INTELLECTUALIZATION OF THE PROCESS OF DIGITAL PROCESSING OF IMAGES CREATE AN ALGORITHM

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Abstract: Research in the field of creating an algorithm for intellectualizing the process of digital processing of images is directly related to the development of computer vision and artificial intelligence technologies. This paper focuses on machine learning, image recognition, segmentation, filtering, object detection, and image restoration to automate and make digital image processing more efficient.

Keywords: Digital Image Processing, Intelligent Algorithms, Machine Learning, Image Recognition, Image Segmentation, Image Filtering, Pixel Processing, Digital Signal Processing, GPU Computing.

Enter

Attention to the development of information and telecommunication technologies and science began to increase from the moment our country gained independence. According to the Law of the Republic of Uzbekistan "On Informatization" [1], the task of the state policy in the field of informatization is to regulate products, services and information technologies in the information market, to stimulate the production of software products, to train specialized personnel and it consisted of improving their quality and, of course, stimulating the requirements for scientific research.

In the decision of the President of the Republic of Uzbekistan "On measures for the wider introduction and development of modern information and communication technologies" [2] normative documents for the use of modern information technologies, the introduction of computer equipment and telecommunication tools to the economic and vital public was determined.

should organize the information technology and system, taking into account the current state of the computer technology development trend in the creation of the national information system .

Intellectualization of the process of digital processing of images by foreign scientists, including R. Agrawal, T. Imielinski, A. Swami, R. Srikant. A. Savasere, E. Omiecinski, and S. Navathe, JS Park, M.-S. Chen, and SY Philip, J. Hipp, U. Guntzer, and G. Nakaeizadeh . many results are given in their works.

Research methodology

Intellectualization of images in scientific work, theory of algorithms, use of methods of intellectualization of car license plate recognition process in image processing.

Analysis results

The technology of intelligent data analysis is called Data Mining (DM) and is widely used in practice. DM usually means two things, namely searching for the required data from a large database (MB) and meaningfully exploring a large amount of raw material.

Figure 1.1. Structure of the DM multi-research environment.

DM stands for intelligent data analysis, pattern discovery environment, knowledge extension, pattern analysis, knowledge information content determination from MB, etc.

DM is a multi-research environment built on the basis of applied statistics, pattern recognition, artificial intelligence, MB theory and other such disciplines.

DM is a decision-making process based on identifying hidden patterns (information patterns) from data.

The essence and purpose of this technology is designed to reveal objective and practical useful laws from large amounts of data.

Currently, DM is gaining more specific directions depending on the type of processed data:

- TEXT MINING (KDT - Knowledge Discovering in Text - in the text knowledge q and determination) ;
- WEB MINING (Web Content Mining and Web Usage Mining) ;
- VISUAL MINING ;
- CALL MINING ;
- AUDIO MINING ;
- IMAGE MINING ;
- MINING VIDEO ;
- CLOUD MINING ;
- GENESIS MINING .

Image Mining is the process of searching and identifying valuable information and knowledge in large volumes of data. Describes the basic principles in Image Mining database, machine learning, statistics, image recognition and soft computing concepts. Intelligent data analysis methods allow more efficient use of Earth observation data bank. The increasing volume of data is leading to new promising applications of surface research in the field of Earth science. For example, the use of ultra-high-resolution satellite images makes it possible to observe even small objects, when a large number of ultra-high-resolution images are processed. The development of this field leads to the creation of sensational innovations in the set of approaches, methods and algorithms that are researched and used in practical problems where the source is a video signal or a static image.

As a rule, such a resource is used in an automated intelligent system, and it is analyzed by obtaining informative symbols.

Intellectualization of image processing, i.e. creating an automated system of processing, the following issues should be resolved:

a) choosing methods of solving the problem;

b) giving recommendations on choosing a method of solutions for a class of problems related to the given problem;

v) synthesis of the algorithmic procedure for solving the given problem;

g) Develop and present synthesis guidelines.

The image is two-dimensional $f(x, y)$ can be viewed as a function, where x and u *are* the spatial coordinates h , and amplitude f *is the intensity for* each pair of (x, u) coordinates, or the light falling on each point h .

The result of signal discretization and quantization is always in the form of a matrix (Fig. 1.2) . Let's say $f(x, u)$ image after the discretization process is represented as a matrix, and this matrix has M rows and N columns. In this case, the image is said to have width M x N. (x, u) coordinate values h always have a discrete value.

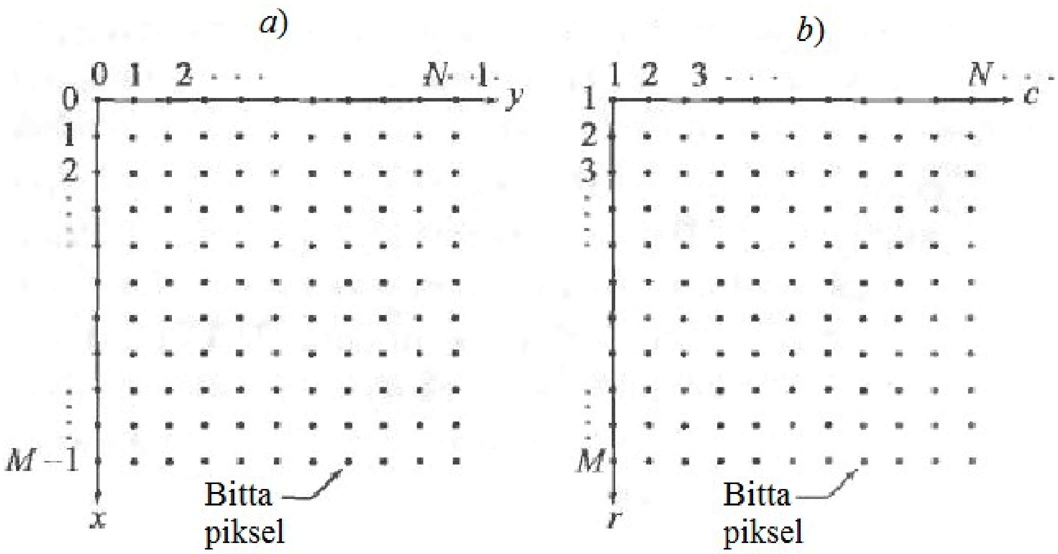

Figure 1.2. Alignment of coordinates: *a*) standard coordinate system; *b*) coordinate alignment in MATLAB system.

The coordinate system in this figure makes the digital image function look like this:

$$f(x,y) = \begin{bmatrix} f(0,0) & f(0,1) & \cdots & f(0,N-1) \\ f(1,0) & f(1,1) & \cdots & f(1,N-1) \\ \vdots & \vdots & & \vdots \\ f(M-1,0) & f(M-1,1) & \cdots & f(M-1,N-1) \end{bmatrix}$$

$$\mathbf{f} = \begin{bmatrix} f(1,1) & f(1,2) & \cdots & f(1,N) \\ f(2,1) & f(2,2) & \cdots & f(2,N) \\ \vdots & \vdots & & \vdots \\ f(M,1) & f(M,2) & \cdots & f(M,N) \end{bmatrix}$$

So, the general view of each pixel is as follows

$$f(m,n) \tag{1.1}$$

is , where $n=1, 2, \ldots, N$ and $m=1, 2, \ldots, M$. This function is a pixel color function, and each pixel color that stores the image has a color value that is a mixture of three "colors" (for example, the RGB model of coloring, Red-red, Green-green, Blue-blue). The number of possible colors is 256*3=16777216. Changing the value of each dye produces a different color. This mode allows you to store, process and transmit an image that does not fall short of the colors observed in living nature. If 3 bytes are required to encode the color of a dot, then byte 1 represents red, byte 2 represents green, and byte 3 represents blue. The larger the byte value of the color set, the more accurate and clear this color will be. In grayscale images, the color at a point is called the pixel brightness or color gradient, and since it is between 0 and 255, the operations performed on it are simplified and the number of colors in the image is reduced by a factor of 2 16 .

All images can be written as $F_{N\times M}$ or F_N (for *the N*=*M* case). In this case, the subscript (expression) in the matrix definition always determines its order (or $N \neq M$ dimension for the case).

Each matrix representing RT is transposed, and operations such as rotation, complex addition, exponentiation, and xk operations can be applied. They can be written in the form of notations accepted for these operations. For example:

$$[F_N]^T,\ [F_N]^{-1},\ [F_N]^{¿},\ [F_N]^k . \qquad (1.2)$$

The following notations are used to denote zero and unit matrices of order N :

$$[0]_N \ and \ I_N,\ when \ [0]_1=0 \ and \ I_1=1 . \qquad (1.3)$$

In addition to simple (Cartesian) matrix multiplication, two types of matrix multiplication are used in the RT processing and detection procedures analyzed below: direct and pointwise.

A_N and B_M the correct (Kronekerov) multiplication for matrices is written as:

$$A_N \otimes B_M = C_{(NM)}, \qquad (1.4)$$

where $C_{(NM)}$ the matrix NM has order.

Proper multiplication of matrices can be right and left. In the right multiplication of two matrices, the result is formed by blocks in such a way that instead of each element of the left matrix, the result of multiplying this element by all the elements of the right matrix is written. $C_{(NM)}$ - the resulting matrix will have the following form.

$$C_{(NM)} = \begin{bmatrix} a_{11} B_M & . & . & a_{1N} B_M \\ . & . & . & . \\ . & . & . & . \\ a_{N1} B_M & . & . & a_{NN} B_M \end{bmatrix}. \qquad (1.5)$$

A_N and B_N the dot product of matrices is written as

$$A_N \Theta B_N = C_N, \qquad (1.6)$$

In this N the ordered C_N matrix is defined as:

$$C_N = \begin{bmatrix} a_{11}b_{11} & . & . & a_{1N}b_{1N} \\ . & . & . & . \\ . & . & . & . \\ a_{N1}b_{N1} & . & . & a_{NN}b_{NN} \end{bmatrix}. \quad (1.7)$$

Adding two images is written in the following form:

$$A_{NM} = P_{NM} + D_{NM} \text{ or } A_N = P_N + D_N \text{, if } N = M. \quad (1.8)$$

When combining several identical images, for example, the use of the "coherent stacking" procedure of different images greatly improves the quality of the resulting image.

The subtraction of two RTs is written in the following form:

$$A_{(NM)} = X_{(NM)} - Y_{(NM)} \text{ or } A_N = X_N - Y_N \text{, if } N = M. \quad (1.9)$$

(1.9) is often used in the implementation of the "unsharp masking" procedure, which allows to prepare a clear contour image of the objects included in the given image.

Dot reproduction of a color image is carried out as follows:

$$Y_N = X_N \Theta X_N \Theta \ldots \Theta X_N, \quad (1.10)$$

This is usually used to improve the quality of images.

When performing operations (1.8) - (1.10), it is necessary to monitor the value (brightness) of pixels, the values of which must be in the given range of the corresponding color model.

Image segmentation is a matter of extracting objects that differ in terms of light, geometric and other properties, as well as in essence. One of the important tasks of segmentation is to discard information that is not used in the next stages of image processing.

There are several mathematical expressions of the problem, the generality of which is given by the homogeneity predicate. If *f(x,y)* is a dividing function; *x* is a finite subset of its domain; $S=\{S_1, S_2, \ldots, S_k)$ – dividing *x* into *K* non-empty connected subsets; P *n is defined in the set* S and only if two points of any subset $S_i : i$

$\in[0,K]$ satisfy a certain homogeneity criterion If *I("true-TRUE")* is a predicate, then image segmentation means dividing it into $S^*=\{S_1^*, S_2^*, ..., S_k^*\}$ parts.

The following:

1) $KS_i^*=x$; 2) $S_i \cap S_j^*=0, \ \forall i=j$;

3) $\forall S_i^*$ - interconnected area;

4) $P(Si^*)=True$, $\forall i$;

5) $P_n(S_i^* \cup S_j^*)=false, \ \forall i=j$;

P_n satisfying the conditions is called a homogeneity predicate, and whether it accepts the values "true" or "false" depends on the properties of the function *f(x,y)* .

The 1st condition is that each point belongs to a sphere, the 2nd condition is that *the spheres* do not intersect, the 3rd condition is that the points of the sphere are interconnected, the 4th condition is the properties that the points of the separated segments must satisfy, the 5th condition the condition indicates that the predicate P_n is different for the points S_i^* and S_j^*. Here it is assumed that the partitioning S^* *is unique.* P_n predicate as follows

$$P_n(S_i^{¿}) = ¿\{true,\ агар\ f(x,y)=...=f(x_m,y_m) ¿¿¿¿$$

in appearance; where $(x_m, y_m) \in S_i^*$, $m=1,2,...,M$, M - the number of points in S_i^*; or

$$P_n(S_i^{¿}) = ¿\{true,\ агар\ |f(x_m,y_m)-f(x_i,y_i)|<T, ¿¿¿¿$$

where $(x_m, y_m), (x_i, y_i)$ are arbitrary points of S_i^*, *the value of the threshold given before* T can be determined in the form.

So the following is the breakdown

$f(x,y) \rightarrow S(x,y)$, $S(x,y)=\lambda_i$, $(x,y) \in S_i^*$, $i=1,2,...,K$; where *f(x,y)* is the source and *S(x,y)* is the output image, $\lambda$and $_I$ can be considered as an operator in the form of field symbol of *L*.

P_n depends on the relationship established between the elements (points, set of points) and called the homogeneity criterion. $Pn(x_1, x_2)=true$; $(P_n(x_1, x_2)=false)$ expression means that the relationship of homogeneity between the elements x_1 and x_2 is not established, that is, the criterion of homogeneity is satisfied or not satisfied. Color, light, gradient histogram and other features of the image are usually used as such criteria.

Conclusions and suggestions

In this article, the process of recognizing registered car numbers through video images is studied, and the process of recognizing car numbers is intellectualized. As a result of intellectualization of the process of recognizing car number plates, the following practical issues were solved :

- General issues of image processing and analysis were considered ;
- MATLAB system and Image Processing Toolbox package were studied ;
- The possibility of basic functions of digital processing of images was considered ;
- Image quality assessment and filtering process were analyzed ;
- The process of determining the quality indicator of digital images according to the rating scale and its mathematical algorithm were analyzed;
- Mathematical basis of filtering algorithms in the process of determining the image quality indicator;
- A car number was taken as an image object, and this number was determined using various functions of the Matlab system to determine the quality indicator of the image on the rating scale;
- Algorithms of image segmentation, contour detection, smoothing and filters were analyzed in the Matlab system;

A decision-making intellectual tree was built to determine car mobile numbers and intellectualization was organized in the Matlab environment;

- All steps to organize the process of intellectualization of the license plate recognition process have been covered.

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