AN INTELLECTUAL COMPONENT RECOGNITION FOR SECURITY SUBSYSTEM

Introduction. With the development of computer technology it became possible to solve a number of problems arising in the process of vital activity, to facilitate, accelerate, improve the quality of the result. For example, the work of various life support systems, human-computer interaction, the emergence of robotic systems.

Recognition systems become an integral and very important part of automated control systems for the shop, plant, industry, since in order to manage the optimal way, it is necessary to have information about the phenomena and processes in the system, is formed, in particular, as a result of the functioning of the corresponding recognition systems.

Human face recognition systems are now being increasingly used in those applications where access to information is differentiated, as well as in security systems. A major problem facing computer vision systems is the large variability of visual images associated with changes in illumination, scales, viewing angles. In addition, people have a habit of walking around the streets and in the premises dressed, which leads to significant variability in the images of the same person.

The results of the research can be used in the development of automated access systems: a personal computer, a bank account, application to access data on the image of a human face in miniature devices where there is no possibility to embed common hardware identification.

Keywords: recognition system, optimization, machine learning, image, information criterion, functional efficiency.

The authors identified the most significant informative features. This is illustrated by Figure 1.
The description of the features is given in Table 1.

| Plot of land | Units | Description |
|--------------|-------|-------------|
| BC           | мм    | Distance from the beginning of hair growth to the eyebrow |
| CE           | мм    | From the eyebrow to the tip of the nose |
| EF           | мм    | From the tip of the nose to the chin |
| AD           | мм    | From the highest point of the head to the eye line |
| DF           | мм    | From the line of the eyes to the chin |
| KL           | мм    | Distance between the inner corners of the eye |
| PK           | мм    | Length of the eye |
| OR           | мм    | Nose width |
| BF           | мм    | Height of the face |
| AF           | мм    | Head height |

An important point to be noted is the aging of the organism, characteristic of the human nature, the growth of hair and the variability of facial expressions, as well as scars and other artificial changes. This all prevents recognition, therefore, selected features of the object that are minimally dependent on these factors [1].

The distinguished features are qualitative, stationary, not stochastic.

Also, the attributes are dependent, for example, the KL region should be smaller than the DF portion by about three times.

**Purpose and objectives of the study. Statement of the research task.** Safety is an important component of human life. A person faces the task of protecting a room (production, office or home).

To date, CCTV cameras have been installed in all large credit institutions, diverse trading enterprises and public entities.

Personality, information and material values are the main objects of protection of the security system.

One of the effective security systems is the pattern recognition system.

The formulation of the problem was formulated as follows. There are 50 photos (10 photos for 5 different people). All photos have a size of 600 × 600 pixels. When a particular person appears in front of the webcam, the system must determine if there is a face image in the field of view. Next, determine whether the image is the face of a particular person from those that are stored in the database. And after that, carry out identification and make a decision.

**Materials and methods for solving the research problem.** The authors analyzed the main methods of identifying a human face, identified the advantages and disadvantages of each of them. During the analysis, the overall structure of the recognition process was identified. It was found that the algorithms analyzed differ only in how the features are found and compared. At the initial stage, the object is detected and localized on the image. At the recognition stage, the image is aligned, then the characteristics are calculated and the found characteristics are compared with the standards set in the database.

As a result of the analysis of methods and approaches to the solution of the problem, the authors selected the most effective for solving the research problem. Namely, one of the approaches, based on neural networks, is the convolutional neural networks.

In order for the neural network to be trained, it is necessary to form a set of learning examples. Key features are extracted by themselves, during training. Further, the importance of the found features is established and the mutual dependence of their individual characteristics is found. When the network is already trained, it is assumed that it can apply the experience obtained to previously unknown images due to generalizing abilities [2].

The convoluted neural network has a peculiar peculiarity, it consists in the following. The limited two-dimensional connectivity of neurons is provided by local receptor fields, and common weights guarantee the detection of certain traits anywhere in the image.

As can be seen from Figure 2, the architecture of a convolutional neural network consists of a number of layers that are periodically repeated. Select the convolution and sub-sampling layers.

![Figure 2](image)

Each layer has a set of planes, neurons of the same plane have equilibrium coefficients of the synapse weights that lead to all local sections of the previous layer. The local receptor field gives inputs to each layer neuron, that is, the input image of the previous layer is scanned as a small window and passed through a set of synaptic coefficients, and the result is mapped to the corresponding neuron of the current layer. A set of planes is a map of characteristics, and each plane finds "its" parts of the image anywhere in the previous layer [3].

The scale of the planes is reduced by the sub-sample layer, that is, the values of the neurons at the output are averaged. More general characteristics are extracted by the following layers.

**Scaling and clustering an image.** When the system finds an object (person's face) on the image, then the searched area is marked with a rectangle. The main difficulty is the fact that in one image several informative candidate plots can be found for the location of the object. An illustrative example of such recognition is shown in Figure 3.

In order to minimize such errors, as well as increase the probability that the investigated object will be highlighted in the image, it is suggested to use scaling and clustering.
Formation of the model of the object is carried out by setting a set of numerical values of the characteristics \( x_1, x_2, \ldots, x_n \), which for objects from the class \( \Omega_i \) are generated as realizations of a multidimensional random variable with a given distribution law \( f(x_1, x_2, \ldots, x_n) \) by one of the known algorithms.

Before entering the input of the recognition algorithm, the numerical values of the parameters \( x_1, x_2, \ldots, x_n \), which represent an object that is recognized, are subject to random distortions, which simulates the result of the impact of various obstacles in the process of determining the characteristics \( x_1, x_2, \ldots, x_n \) with the use of appropriate technical means with certain characteristics of accuracy. Distorted value \( x_1, x_2, \ldots, x_n \), which represent the object observed in the form in which it is perceived by the system, arrive at the input of the recognition unit, which determines the belonging of the object to one of the classes \( \Omega_1, \Omega_2, \ldots, \Omega_m \). Matches the number of the class to which the object belongs with the recognition unit, with the "true" number, that is, with the one set at the first stage of object formation, determines the correctness of object recognition and systematizes the relevant information to calculate the probability estimates of the correct and erroneous solutions. When recognizing objects from a class \( \Omega_i \), probability evaluation \( w_i \), the correct answer is the ratio of the number of correct answers \( N_{pr}^i \) to the total number of tests \( N^i \) over objects of a class \( \Omega_i \):

\[
w_i = \frac{N_{pr}^i}{N^i},
\]

Number of tests \( N^i \) is determined by the confidence probability given in the formulation of the research task. The considered statistical model allows to find the dependence of the system efficiency index \( W \) from the type and number of attracted for recognition indications \( x_1, x_2, \ldots, x_n \) and accuracy of technical means \( k_1, k_2, \ldots, k_n \), which are equipped with the recognition system:

\[
W = W(x_1, x_2, \ldots, x_n; k_1, k_2, \ldots, k_n)
\]  

The information contained in (2) – output for tasks on determining the composition of technical means of observing the recognition system, the necessary accuracy of their work.

**Conclusions.** A comparative analysis of approaches and methods to solving the problem of detecting and identifying a person's face on an image is conducted, their advantages and disadvantages are considered. As the most effective approach is chosen using convolutional neural networks. A method for selecting a face in an image by its features is proposed. A modified algorithm for scaling and image clustering is proposed, which is used to prepare the image for recognition. The mathematical and algorithmic
support of the procedure for solving the research problem is developed.

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