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Research and Comparative Analysis of Person Identification Information Technology

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Introduction

At the present face recognition and identification technologies are one of the most important technologies used to ensure security in a variety of industries, such as border services, police, and military affairs.

The most common areas of face identification technologies appliance are the following: access control – confirmation of a person's identity by a facial image; identification of wanted persons – person identification using surveillance cameras in real time, that allows to quickly neutralize suspects and increases the level of security in public places; criminal investigations – confirmation of the suspect's identity at the scene of the crime based on the image from surveillance cameras.

Constant improvement of face identification technologies allows to use them on an even larger scale and in more complex conditions. In the future, such technologies may be implemented in unmanned aerial vehicles of special operations forces for perimeter protection, intelligence gathering, and rescue missions.

The use of such technologies in sensitive areas, where incorrect identification can lead to irreparable consequences, such as reputational damage, wrongful conviction, or even human death, leads to the need to improve identification technologies in order to reduce the probability of identification errors.

Research Objective

Currently, most works devoted to the research of face recognition and identification technologies use approaches based on neural networks. According to the results of the analysis of several studies comparing different approaches to face recognition, it was found that deep convolutional neural networks provide high accuracy of face recognition by learning more discriminative functions on large datasets and outperform the recognition performance compared to holistic, geometric, and local-texture approaches.

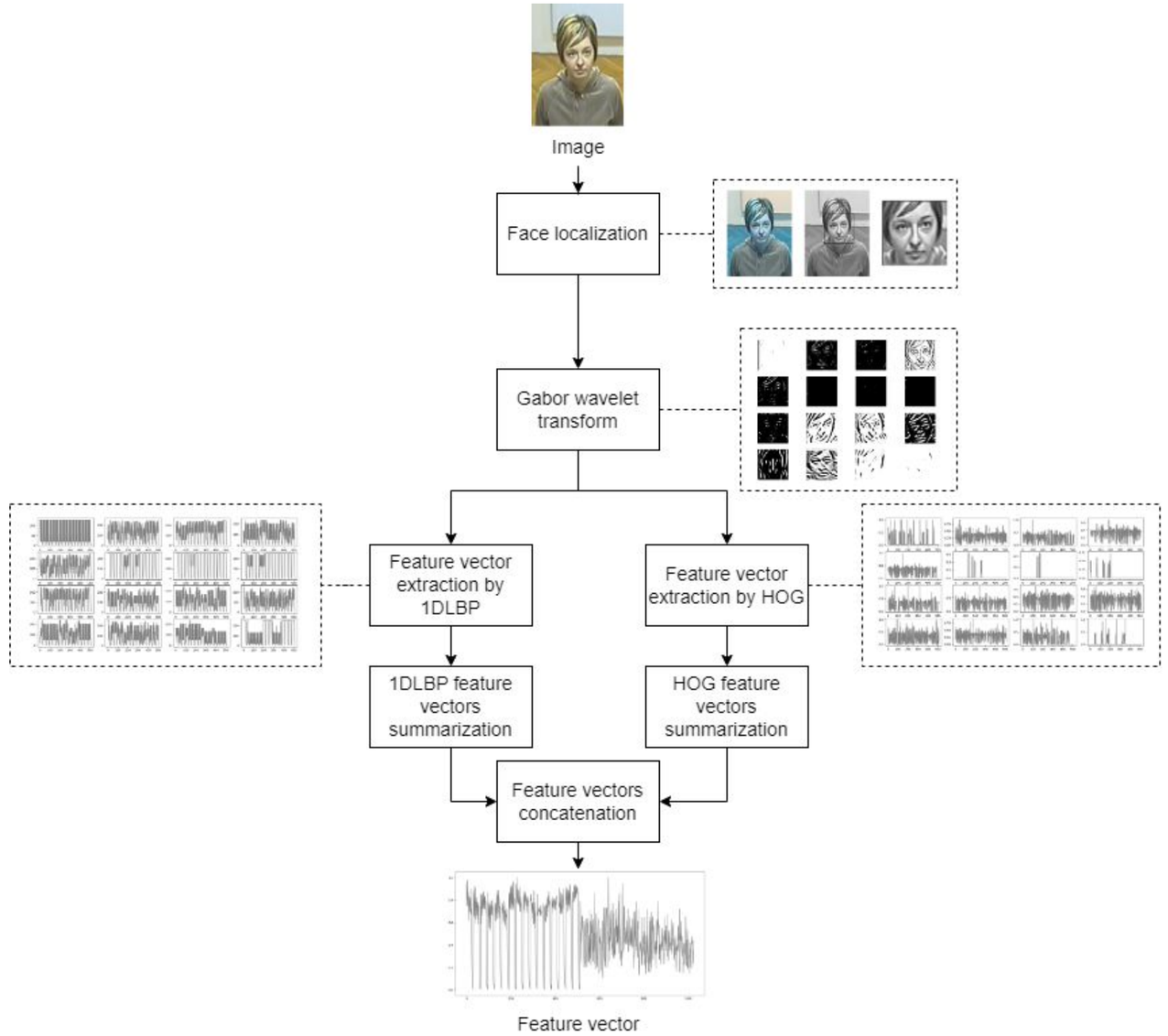
However, approaches based on neural network methods are not sufficiently flexible and able to quickly adapt to the conditions of the real world, which can change rapidly. Since algorithms based on neural networks require a large amount of high-quality data for training and are also expensive to maintain, most developers are unable to quickly adapt such algorithms to the fast-moving conditions of the real world.

An alternative to approaches to face recognition and identification based on neural networks can be a local-texture approach, which is characterized by such advantages as high efficiency of analysis time and recognition speed.

In our previous work there was firstly proposed a person identification information technology, based on an algorithm containing local-texture descriptors. The purpose of this paper is to study the proposed information technology and compare the results of the algorithm, underlying in its basis, with the known results of algorithms based on neural networks that were presented in the reviewed literature.

Proposed Approach

The algorithm, on the basis of which the proposed information technology of person identification is built, contains such methods of the local-texture approach as local binary patterns in one-dimensional space (1DLBP) and histogram of oriented gradients (HOG):



Proposed Approach

The proposed algorithm consists of the following stages:

1. Localization of a person's face in the image. For this, the method of detecting objects in images is used – a classifier based on Haar features. As a result of learning features f_j, it is possible to obtain the limit value θ_j and the value of comparability module p_j. Simple classifier can be described as follows:

2. Processing of an image containing only a face by Gabor wavelet transform. The Gabor function in the spatial domain is defined as:

where $s(x, y)$ is a complex sine wave, or carrier, and $\omega_T(x, y)$ is a 2D Gaussian function, or envelope function.

3. Extracting the vector of image features. The methods of the local-texture approach are consistently applied to the images formed as a results of Gabor wavelet transform processing. LBP in one-dimensional space (1DLBP) provided an efficient way to better describe local and global patterns, the algorithm uses a one-dimensional row projection of each level of the image matrix:

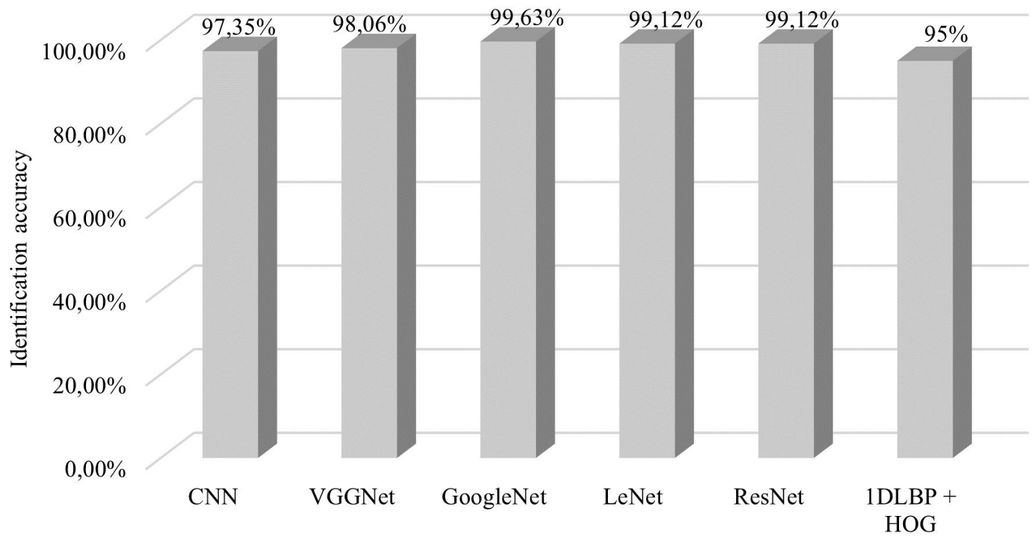
where $(x,y)_n$ and $(x,y)_0$ are the values of the central element and its one-dimensional neighbors.

The HOG method is applied to wavelet-transformed images to extract image shape features. The number of edges of image objects that have an orientation with a certain range is represented by each interval within the histogram. The gradient is calculated by first convolution filtering with one-dimensional horizontal 1D and vertical 1D discrete derivative masks. The resulting value is the sum of adjacent pixels, taking into account the weight of the mask:

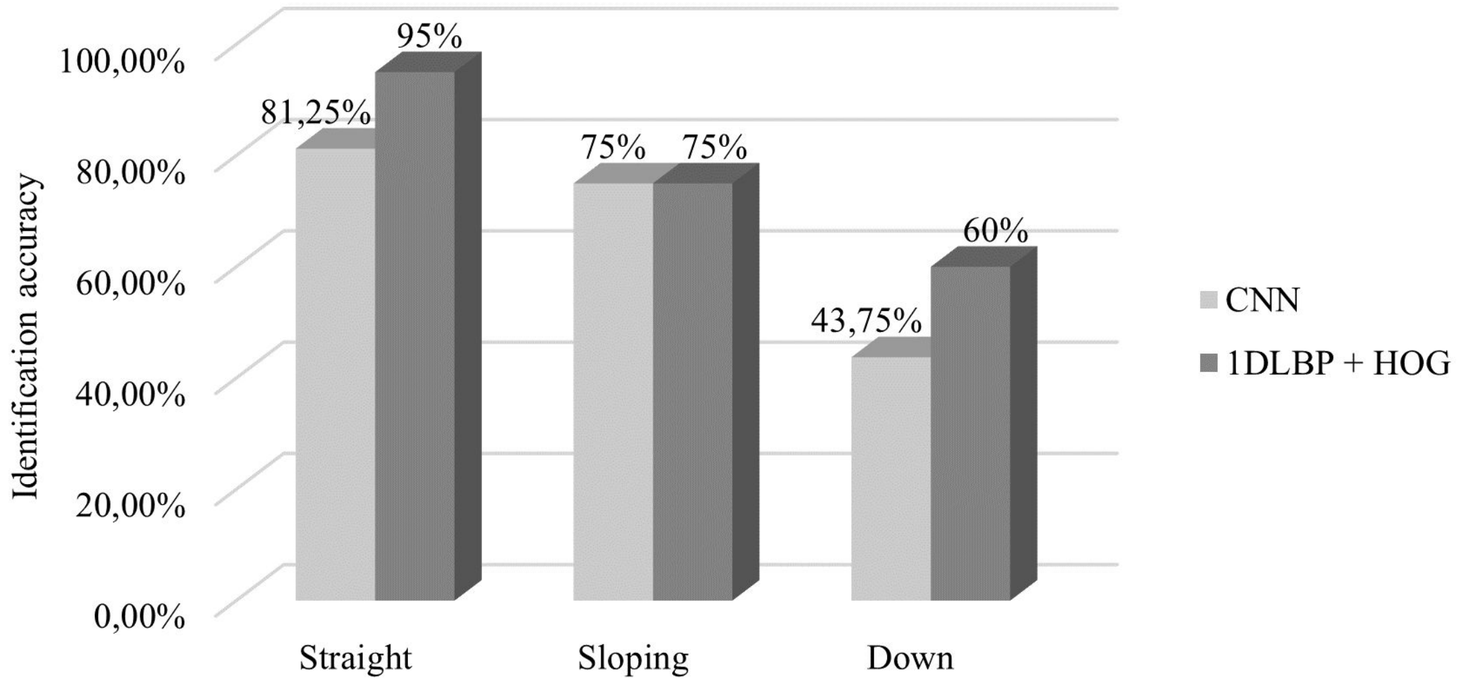
Experimental Research

Experimental research was conducted in order to establish the efficiency of the proposed algorithm on images with various parameters and to compare it with the most common algorithms based on neural networks.

During the experiments there was used a dataset of face images captured from different distances and angles of view of the camera on the subject, with various head positions (the subject looks directly into the camera, the camera is placed above the subject's head, or the subject look at different non-fixed points), with changes in lighting, facial expressions (unsmiling or smiling, closed or open eyes) and in the presence of some face details (such as glasses). Dataset was formed from 136 images of 40 individuals.

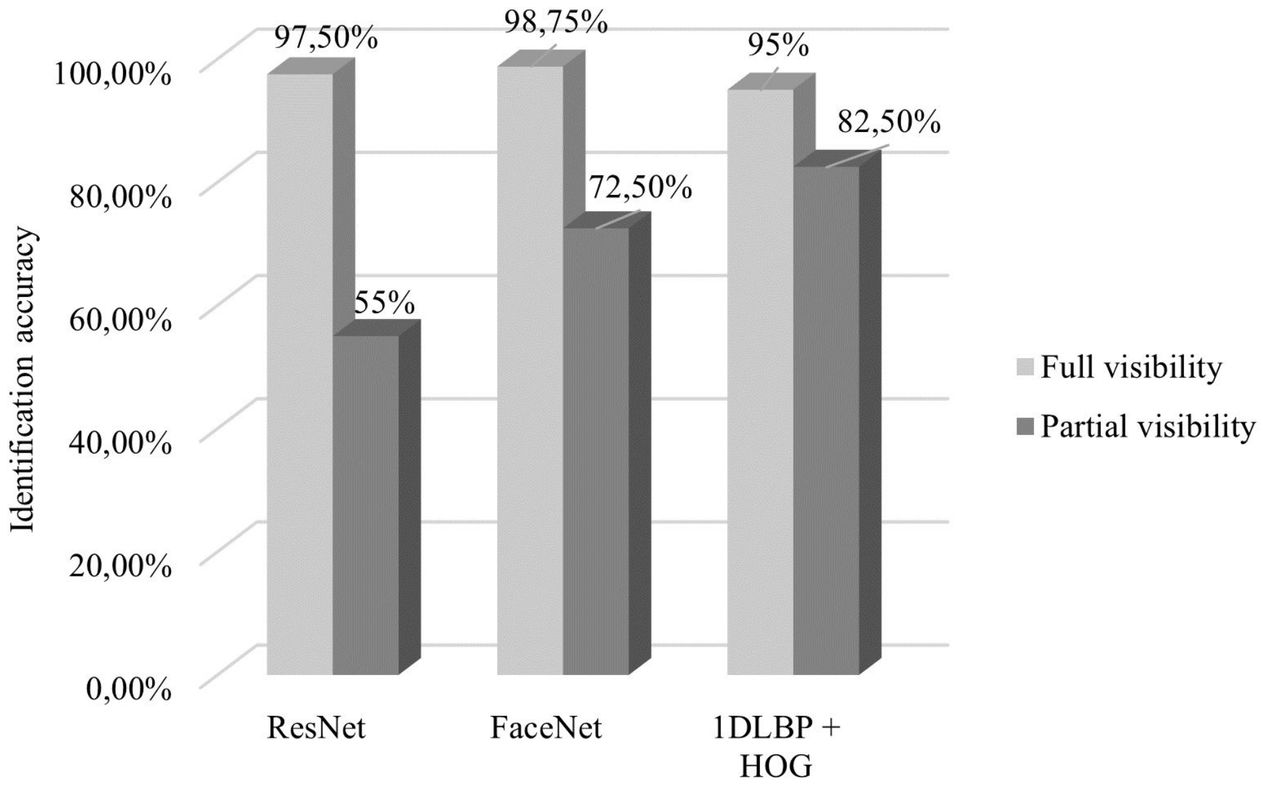


Comparative diagram of algorithms identification accuracy rates



Comparative diagram of algorithms identification accuracy rates

Experimental Research



Comparative diagram of experiment results on partially hidden face images

Experimental Research

Conclusion

This paper is devoted to the research of the information technology of person identification by face image, the basis of which is an algorithm containing the methods of the local-texture approach, with the purpose of establishing its efficiency in comparison with algorithms based on neural networks.

Based on the results of an experimental research performed on 136 images of 40 individuals with variations in the position of the subject's head relative to the camera, it was established that the proposed algorithm is more resistant to such recognition and identification conditions. On images where the subject looks directly into the camera, the identification accuracy of the proposed algorithm is 13.75% higher than that of the neural network based algorithm, and on images where the subject is looking down – on 16.25%.

During the analysis of the results obtained after conducting the experiments on the images of a partially hidden face, it was established that the algorithm based on local-texture methods is more resistant to the condition of recognition and identification, when the features of the human face are not fully visible. The identification accuracy of the proposed algorithm on 10.5-27.5% higher than the accuracy of neural network algorithms. At the same time, the percentage of reduction in identification accuracy for the proposed algorithm is 12.5%, while for algorithms based on neural networks – from 26.25% to 42.5%.

Thus, the main scientific contribution of this paper is the results of comparative analysis, based on which it can be concluded that the efficiency of the researched algorithm, which contains local-texture descriptors and underlies in the basis of the person identification information technology, exceeds the efficiency of algorithms based on neural networks under the conditions of different positions of the subject's head and partial visibility of facial features in the image.

Thank you for attention!

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