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ANALYSIS OF METHODS FOR DETECTING AND CLASSIFYING THE LIKENESS OF HUMAN FEATURES

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Pattern recognition is assigning initial data to a certain class by isolating essential features that characterize this data from the total mass of irrelevant data [1-3].

To date, there are 4 groups of object recognition methods:

– Comparison with the sample (we implement these methods using geometric normalization and consider the actual distance to the prototype) [4, 5];

– Neural networks (for the selected network, the coefficients are selected. The neural network processes the incoming object. The group of network receptors receives its characteristic property) [6, 7];

– Statistical methods (such methods include elements of the theory of statistical decisions and the Bayesian approach) [8];

– Structural and syntactic methods [9] (break the input object into its components. They built rules depending on the occurrence of these components in a certain class).

The problem of face recognition comprises two subtasks: automatic recognition of faces in the frame and identification of the person behind the face [3, 10].

Face recognition belongs to the tasks of image recognition. Such problems do not have a precise analytical solution.

The key idea of human face recognition is the extraction of informative features of the image, encoding, and comparison of the encoded face with the database. In the most general case, the algorithm for solving the problem of recognizing a person’s face in an image comprises the following stages [11]:

– Revealing the fact of the presence of a person's face in the image and highlighting this face;

– Recognition and description of key facial features (such as eyes, nose, eyebrows, mouth, ears, etc.);

– Representation of a face in a specific space (modeling);

– Comparison with standards and identification (classification).

Today, the Viola-Jones method is the most popular method for finding facial areas in images because of its high speed and efficiency.

The Viola-Jones face detector is based on three fundamental principles:

– Integrated representation of images according to Haar characteristics, which allows you to quickly calculate the features;

– A method for constructing a classifier based on an adaptive gain algorithm (AdaBoost);

– A method of combining classifiers into a cascade structure.

These technologies allow you to implement face detection in an image in real-time.

To detect a face in an image using the Viola-Jones method, it is necessary to have the image itself, the selected scanning window, and the selected features used. Next, the scanning window moves along the image with a step of 1 portion of the window (for example, the size of the window itself is a portion of 24×24). When scanning an image in each window, 200000 variants of the location of features are calculated by changing the scale of features and their position in the scanning window.

Scanning is carried out for different scales. It is not the image itself that is scaled, but the scanning window (the size of the scanned area is changed). All found features go to the classifier, which decides whether or not there is a face in the image [12].

Benefits of the Viola-Jones Method:

– High speed of object detection;

– High probability of accurate face recognition at various small angles;

– Low probability of false face recognition.

Disadvantages of the Viola-Jones method:

– It takes a lot of time for training;

– At a large angle, the detection accuracy drops;

– High sensitivity to lighting.

The basis of the pattern comparison method [13] is the selection of areas of the face in the image, and then the comparison of these areas for two different images. Each area that converges increases the similarity of the images. Simple algorithms such as pixel comparison are used to compare image regions.

The disadvantage of the pattern comparison method is that it is resource intensive both for storing regions and for matching them. Since the simplest comparison algorithm is used, the pictures must be taken under established conditions: noticeable changes in angle, lighting, emotional manifestations are not allowed.

The recognition accuracy using the pattern comparison method is about 80%, which is an excellent result.

The eigenperson method uses principal component analysis to reduce the dimensionality of the data without significant information loss.

The personal space is formed using the method of the main components of the educational set of images. Educational images are projected onto the space of their faces. The test image is projected onto a new space and the distance between the projected test image and the images from the training set of images is calculated. The recognized image is the one that is closest to the training one.

In addition, we used principal component analysis only for recognizing facial contours in an image. For persons, the values of the components in their own space are of great importance, and in complementing their own space, they are close to zero. Based on this, you can find out if the input image is a face [3].

The advantage of this method is that if we meet the idealized conditions, then the recognition accuracy using it can reach values of over 90%. It is also possible to store and search images in large databases, image reconstruction. But the calculation process

itself is very laborious. Images should be obtained in good lighting conditions, high-quality preprocessing should be carried out, and we should bring images to standard conditions.

The advantage of using methods based on artificial neural networks for identifying faces is the ability to train systems to select key characteristics of faces on training samples.

Neural networks provide the ability to obtain a classifier that models well the complex distribution function of the face image. In the tasks of classification, there is an implicit assignment of key features within the network, determining the significance of these features and systems of mutual dependencies between them.

Among neural networks, for solving pattern recognition problems, multilayer perceptron's with back propagation of an error, networks with radial basis function, and convolutional neural networks (Convolutional Neural Networks) are most often used [12]. The success is because of the ability to consider the two-dimensional topology of the image, in contrast to the multilayer perceptron.

Distinctive features of the neural network are local receptor fields (which provide local two-dimensional connectivity of neurons), general weights (which allow detection of some features anywhere in the image), and a hierarchical organization with spatial sub-sampling. Thanks to these innovations, the neural network provides partial resilience to changes in scale, turns, angle changes, and other transformations.

We can successfully apply neural networks to identify faces in images and to verify a person by face. The recognition quality decreases with an increase in the number of classes that must be provided.

Disadvantages of methods based on artificial neural networks:

– The need for complete retraining of the network on the entire available set in case of adding a new reference person to the database;

– We need a lot of time for training.

The selection of features is a necessary step in the construction of classification systems. A successful solution to this problem provides both a decrease in the dimension of the measurement vector and description of objects and an increase in the classification's efficiency system [14].

Let the entire set of images Ω in the database (a sample of images is used to select features) is subdivided into groups (classes), each class Ω_l consists N of images $X^{(n,l)}$.

We can consider each digital image as a set of numerical features specified in space, the dimension of which is determined by the number of pixels in the image [15].

However, the classification of objects (images) in such a space is practically impossible for some reasons. First, the presentation of the image is excessive; its features are highly dependent. Second, training many parametric classifiers for a large dimension of features requires significant resources (time, training sample size, etc.), and the quality of such classifiers in real use may not meet the specified requirements [8]. Third, searching for an image in large databases using many features requires large computational resources. During transformation to another space without decreasing

its dimension (for example, by spectral transformation), these problems remain unchanged.

We can carry the choice of features out without considering the connection with the quality of the classification when the features are selected based on the minimization (maximization) of some criterion [16]. The best feature selection procedure is using the Chernov bound or Bhattacharya distance, however, these criteria are limited to problems with a known probability density. With known feature distributions, the concept of divergence and entropy can be used [8]. When the distributions of features for classes are unknown, the best choice is an obvious criterion for the probability of classification error, which is assessed.

To select informative features that provide a solution to the recognition problem, there is another method comprising three stages [3, 9]:

– Preliminary selection of informative features;

– Formation of sets of informative features;

– The final selection of informative features.

At the first stage, a preliminary selection of features is carried out. Pre-selection of informative features based on analysis of variance and allows you to reduce the dimension of the feature space from several hundred thousand features (pixel values) to several tens or hundreds of features.

In the second stage, using the attachment-rejection method, the most informative sets of features are formed. The set of features formed at the first stage (determined by the set of pixel indices on the feature fields, which are calculated according to an algorithm) is very excessive, but it can serve as a basis for further feature selection. The purpose of the second stage of feature selection is to find various options for feature combinations that provide the best classification results for different classifiers and classification criteria. A complete enumeration of all combinations of features is a task that is almost impossible to implement. Therefore instead of an exhaustive search, combinations of sequential attachment and sequential feature rejection algorithms are used.

At the third stage, using the classification criterion, one or more sets of features are selected that provide the most effective solution to the classification problem. First, we calculate arrays of feature vectors for the specified reference and control samples of images. Then all the sets of features obtained in the second stage of feature selection are considered. For each set, there is a known type of classifier and classification criterion for which this set was selected. For each such set, the classifier is trained, and we check the result using the reference and control samples. In the end, one (or several) we select multiple features based on the test results and the applied classification criterion [1, 4].

We base the described method for the selection of informative features on the calculation of both local and global features, as well as on the use of the algorithm of attachment-rejection of features and classification criteria is quite effective for recognition problems in images.

After analyzing the literature [1-16] and researched the proposed methods, it is possible to draw certain conclusions on the implementation of the development of an application for detecting and classifying the similarities of human facial features.

To recognize a person's face in an image, first, you need to identify where the person's face is in the photo. To do this, you need to highlight its main key components, such as eyes, nose, lips, forehead, and so on. We can do this using the Haar template primitive. If the patterns correspond to specific areas in the image, we assume that the image contains a human face. For each of the templates, the difference between the brightness of the white and black areas is calculated. We compare this value with a reference, after which a decision is made whether a part of the human face is in the image or not.

The Viola-Jones method (Haar cascades) was chosen to develop an application for detecting and classifying the similarity of human features. To identify faces of different sizes in the picture, the scanning window method is used. It is in this window that all primitives are calculated. For a certain number of iterations, it goes through the image and processes it. When the face was not detected, the scanning window is enlarged and traversed over the image again. The method does not end until a face is detected, or the size of the scanning window becomes equal to the size of the image itself.

After the face in the image has been detected, we must identify it. The Local Binary Patterns method will solve this problem. Its essence lies because we divide the image into parts. In each such part, we compare each pixel with the adjacent 8 pixels. If the value of the central pixel is greater than the neighboring one, then 0 is fixed, otherwise – 1. For each pixel in the image, a certain value is calculated.

Further, based on these values for all parts into which the image was divided, we build a histogram. We combine all histograms from all the parts into which we divided the image into one vector, then characterize the image. If you need to find out how similar two people are, you need to calculate such a vector for each of them and compare them. We base the choice of this method for the implementation of application development on the fact that it is very effective, its recognition results are obtained quickly, and there is also the possibility of identifying over one face.

Another positive factor is that the method is implemented partially in the OpenCV library. Among the disadvantages, we can note that it is difficult to train since training requires an enormous amount of test data and involves a long training time.

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