**АХМЕТ БАЙТҰРСЫНОВ АТЫНДАҒЫ**
**ҚОСТАНАЙ МЕМЛЕКЕТТІК УНИВЕРСИТЕТІ**

**КОСТАНАЙСКИЙ ГОСУДАРСТВЕННЫЙ**
**УНИВЕРСИТЕТ ИМЕНИ АХМЕТА БАЙТУРСЫНОВА**

# «ЗАМАНАУИ ҒЫЛЫМНЫҢ БОЛАШАҒЫ ЖАСТАР КӨЗІМЕН: ӨНДІРІСТІК, ӘЛЕУМЕТТІ-ЭКОНОМИКАЛЫҚ ЖӘНЕ МӘДЕНИ-ӨНЕГЕЛІЛІК ДАМУ ТҰРҒЫЛАРЫ»

**тақырыбындағы халықаралық студенттік және магистранттық ғылыми-практикалық конференция материалдарының жиынтығы**

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**ҚОСТАНАЙ, 2018**

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**ББК 72+74.480**
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**Б 90 «Будущее современной науки глазами молодежи: производственные, социально-экономические и культурно-нравственные аспекты развития»**: мат-лы межд. науч.- практ. конф. студ. и магистр. – Костанай: Костанайский государственный университет им. А.Байтурсынова, 2018. – 464 с.

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В данном сборнике представлены материалы международной научно-практической конференции студентов и магистрантов **«Будущее современной науки глазами молодежи: производственные, социально-экономические и культурно-нравственные аспекты развития».** В сборнике собраны научные статьи, посвященные актуальным вопросам аграрно-биологических, ветеринарных, сельскохозяйственных, технических, исторических, юридических, социально-гуманитарных, информационных и экономических наук.

Материалы данного сборника предназначены для студентов и магистрантов высших учебных заведений.

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## USING PIXEL BRIGHTNESS HISTOGRAMS IN THE RECOGNITION PROCESS

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*Object of research of this article was application of the form of histograms of distribution of brightness of pixels as a sign vector for classification of images with persons. Within the task of recognition it is considered that to every image the unique value of a vector of signs is put in compliance. Vectors of images contain all information on an image striking to coding and are considered as n points – a measured Euclidean space. Classification of images was carried out by criterion of a minimum of distance between vectors. In article use of histograms of brightness of pixels in image brightness stabilizing was also described. Results of testing of a method by different modifications over computation of the histogram, results of comparing of experiments of recognition for complete and composite histograms of signs are given. Analyzing the received results confirm a hypothesis of use of brightness histograms as the initial vector of signs. In turn, comparing of two similar images in which there are little changes in separate insignificant elements of a scene can be based on application of the histogram of brightness in which the parameter of levels of samplings is picked effectively up. In completion of article the description of shortcomings and advantages of this method is attached. Testing was executed over a basis of images of the persons Olivetti Research Laboratory.*

***Keywords:*** *identification, signs of an image, recognition process, histogram of distribution of brightness, computing technologies.*

Currently, the intellectualization of data processing and analysis methods are the main baselines of the "fourth generation" computing technologies. All-pervasive computerization provides the development of new methods of zero interaction with the computer, modelling human intelligence. The main task of the next-generation interfaces is the ability to identify objects. And one of the first tasks that contributed to the development of the theory of pattern recognition was the problem of recognizing a person, where a human face serves as the source of the physical sign.

The concept of the theory of pattern recognition is at the core of modern information systems implemented by applying the latest computer technologies [1]. The most common recognition systems are those that analyze visual information from physical objects [2]. The current level of development of computing technologies makes it possible to combine both approaches to the description of images in recognition systems and methods involved in the recognition process. The main goal of developers working in this direction is the creation of an algorithm for the recognition system to determine the identity of a person [3].

As it was proved as far back as 1964 and 1965 by Woodrow Wilson Bledsoe in cooperation with Helen Chan, and Charles Bisson, the process of face recognition is greatly influenced by changes in the lighting, perspective and facial expressions, as well as biological aging. The search for a solution to this issue is prolonged by measuring subjective facial features, such as the distance between the eyes or the position and width of the nose, etc. Measurements in many tasks of machine vision are done on the brightness of the image, sudden drops of which often correspond to the features of the face – the outlines of the mouth, eyes, eyebrows and nose.

In the areas of image processing and machine vision, an important role is played by histograms of the distribution of digital image brightness levels. The image is a two-dimensional function $f(x, y)$, where $x, y$ are coordinates in the plane, $f$ amplitude at any point with the pair of coordinates $(x, y)$ is called the *intensity* or *brightness* of the image color at this point. Thus, if coordinates $x, y$ and $f$ amplitude value take values from a discrete set, then we speak of a *digital image* [4, p 18].

In mathematical statistics, a histogram is viewed as a function that approximates the probability density of a certain distribution (*for example, the distribution of pixels of a certain brightness*) based on a sample from it. The histogram of a digital image is a graph that shows the number of pixels at each level of color intensity, where the intensity is the level of color concentration, that is, the predominance of one or another tone. The tonal range of images contains a certain number of pixels in all areas with a color depth of 256 gradations. In the digital world, most devices operate with 8-bit images, hence 256 different states are encoded.

**The application of pixel brightness histograms in stabilizing the brightness of an image**

The recognition process is greatly influenced by lighting. In case of insufficient lighting, we encounter a narrow shifted range of pixel brightness. This is often found in dark images and in images that have pixel brightness overexposure. Most pixels are concentrated in one area, instead of occupying the entire range of brightness values from 0 to 255. The brightness of such an image is transformed, which compensates for the undesirable effect. Another reason for the lighting of the image is more problematic: when an image consists of pixels of the darkest tones and the lightest tones, but still most of the pixels are concentrated around a certain brightness.

Based on the definition of the pixel brightness histogram, it is possible to numerically estimate the unevenness of the lighting. And if the image has an incorrect contrast, then you can apply global brightness transformation to it – tonal correction.

The image brightness transformation is described by the following function: $f^{-1}(y) = x$, where *y* is the pixel brightness in the original image, and *x* is the pixel brightness after correlation. The first cause of the brightness of the image can be managed with the help of linear correction, where the *linear stretching of the histogram* will compensate for a narrow range of brightness. Linear correction is a transformation that converts the darkest pixels into black, and the lightest – into white. The image becomes more contrast when the histogram is "spread out". But the linear correction method is not appropriate for an image in which a large proportion of pixels are very dark / light, since the minimum pixel value in the image will be zero, and the maximum is 255. After applying the linear correction, we get the same image itself. In this case, it is necessary to use nonlinear correction of brightness values: gamma correction, logarithmic correction.

However, there are types of images for which linear or nonlinear transformation of brightness ranges is not always effective. First of all, this concerns images, the brightness gradations of which occupy the maximum possible range, and the brightness range of potentially informative image areas is a small part of the range. For such images, it is recommended to apply the method of piecewise linear or piecewise nonlinear transformations of brightness ranges. [5]

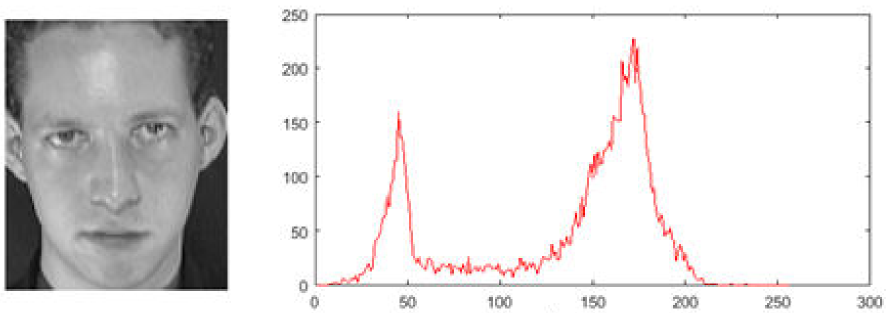
**Calculation of the histogram of the distribution of pixel brightness values**

In finding the similarity between images, the *form* of a histogram is important. The peculiarity of the form is that if the original image is rotated on the plane by any angle or is scaled on any of the axes, the form remains the same. The number of sampling levels is determined by the *BIN* parameter. The *BIN* parameter splits the histogram into *x*-intervals, in every *j*-th element of which the number of pixels belonging to the specified interval with a certain brightness is counted. The element *j* of the histogram *H(j)* is constructed from the sum of the number of pixels having a corresponding brightness with values *j* = 0, 1, ... 255.

The calculation of the brightness characteristics is carried out as follows:

$$H(x) = \sum_{j=(x-1)\frac{256}{BIN}}^{\left(x\frac{256}{BIN}\right)-1} H(j), \qquad x = 1, 2, \dots BIN. \qquad (1)$$

Figure 1 shows the pixel brightness range that make up the image. The *BIN* parameter, as mentioned earlier, is intended for dividing the distributed information into *j* columns. The height of the column is characterized by the number of pixels that fall in the corresponding interval. In the first peak of the function, the main pixels forming the background of the image are concentrated. The width of the tonal range also depends on the uniformity of the background. At the maximum peak formed at the end of the histogram, the pixels related to the object of the study (face) are concentrated. The main brightness of which is fixed at the point of a limited maximum. The height of brightness distribution function depends on the uniformity of the color intensity of the object. A small fraction of pixels scattered in the middle of the histogram is formed by the presence of noise.




а) б)

Figure 1 - a) the original face image, b) the calculated histogram of the brightness distribution

Figure 2 shows the identification of test image №10 of the first class from Olivetti Research Laboratory (ORL) test base. The procedure for identifying image №10 is based on finding the minimum distance between histograms of standards of all classes, which are represented in the form of column vectors. As a result, each class of face images is associated with a set of vectors - columns of images. In this case, the attribute space is divided into regions corresponding to classes, which are called *clusters* [6]. As a result of all stages of cluster analysis, clusters of "similar" images are created. As a function of distance of image vectors interpreted as points in Euclidean space, we can use the following Euclidean metric [7]:

$$d(x,y)= \|x-y\|= \|y-x\|=[(x_1-y_1)^2+...+(x_n-y_n)^2]^{1/2} \qquad (2)$$

In the Matlab system, this metric can be described as follows:

$$DIST(j) = sum\left(abs(HQF - BASE(:,j))\right),$$

where *HQF* is the histogram of the brightness distribution of the test image, *BASE* is an array consisting of histograms of the standards of each class.

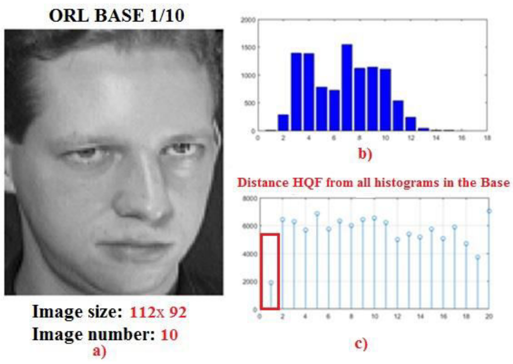



Figure 2 - a) image №10, 1 class, b) histogram of the reference image №1 1 class; c) the distance of the test image (image №10, 1 class) from the images stored in the base of standards of all classes

**Testing the method of image recognition by matching the forms of the pixel brightness values distribution histogram**

Testing was carried out on the basis of images of ORL faces, the parameters of which were given in the article [8].

As a result of testing, the highest recognition result (RR) is 64%, for a given amount of the standard L = 1 in each class, with a sampling rate of BIN = 32; the highest RR is 72%, for the given L = 3 with the BIN parameter = 128; at the given L = 5 the highest result is 92.5%. Recognition gave a test with the parameter of BIN = 256.

It can be said that the obtained attribute vectors differ from the primary ones (see Table 1) due to different sampling of the distribution of pixels composing the image. Accordingly, the value of the minimum distance between vectors also changes, and the recognition result undergoes a change. In tasks for recognizing images with faces, the BIN value is selected from 8 to 64 [9, p 206.].

**Table 1. Dependence of the recognition result for 40 classes on the number of standards and levels of histogram sampling**

| Number of standards in the class | Number of reference / test images in the database BIN | BIN | Recognition result, % |
|---|---|---|---|
| 1 | 40/360 | 16 | 58.3333 % |
| | | 32 | 64.1667 % |
| | | 64 | 60.8333 % |
| | | 128 | 60.8333 % |
| | | 256 | 61.1111 % |
| 3 | 120/280 | 16 | 69.6429 % |
| | | 32 | 71.0714 % |
| | | 64 | 71.0714 % |
| | | 128 | 72.1429 % |
| | | 256 | 71.4286 % |
| 5 | 200/200 | 16 | 91 % |
| | | 32 | 90.5 % |
| | | 64 | 91.5 % |

| | | | |
|---|---|---|---|
| | | 128 | 92 % |
| | | 256 | 92.5 % |

Another feature of recognizing the forms of image histograms is that the histograms of two semantically different images can be similar. The method is based on the representation of source images as a collection of rows and columns. The method does not require a preliminary reduction of sizes of original images, it is not iterative and is directly realized in two directions of coordinates – namely, by rows and columns of the original image. [10]

To be certain that the face is represented in the image, we can calculate the characteristic vector for the entire histogram of the whole image (M×N) and compare the resulting vector with the attribute vector for the composite histogram (M/2×N, M/2+1×N). If the value of the minimum distance of two histograms (composite and full) coincides, it means that the images represent the same person. Thus, it can be assumed that the method of comparing the form of the obtained histograms of brightness has semantic segmentation.

Histograms of the upper and lower half of the face horizontally are calculated by dividing the lines in half (see Fig. 3). Next, histograms of pixel brightness values for each half are calculated, after which the histograms obtained are connected to each other in the order of the halves, and a complete histogram of the original image is obtained.

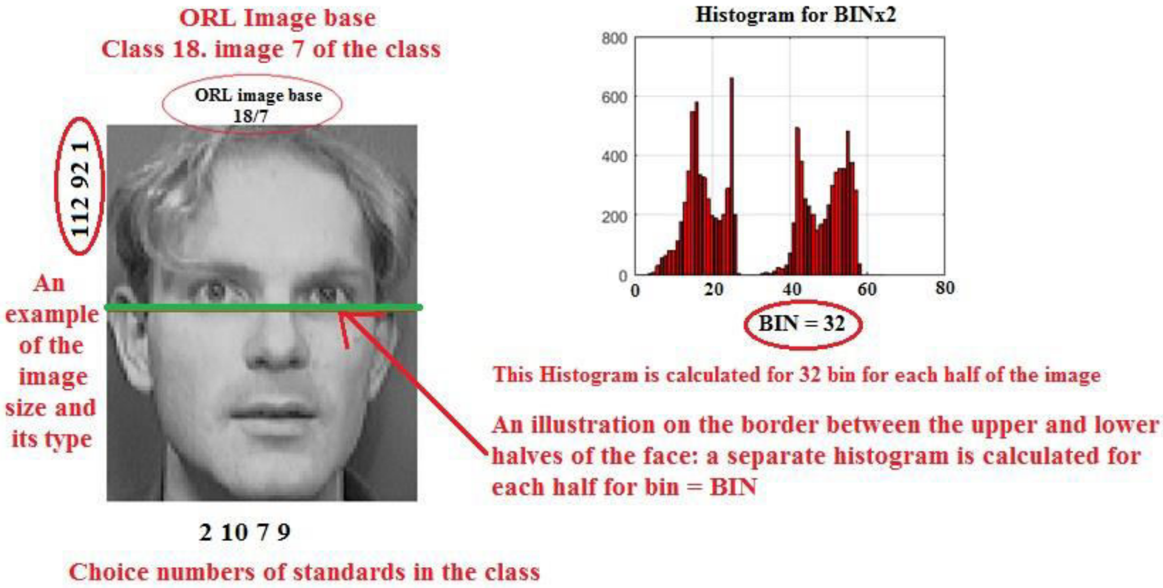



Figure 3 - Forms of two histograms of the upper and lower half of the face image

Testing for full and composite histograms showed the best quality of recognition. Table 2 shows the following data: the BIN value, recognition results for full and composite methods, the percentage improvement of recognition result using the method of calculating the histogram of the upper and lower half of the face image in relation to the recognition result of the forms of the complete histogram. The test was conducted with the ORL database for 40 classes, consisting of 10 images, which were divided randomly into 5 test and 5 reference images.

**Table 2. Comparison of recognition results for the full and composite histograms of attributes**

| **BIN** | **Recognition results, %** | | **Recognition improvement, %** |
|---|---|---|---|
| | **Full** | **Composite** | |
| 16 | 90 % | 96 % | 6 % |
| 32 | 91 % | 98 % | 7 % |
| 64 | 92 % | 97 % | 5 % |
| 128 | 92 % | 97 % | 5 % |
| 256 | 93 % | 97 % | 4 % |

Based on the improvement in recognition percentages presented in the third column of Table 2, the attribute extraction method based on the construction of composite histograms has better recognition quality indicators.

**Conclusion**

Histograms of the distribution of brightness levels are the transformation of an image into a multidimensional attribute vector, by means of which it is possible to compare images based on distance functions. We can say that the belonging of the vector of the test image to a specific class is determined by the fact that this vector is closer to the vectors of images of this class.

Thus, pixel brightness histogram forms are good attributes for comparing images, since they have resistance to small deformations, such as rotation and scaling of the image. The advantage of the method of recognition with the help of histograms is the simplicity of calculations. The disadvantage of the method: if two structurally or texturally identical images have different brightness, the image data forms will be different, since the histogram calculates the brightness distribution of pixels. Therefore, there are distortions of the cyclic shift and additional distortions at the boundaries of the histograms. This fact excludes the possibility of using this method in recognition processes in uncontrolled lighting conditions.

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УДК 004.3

## БЕСПРОВОДНАЯ СВЯЗЬ ПЛАТ ARDUINO ПОСРЕДСТВОМ МОДУЛЯ NRF24L01

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*Аннотация: В данной статье рассмотрена возможность беспроводного соединения двух и более плат Arduino посредством модуля NRF24L01. Соединенные, таким модулем платы Arduino, могут передавать друг другу данные. И, исходя из этого можно управлять платой Arduino при помощи другой платы Arduino на расстоянии.*

Наличие двух или нескольких плат Arduino, которые были бы в состоянии отправлять друг другу данные по беспроводной сети на расстоянии, открывает множество возможностей:

- Дистанционные датчики температуры, давления, аварийных сигналов и многое другое;
- Управление роботом и мониторинг на расстояния;
- Дистанционное управление и мониторинг соседних зданий;
- Автономные транспортные средства всех видов.

Рассмотрим подробнее Wi-Fi модуль NRF24L01, сам модуль показан на рисунке 1. Он использует полосу 2,4 ГГц и может работать со скоростью передачи данных от 250 кбит / с до 2 Мбит / с [1,с.2]. При использовании на открытом пространстве и с меньшей скоростью передачи его дальность может достигать около 700 метров.

# СОДЕРЖАНИЕ



**Секция 4. ФИЗИКО-МАТЕМАТИЧЕСКИЕ И ИНФОРМАЦИОННЫЕ НАУКИ**