RESEARCHING A MACHINE LEARNING ALGORITHM FOR A FACE RECOGNITION SYSTEM

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Abstract: This article investigated the problem of using machine learning algorithms to recognize and identify a user in a video sequence.
The scientific novelty lies in the proposed improved Viola-Jones method, which will allow more efficient and faster recognition of a person’s face.
The practical value of the results obtained in the work is determined by the possibility of using the proposed method to create systems for human face recognition.
A review of existing methods of face recognition, their main characteristics, architecture and features was carried out. Based on the study of methods and algorithms for finding faces in images, the Viola-Jones method, wavelet transform and the method of principal components were chosen. These methods are among the best in terms of the ratio of recognition efficiency and work speed. Possible modifications of the Viola-Jones method are presented.
The main contribution presented in this article is an experimental study of the impact of various types of noise and the improvement of company security through the development of a computer system for recognizing and identifying users in a video sequence.
During the study, the following tasks were solved:
– a model of face recognition is proposed, that is, the system automatically detects a person’s face in the image (scanned photos or video materials);
– an algorithm for analyzing a face is proposed, that is, a representation of a person’s face in the form of 68 modal points;
– an algorithm for creating a digital fingerprint of a face, which converts the results of facial analysis into a digital code;
– development of a match search module, that is, the module compares the faceprint with the database until a match is found.
Keywords: approaches and algorithms for human resource processing, computer vision technologies, machine learning algorithm, Viola-Jones algorithm, image recognition

1. Introduction

Modern methods of recognizing objects in video or images have a wide range of uses ranging from the protection of private areas to the creation of special effects in films. Every day, large companies and small teams of enthusiasts create new approaches and algorithms for human resources processing to develop computer vision technologies.

At present, ready-made recognition solutions have already been developed, but they have certain shortcomings. With the help of DeepFace technology from Facebook, 97.25 % of people can be recognized. However, this technology is used only within Facebook, and only documentation is publicly available. The technology has impressive results, but it is not possible to test it.

Therefore, the development of a computer system that would automatically recognize employees of a company to provide access to the premises is an urgent scientific and technical task, and the search for more alternative methods of human face recognition and search for modifications of such methods was the aim of this study.

So, the aim of an article is to introduce a computer system that would automatically recognize the employees of the company to provide access to the premises.

2. Literature Review

Due to the significant development of machine learning, the computing environment, and recognition systems, a lot of investigators have closely work with recognition algorithms and identification using different building modeling strategies. Here are some of the most common recent works on FR systems.

In [1] propose a new way to transform learning into automatic emotion recognition (AER) in different ways. An estimation of the model showed that the new model could fit in more quickly to a new place when it was necessary to keep attention on parts of the input that were mature pertinent [2] automated method of face recognition using a convolutional neural network (CNN) by learning transfer approach.

[3] proposed to use an additive angular height loss (ArcFace) to confirm the face. The proposed ArcFace has an apparent geometric understanding as a result of the specific correspondence of the geodetic division on the hypersphere. The validation efficiency of open source FR models on LFW, CALFW and CPLFW data sets reached 99.82 %, 95.45 % and 92.08 %, respectively [3].

[4] proposed a large cosine loss margin (LMCL), reformulating SoftMax losses as cosine losses on L2, putting in ordering the couple principal moments and weight vectors to eliminate general variations, and using the term cosine edge to precisely expand the space selection boundary. They named their prepared model LMCL CosFace. They based their experiment on Labeled Face in the Wild (LFW), YouTube Faces (YTF) and MegaFace Challenge. They confirmed the effectiveness of their approach, achieving an accuracy of 99.33 %, 96.1 %, 77.11 % and 89.88 % for the data sets LFW, YTF, MF1 Rank1 and MF1 Veri, respectively [4].

[5] presented a matching between deep learning and traditional artificial intelligence strategies (e.g., artificial neural networks, extreme learning machines, SVM, optimal path forest, CNN) and deep learning. For biometric identity verification, they focused on CNN. They used three datasets: AR Face, YALE and SDUMLA-HMT [6]. Further research on FR can be found in [7–10].

3. Methods

To solve the problem of facial recognition, an algorithm based on the application of the Viola-Jones method, wavelet transform and the principal components method is proposed. The proposed algorithm consists of two processes: saving the features of famous faces in the database and face recognition.

The process of preserving the features of famous faces is as follows:

1. Converting a video frame image to a half-toned image.
2. Searching the facial area.
3. Reducing the size of the face area to 64×64 pixels.
4. Removing facial features (wavelet coefficients).
5. Extracting features with features in the database.

Therefore, in this case, the recognition of the image to identify a person in the video at the entrance to the office of the IT company was considered to identify its identity and make an immediate decision to grant access to the premises. To solve the problem of facial recognition, an algorithm based on the application of the Viola-Jones method, wavelet transform and the principal components method is proposed.

4. Results

To test the developed approach, the series of numerous computational computer experiments were carried out. A series of photographs taken from different angles were used to form the standard. At the same time, the face was not covered by other objects in the frame, either partially or completely. Also, the maximum deflection of the face relative to the camera lens was no more than 60 degrees. The removal was realizable in dynamics in the video stream.

After a series of photos was taken, the formation of a descriptor based on these images was started. The output is 128 unique characteristics, which were formed by the hypertrophic neural network, **Fig. 1**.

The experiment is carried out for 30 seconds, that is, approximately 90 results of this program were obtained. Thus, the results of the experiment in all four recognition conditions are shown in **Table 1**.

Table 1

Estimation matrix

Recognition conditions	Number of experimental results	Number of successful identifications	Percentage of successful identifications, %
Up close in good light	93	93	100
Up close in low light	91	61	67
From afar in good light	94	81	86
From afar in low light	90	54	60

Thus, the results of the first experiment, in which there were no obstacles in the form of glasses or hats, the recognition deteriorates by an average of 10.5 percent when shooting from a distance, and when the lighting deteriorates, then the results fall by an average of 32.5 percent. Looking at the results of the experiment, it is possible to conclude that, in good light, the program gets high results of identification success both near and far, but if the video is made in poor lighting, the success rate deteriorates. Thus, the program is able to successfully identify a person by recognizing the face at different distances, and when the identification is conducted in poor lighting, then some problems may arise, but they are not critical.

The second experiment will be the same as the previous one, with the same recognition conditions, except for one - sunglasses will be worn on the person's face, which should prevent the identification of the person. The results of the experiment in four recognition conditions are shown in **Table 2**.

Table 2

Estimation matrix

Recognition conditions	Number of experimental results	Number of successful identifications	Percentage of successful identifications, %
Up close in good light	89	85	96
Up close in low light	92	60	65
From afar in good light	91	74	81
From afar in low light	94	50	53

5. Discussion

If to compare the results of the second experiment with the first, it is possible to see that the percentage of successful identifications of people under all conditions of recognition decreased by 3–7 percent, so on average, in the presence of glasses at recognition, the results deteriorate by about 5 percent. So, when there is an obstacle in the form of glasses, the program returns a good percentage of success, and it does not greatly affect the presence of a person on the camera lens. That is, from this experiment it is possible to conclude that the program copes with identification, both in the presence of obstacles and without them.

6. Conclusions

The developed software is not time consuming, has good indicators of recognition quality through the use of efficient algorithms. Also, the software does not require expensive equipment, which is quite a big advantage, because small IT companies can easily afford it, providing secure access to their employees.

Thanks to the above numerical experiments, it is possible to say that the program has good personal identification and is able to recognize faces at different distances, lighting, as well as in the presence of some obstacles.

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 0.09018327, -0.01420533, -0.02740817, -0.02799697,  0.01150011, 0.19506745, -0.14034162, -0.00315567, -0.0278007 , -0.08226821,
 0.08042386,  0.01210389, -0.01273325,  0.05039834,  0.11608807, 0.12710042, -0.02132296,  0.01589148, -0.0100461 , -0.12186565,
-0.02874365,  0.04202215, -0.06090797, -0.11242695,  0.01802301, 0.00340901,  0.11843031, -0.09176139,  0.02322394,  0.04461421,
 0.13747421,  0.05561186,  0.11100591,  0.04100607,  0.04828874, -0.13406801,  0.01683353,  0.1227136 ,  0.03837224, -0.03182591,
 0.00441412,  0.07099265,  0.05572055, -0.00997687,  0.02618701, 0.13844964,  0.01790146, -0.1207578 , -0.06277931,  0.05708275,
-0.14231467,  0.16631706, -0.07847071,  0.19809206, -0.0882244 , -0.05824238, -0.04893727,  0.02503063,  0.10818931,  0.11280183,
 0.02836587, -0.02733412,  0.09332038,  0.02204283,  0.04275179, -0.02466655, -0.03013373,  0.00541282,  0.07531644,  0.08733613,
-0.10061324,  0.02807235, -0.03258325, -0.00552741,  0.07839686, -0.16842924, -0.10659596, -0.00907769,  0.09185477,  0.00693807,
 0.05110248,  0.05591932,  0.1939636 , -0.16496305, -0.0313029 , -0.09685852, -0.07484679, -0.06407107, -0.21544632, -0.16300833,
 0.11835157, -0.05251027, -0.10146299, -0.07974914, -0.01586063, -0.00813265,  0.0127035 , -0.06149791, -0.06408783,  0.11897956,
-0.02062829,  0.07474449,  0.03775677, -0.02127094, -0.06902238,  0.08424024,  0.11412962,  0.04737078, -0.00580862, -0.08089229,
-0.0466181 ,  0.16876404,  0.10821649,  0.05335474,  0.00462111,  0.20461601,  0.06632814, -0.16183478, -0.14455113, -0.132548  ,
 0.05325456, -0.12856409,  0.14038205, -0.02035958,  0.03337304,  0.00588569,  0.13302019,  0.00512493
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Fig. 1. 128 unique characteristics

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