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Development of Information Technology for Person Identification in Video Stream

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INTRODUCTION

The COVID-19 pandemic catalyzed the fast spread of face recognition solutions. During the pandemic in some countries started to use citywide video surveillance system that allow to find quarantine violators.

The global facial recognition market is expected to grow at a CAGR of 15.4% from 2021 to 2028 to reach USD 12.11 billion by 2028.

Facial Recognition Market Report Scope

Report Attribute	Details
Market size value in 2021	USD 4.45 billion
Revenue forecast in 2028	USD 12.11 billion
Growth Rate	CAGR of 15.4% from 2021 to 2028
Base year for estimation	2020
Historical data	2017 - 2019
Forecast period	2021 - 2028
Quantitative units	Revenue in USD million and CAGR from 2021 to 2028
Report coverage	Revenue forecast, company ranking, competitive landscape, growth factors, and trends
Segments covered	Technology, application, end-use, region
Regional scope	North America; Europe; Asia Pacific; South America; MEA
Country scope	U.S.; Canada; Mexico; Germany; U.K.; France; China; Japan; India; Brazil
Key companies profiled	Aware, Inc.; FacePhi.; NEC Corporation; IDEMIA; TECH5 SA; Onfido; Ayonix Corporation; Gemalto NV; Cognitec Systems GmbH; Fujitsu
Customization scope	Free report customization (equivalent up to 8 analysts working days) with purchase. Addition or alteration to country, regional & segment scope.
Pricing and purchase options	Avail customized purchase options to meet your exact research needs. Explore purchase options

RESEARCH OBJECTIVE

The purpose of the research is to develop an information technology of person identification in video stream based on the algorithm that provides high identification results being applied on images with low quality and resolution. Task solution methods:

- anisotropic diffusion,
- Gabor wavelet transform,
- histogram of oriented gradients (HOG);
- local binary patterns in 1-dimensional space (1DLBP).

TASK SOLUTION METHODS: Anisotropic Diffusion

Anisotropic diffusion equation:

$$I_t = div\big(c(x,y,t)\nabla I\big) = c(x,y,t)\Delta I + \nabla c \cdot \nabla I,$$

where *div* is the divergence operator, ∇ is the gradient operator, Δ is the Laplacian operator, $I_o(x, y)$ is the input image, t is the Gaussian kernel variance, $G(x, y, to)$ and $I(x, y, t)$ is a family of derived images obtained by convolving the original image $I_o(x, y)$ with a Gaussian kernel $G(x, y, t_o)$.

TASK SOLUTION METHODS: Gabor Wavelets Transform

The complex Gabor function in the spatial domain can be written as follows:

$$g(x,y) = \mathrm{K} \cdot \exp\left(-\pi(\alpha^2(x-x_0)_r{}^2 + b^2(y-y_0)_r{}^2)\right)\exp(j\left(2\pi\left(u_0x + v_0y\right) + P\right),$$

where *K* - scales the value of the Gaussian envelope;

(a, b) - scales two axes of the Gaussian envelope;

(x_0, y_0) - peak coordinates of the Gaussian envelope;

(u_0, v_0) - spatial frequencies of the sinusoidal carrier in Cartesian coordinates;

P is the phase of the sinusoidal carrier.

TASK SOLUTION METHODS: Histogram of Oriented Gradients

The gradient histogram retrieves with the equations:

$$D_x = \begin{bmatrix} -1 & 0 & 1 \end{bmatrix}, \qquad D_y = \begin{bmatrix} 1 \\ 0 \\ -1 \end{bmatrix}.$$

D_x is a 1-dimensional horizontal discrete derivative mask, D_y is a 1-dimensional vertical discrete derivative mask. The gradient histogram retrieves with the equations:

$$I(x) = I \cdot D_x, \qquad I(y) = i \cdot D_y.$$

Orientation is calculated with the following equation:

$$\theta = \tan^{-1} \frac{I_y}{I_x}.$$

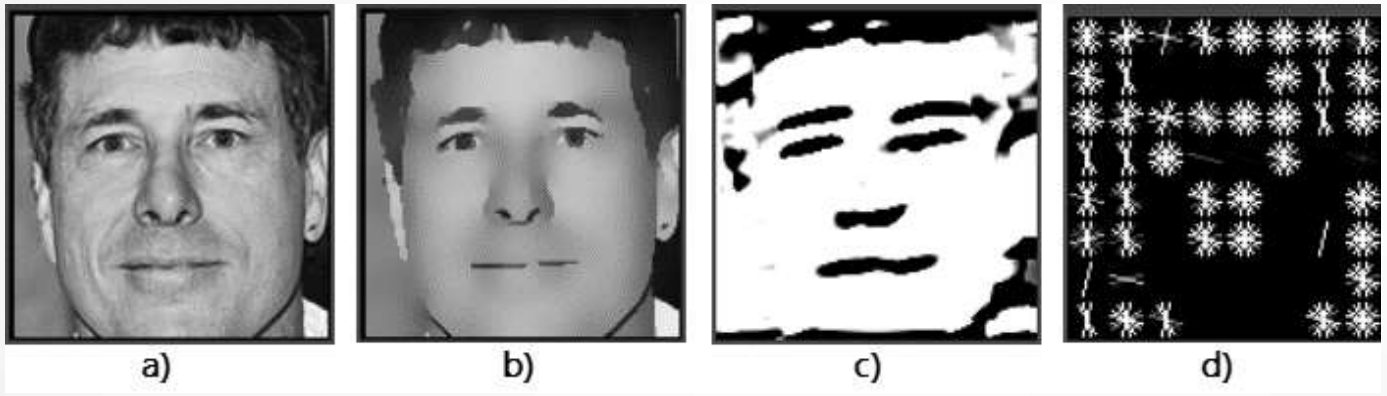
TASK SOLUTION METHODS: Local Binary Patterns in 1-dimensional space

The purpose of the 1DLBP method is to describe the local agitation of 1-dimensional signal segment in binary code. That description can be obtained by comparing of the neighbor pixel values with the central pixel value. All neighbor elements get the value of 1 if they are greater or equal to the current element and value of 0 if they are less than the current element. Then, each element of the obtained vector is multiplied by a weight according to its position. Finally, the current element is replaced by the sum of the values of obtained vector. Described process can be expressed as follows:

$$1DLBP = \sum_{n=0}^{N-1} S(g_n - g_0) \cdot 2^n .$$

S(x) function defines as *S(x)={1 if x⩾0; 0 otherwise};* g_0 and g_n are the values of the central element and its 1-dimensional neighbors, respectively. The index *n* changes its value increasingly from the left to the right in the 1-dimensional string.

EXPERIMENTAL RESEARCH AND ANALYSIS

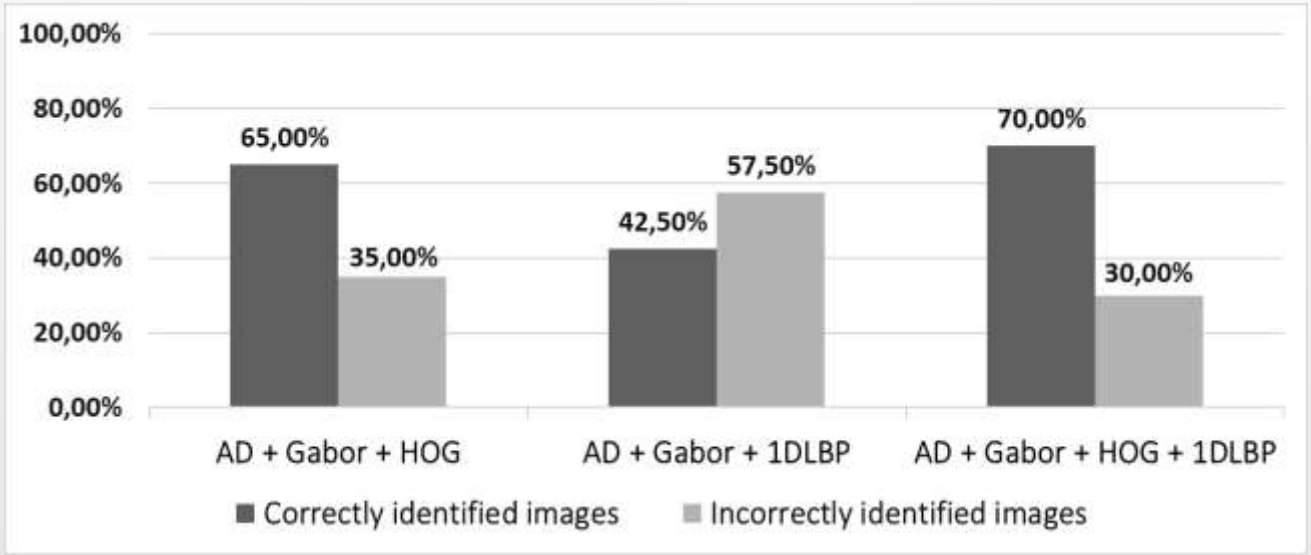


Examples of images: a) original image; b) image processed with anisotropic diffusion; c) image processed with Gabor wavelet transform; d) histogram of gradients of given image.

EXPERIMENTAL RESEARCH AND ANALYSIS

Results of experiments with The Database of Faces

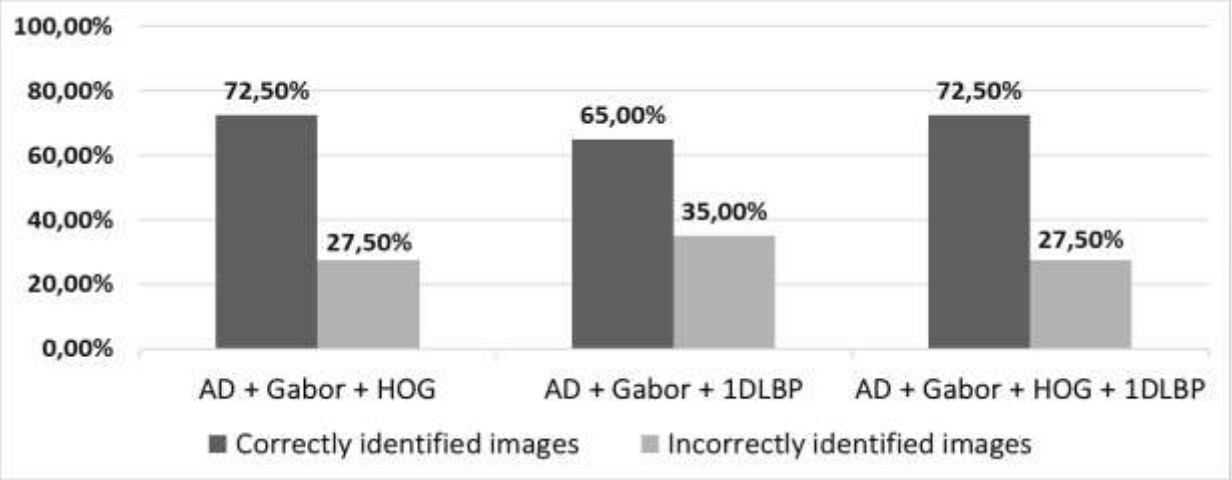
	AD + Gabor + HOG		AD + Gabor + 1DLBP		AD + Gabor + HOG + 1DLBP	
	Identification accuracy rate	False recognition rate	Identification accuracy rate	False recognition rate	Identification accuracy rate	False recognition rate
Total number of images	40		40		40	
Number	26	14	17	23	28	12
Identification accuracy rate	65%	35%	42.5%	57.5%	70%	30%



EXPERIMENTAL RESEARCH AND ANALYSIS

Results of experiments performed with The FERET Database

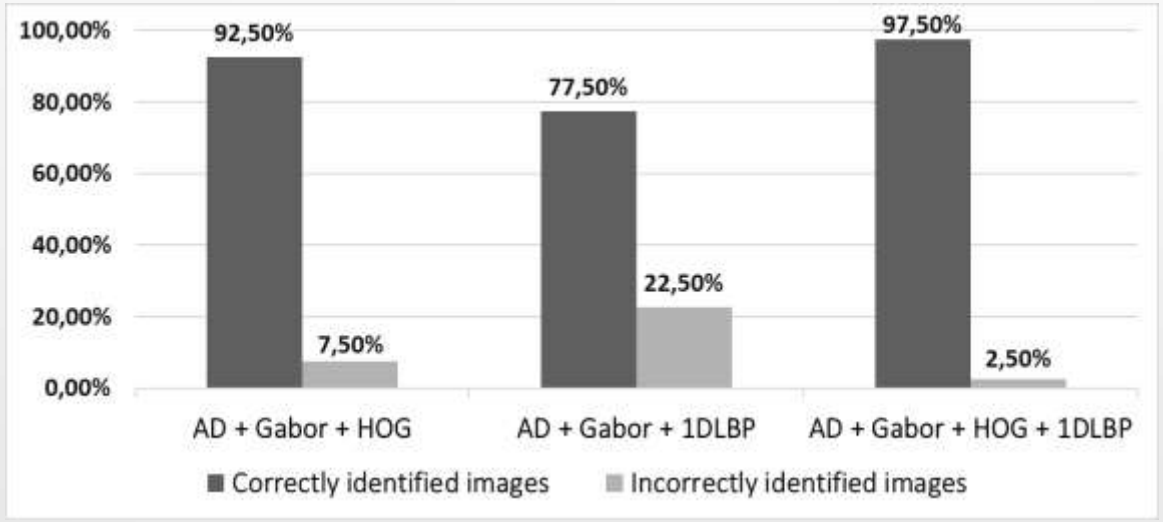
	AD + Gabor + HOG		AD + Gabor + 1DLBP		AD + Gabor + HOG + 1DLBP	
	Identification accuracy rate	False recognition rate	Identification accuracy rate	False recognition rate	Identification accuracy rate	False recognition rate
Total number of images	40		40		40	
Number	29	11	26	14	29	11
Identification accuracy rate	72.5%	27.5%	65%	35%	72.5%	27.5%



EXPERIMENTAL RESEARCH AND ANALYSIS

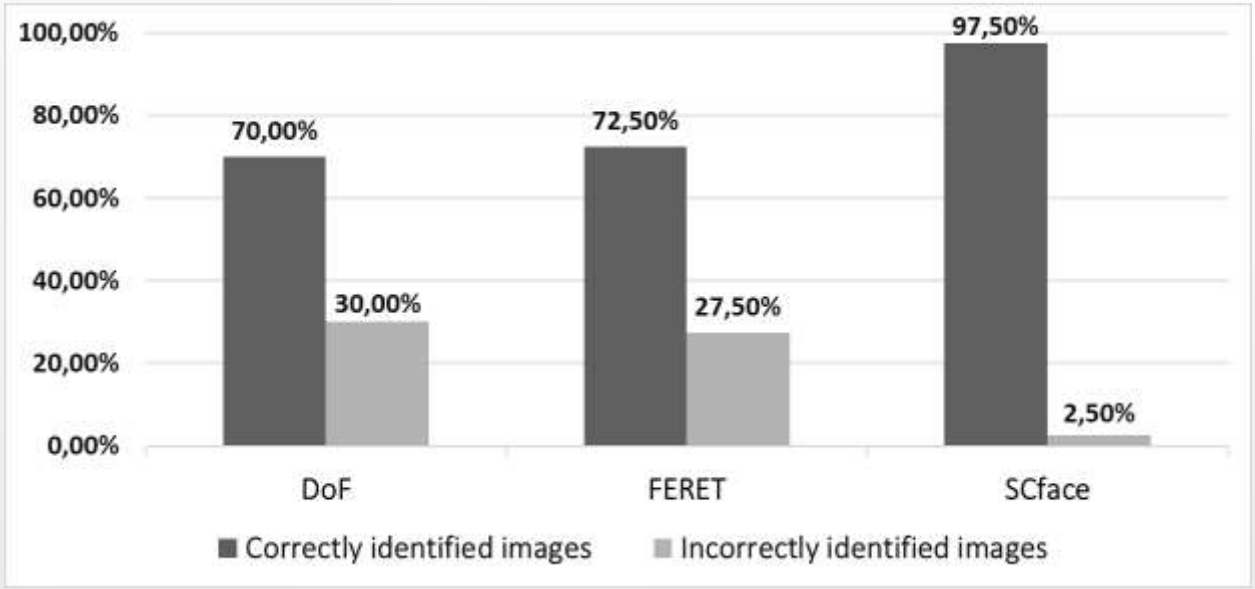
Results of experiments performed with the SCface Database

	AD + Gabor + HOG		AD + Gabor + 1DLBP		AD + Gabor + HOG + 1DLBP	
	Identification accuracy rate	False recognition rate	Identification accuracy rate	False recognition rate	Identification accuracy rate	False recognition rate
Total number of images	40		40		40	
Number	37	3	31	9	39	1
Identification accuracy rate	92.5%	7.5%	77.5%	22.5%	97.5%	2.5%



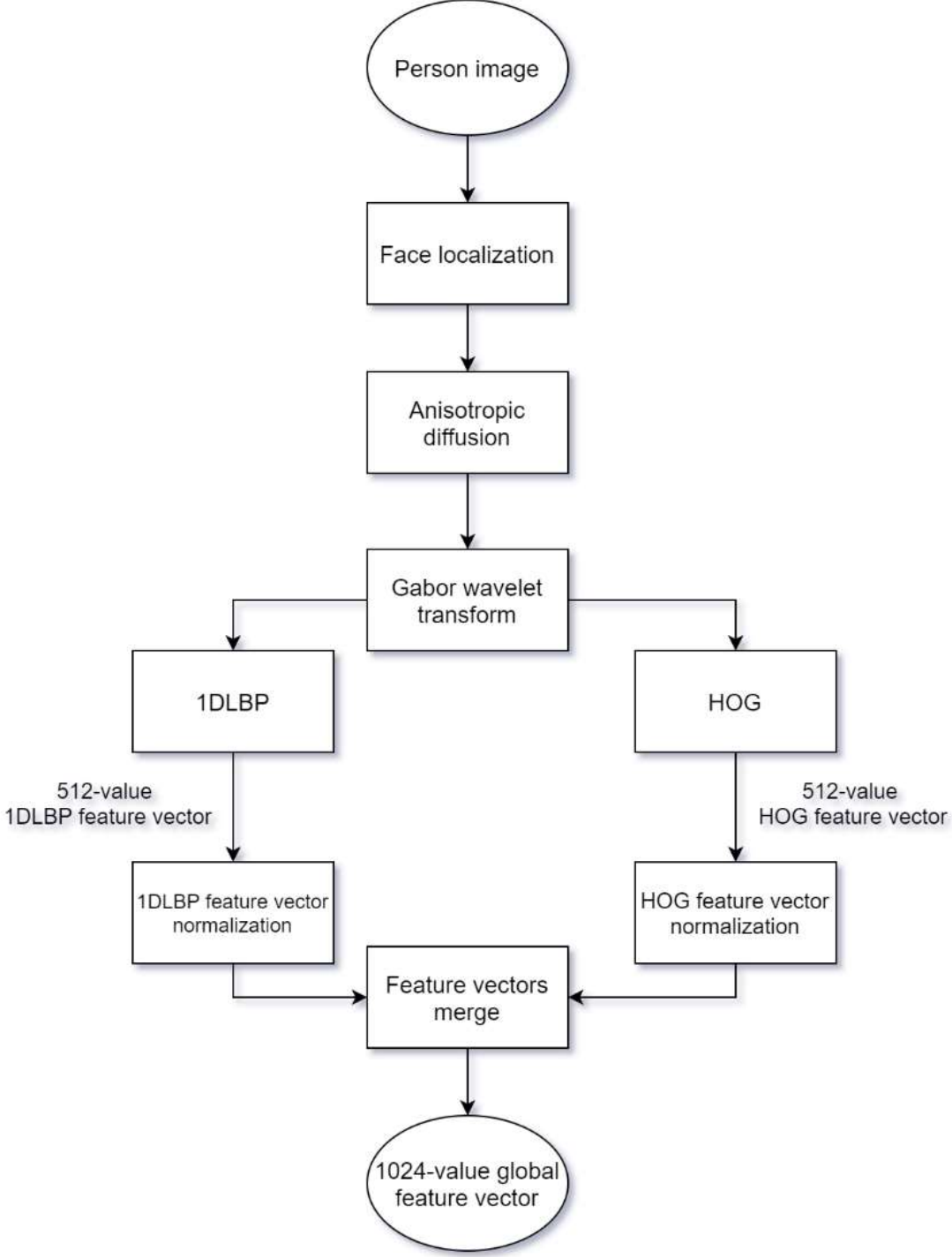
EXPERIMENTAL RESEARCH AND ANALYSIS

Comparative diagram of the experimentational results of the researched methods appliance to different databases



EXPERIMENTAL RESEARCH AND ANALYSIS

Data flow diagram of the proposed algorithm



CONCLUSION

- ✓ During the research, experiments were performed on the testing of methods being applicable in face recognition in order to establish the most efficient combination of methods by comparing results of their work with the use of one feature extraction method (HOG or 1DLBP) and the use of combination of feature extraction methods (HOG and 1DLBP).
- ✓ The obtained results indicated that the highest identification accuracy rate of 97.5% was obtained with both feature extraction methods (HOG and 1DLBP) on the images from SCface database, which are low-quality video surveillance images. Experimental results on the Database of Faces and FERET database provides from 70 to 72.5% of correctly identified images.
- ✓ Proposed algorithm is based on anisotropic diffusion as an image preprocessing method, Gabor wavelet transform as an image processing method, histogram of oriented gradients (HOG) and local binary patterns in 1-dimensional space (1DLBP) as the methods of feature vector extraction from the images, square Euclidean distance metric for vector classification. The algorithm can be applied for face recognition and person identification in conditions of face images with low quality and resolution.

Thank you for attention!