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Minimization of Visual Information

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One of the important issues in the problem of automatic recognition of visual images is the question of reducing the amount of input information into the CM (Computing Machine) of the initial information (the number of image discretization elements). The degree of discretization of pictorial (multi-gradation) image of objects for normal operation of recognition algorithms can be hundreds of thousands of discretization elements. Such a volume of data, even after their compression during encoding, is difficult to insert into the operative memory of modern computers. When using the same long-term memory of the machine dramatically increases the time of the task. Therefore, not all information about objects should be entered into the memory of the machine, but only its most informative part.

When recognizing visual images, most often these are the coordinates and brightness of the points of the contour lines of the images of objects. Therefore, from all points read from an image (for example, when processing a television, photographic or other image), it is necessary to exclude points of the background, as well as points that are located within simply connected geometric contours and have the same brightness. Such image processing is called *minimization of the initial information.* Minimization of the initial information can be *hardware* or *algorithmic*. Devices that perform *hardware* and *algorithmic* minimization can be constructed according to various principles.

Hardware minimization. A device that implements this minimization method works on the principle of comparing the brightness of image points obtained, for example, on the screen of a cathode-ray tube, with the level of the video signal from the background of the image. The device allows you to enter information into the CM in the address and addressless modes. In *the address input mode*, the *i* elements of the object image discretization is represented as a point with coordinates x_i, y_i, B_i; in the case of the unaddressed input mode, only the brightness code B_i is assigned to the sampling element *i* (the formation of the coordinates of the image points is done in a program way). We show that in order to save CM memory in the system of reading and entering information into the machine, it is advisable to have both modes of operation.

In fact, in the unaddressed mode, entering the number of binary digits of a machine to place polar observations in it (for example, a television raster) is $N_b = qN_\text{p}$, where $q = Ent * (\log_2 t) + 1$ is the number of binary differences for encoding brightness element of the discretization (t is the number of gradations of the brightness of the image of the object); N_p is the number of raster discretization elements (field of observation).

In accordance with the address mode of memory input, the number of binary digits is $N_a = \xi N_a I = \xi N_p(q + n_x + n_y)$, where $\xi = S_o/S_p$ is the fill factor of the field of observations; S_o is the area of the image of the object; S_p is raster area; / is the number of binary digits required to record one element of discretization; $n_\text{x} = Ent\ (\log_2 p)\ +\ 1$ is the number of binary orders needed to encode the coordinates of the discretization elements (p is the number of elements of the image decomposition in a row); $n_\text{y} =\ Ent\ (\log_2 d) + 1$ is the number of binary digits required to encode

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coordinates in the *y* discretization elements (*d* is the number of lines of the image decomposition in the raster) [1].

When comparing the memory volumes with the address and unaddressed information input modes, it can be seen that if $N_a = N_б$, then ξ= $\xi_{cr} = 0.15$ (ξ_{cr} is the critical value of the fill factor); if $\xi > \xi_{cr}$, then it is more profitable to use the addressless mode of entering information, if $\xi < \xi_{cr}$, then the addressable mode of entering information is advantageous; if $\xi = \xi_{cr}$, both modes of information input are equivalent in terms of the required amount of memory (figure 1).

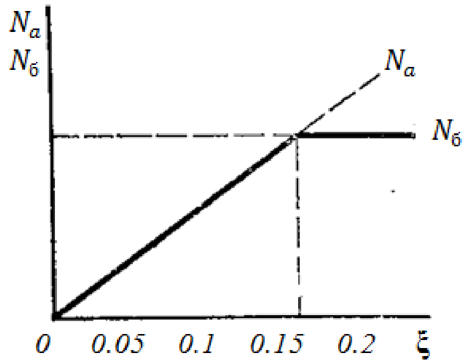

Figure 1. The graph of the dependence of the memory capacity of the device from filling $N = f(\xi)$.

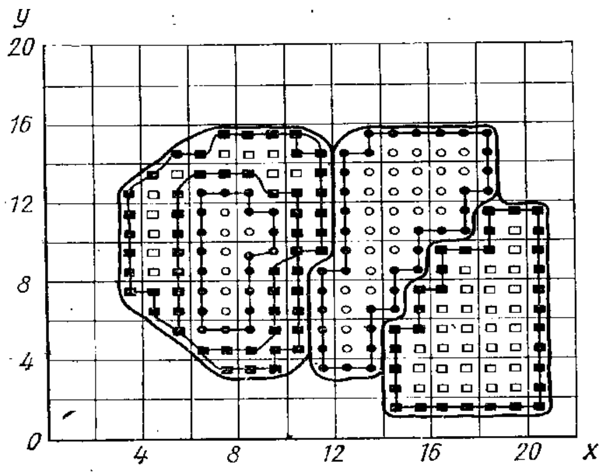

Figure 2. Discretized image of the coefficient object

In this case, however, you should prefer the address input mode, since with it the information (entered into the machine can be immediately used for subsequent transformations of the coordinates of the image points, while in the non-address input mode, their coordinates still need to be programmed The input system should automatically select one or another mode of operation.

Algorithmic minimization. The CM implements this method of image minimization. With this software by eliminating all internal points of simply connected contours that make up the image of the object. As a result, only points remain (in this case, a pair of contour points for each element of the discretization), which refer to contour lines [2].

Let, as the initial information there is a pictorial image representing a multiply connected contour consisting of four simply connected geometrical contours. Elements of discretization of contours are presented in figure 2 (where light circles and small squares are elements of discretized contours, dark circles and small squares are elements of contour lines selected at the preparation stage or after

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the image minimization stage). The field of observation is conventionally divided into the rows and columns. At the intersection of the j rows and the i columns there is a sampling element with a brightness of B_{ij}. To determine whether it belongs to the contour line or not, a comparison of its brightness with the brightness of adjacent elements of a discrete raster is carried out. The condition that the raster element belongs to the contour line is the following inequality:

$$G = |B_{i-1,j} - B_{ij}| + |B_{i,j-1} - B_{ij}| + |B_{i,j+1} - B_{ij}| + |B_{i+1,j} - B_{ij}| > 0$$

with $B_{ij} \neq B_f$, where B_f is the brightness code of the background element.

If $G = 0$, then this means that the element B_{ij} does not lie on the boundary of a simply connected domain (white squares and circles).

For the convenience of the subsequent operation of the recognition algorithm, often, as is done in this case, each point of the inner contour line is associated with two adjacent points along the line with their luminance. The coordinates of these points may differ from each other by one raster discretization element. The result of this minimization algorithm is arrays of points of contour lines.

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