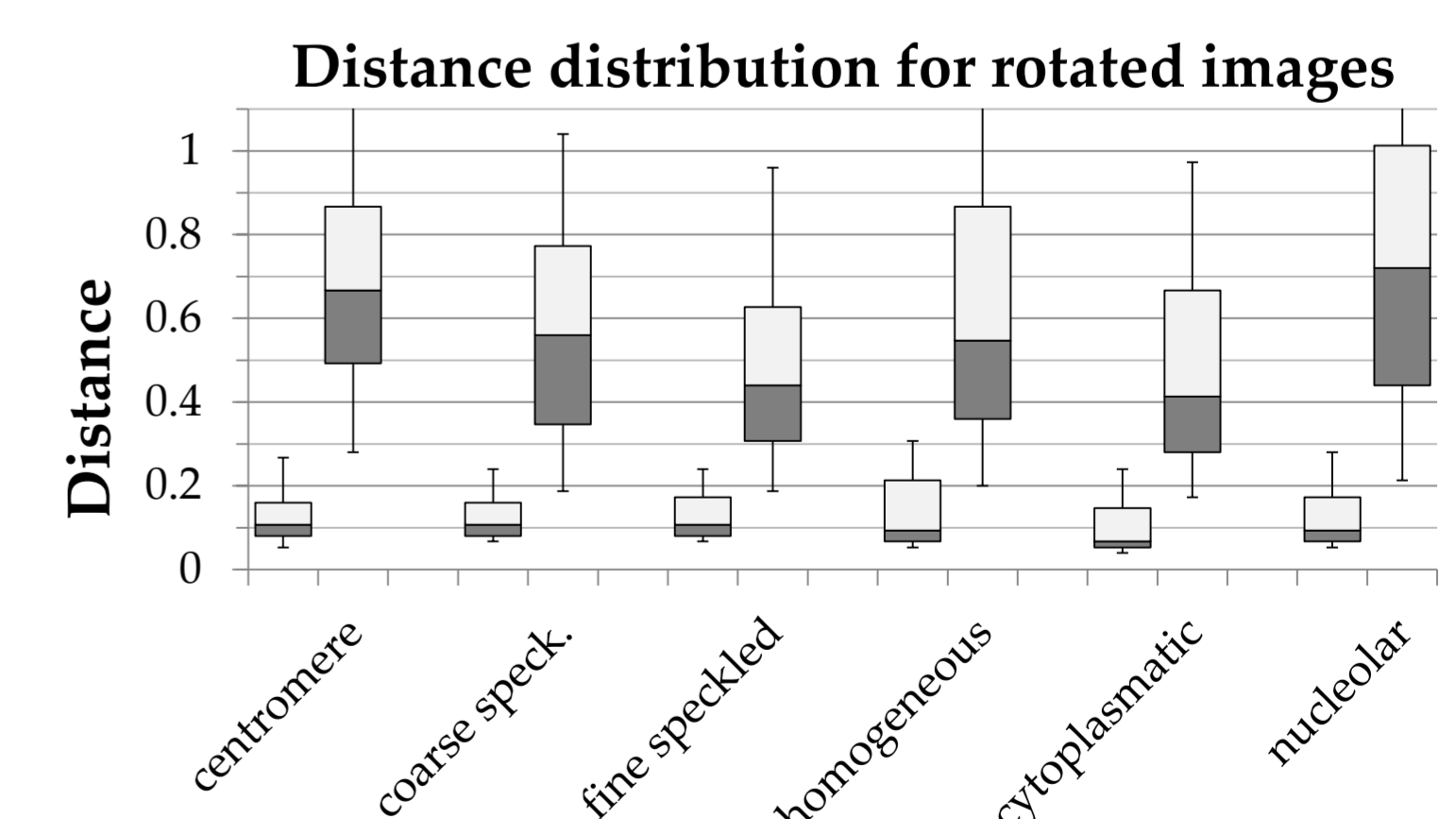


Figure 4: Distance distribution for rotated images (left-hand side box) and intra-class distance distribution (right-hand side box) for each of the 6 classes.

## References

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