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Basic issues of face recognition

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Abstract. This research work is dedicated to solving the problems of facial image recognition, in which the recognition is studied by separating the problems of searching from a large database, permissions and control of images in documents. Errors of the first and second type encountered in classification problems are also described, and their detailed descriptions are given.

Keywords: *image, recognition, Gaussian distribution, Euclidean distance, method of principal components, verification, identification, neural network.*

Facial recognition is divided into large-scale database searches, permissions, and document image control. They differ in terms of requirements, the type of information included in the recognition system, and the method of solving. Therefore, they are treated as separate class issues. For such classes, the requirements for first and second type errors are also different [1].

The first type of error (type I error, misdetection) refers to a situation where the system cannot recognize or skips an object of a given class. The second type error (type

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II error, false alarm) means that the system perceives an object of a certain class as an object of another class. In addition, the system creator is required to distinguish between the concepts of verification and identification (recognition) [2].

In verification, an unknown object declares itself to belong to a class known to the system. The system will either accept or reject it. In verification systems, the first type of error is defined as an object belonging to classes known to the system as an object belonging to classes unknown to the system and rejected by the system. The second type of error is defined as an object belonging to classes unknown to the system as an object belonging to classes known to the system and accepted by the system [3-4]. In recognition, it is required to give a conclusion that the object belongs to one of the given n classes or does not belong to them. The accuracy of this recognition step depends entirely on the results of image preprocessing algorithms [5-12], segmentation [13-17] and feature extraction algorithms [18-20].

Image search in a large database. The requirement that the recognition system find as many images of a given person as possible without missing any such images is a high requirement of Type 1 error. This is appropriate when the number of other individuals in the comparable sample is small. It is usually required to find an image that is similar to a given image in a large database (104-1010 images) [21]. In this case, the search must be carried out at a reasonable time. Therefore, it is necessary to store in the base informative features formed from images and maximally characterizing them. In such cases, accuracy requirements are not as important as in access and document management. Among the methods of this class, the principal components method (PCA) can be cited first [3, 22-24]. In PCA, the coefficients are determined by spreading the incoming image into the principal components, and the images are compared by calculating the Euclidean distance based on them. In modern methods, Mahalanobis distance and Gaussian distribution are used instead of Euclidean distance [25].

PCA developed on the basis of a neural network is described in detail in works [27-28]. Possibilities of using features formed in the last layers of a special convolutional neural network for image recognition by the nearest neighbors method are mentioned in [28].

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The algorithm of the system's operation when searching for information from the database is presented in Fig. 1, in which the tracking system initially captures a person. Then, based on the neural network, the face area is determined from the image, and the brightness and contrast are optimized and the image is normalized. The normalized image is passed to a second neural network for recognition, and this neural network performs recognition on the input image and selects several similar images from the base.

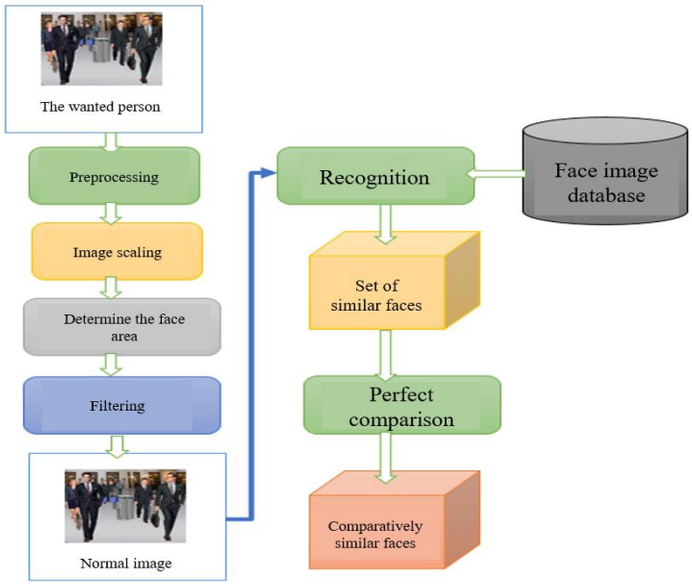

Figure 1

Algorithm of operation of the search system

The issue of access control. In this case, the requirement for the second type of error is very important. The recognition system must not recognize strangers even by increasing the second type of error (rejection of recognition).

Suppose a group of individuals is given and a recognition system allows them access to a building or program based on facial images. The system is strictly required not to provide access to persons who do not belong to this group. This may include one of the following:

- when it is required to identify a specific person by facial image. This requires a high level of recognition reliability from the system, even at the expense of an increased number of rejections of familiar objects.

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– several face images of each individual taken under different conditions are taken as training sample images. This can be a change in perspective, lighting conditions, the presence or absence of glasses, hairstyles, facial expressions. The system must work within real-time requirements, and the setup process can be time-consuming and upfront.

– when introducing the system, it must be retrained as soon as possible with incoming new images. There are no restrictions on the method used, but all methods rely on the availability of a set of face images of a given group of individuals for training. A system refers to a set of images in training or recognition.

The operation of a system similar to an access control system can be described as follows. At the entrance, a photo or video camera registers a person and takes a picture of person's face. Recognition is done based on the received face image. If there is a face image in the database corresponding to the face in the photo, then additional information such as last name, first name, age, and place of birth is read from the database. Based on the received information, the system grants or denies permission.

The system operation algorithm for entering information into the database is presented in Fig. 2.

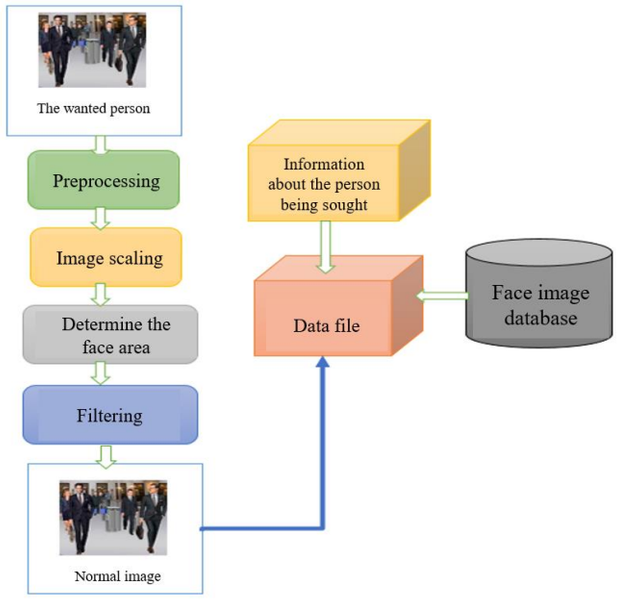

Figure 2
Algorithm of entering data into access control systems

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In this case, the image of the person is transferred to the system login. Based on the neural network, the face area in the image is determined. Then the face area is extracted, the brightness and contrast of the image is optimized, the image is stored in the database in the form of a separate file. The system user can enter additional information about the person. Additional input data is also stored in the database.

The issue of control of images in documents. For systems such as identification or verification, formulating type 1 and type 2 error requirements would be inappropriate in a "one-to-one" comparison. Because the recognition system does not work with incoming classes. However, it is desirable to estimate the errors so that the system does not make a large error in the comparison.

Conclusion

In this work, the main issues of recognizing a person based on a face image were studied. In this case, it is necessary to compare the face image of the person taken at the moment with the image in the document during the control of the photos in the documents. That is, the system must answer yes or no to the question whether the received image is the same as the image in the document. These class problems are relatively complicated, firstly, the system has not seen this person's face image before. The system always compares different images. It is very difficult to take into account the possible changes in the reading or adjustment process. Secondly, much attention is paid to age and facial changes. Thirdly, the quality and contrast of the scanned image is much lower than the image taken from the camera. Many methods designed to solve this class of problems cannot be applied without special adaptation. There are currently no works devoted to solving this class of problems by means of neural networks. To do this, it is necessary to develop adaptive neural networks to extract key features of images and compare two images.

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