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PROCEEDINGS

INTERNATIONAL CONFERENCE ON:

IMAGE ANALYSIS AND PROCESSING

October 22 - 24, 1980 PAVIA

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AN APPLICATION OF C.MATRIX.

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In this work we present some application of C-Matrix, as the output of C-Transform, that we have just introduced in our previous works. Using some features extracted by C-Matrix method we propose two algorithms contour extraction and segmentation.

1. INTRODUCTION

What is Picture processing? In a broad sense, we intend the manipulation of multidimensional signals for istance biological images, radiographies, air images or from satellite etc.
The purpose of processing these multidimensional signal is manifold, however, also in rough way, we can see up them, in the following four classes, enhancement, pattern recognition, efficient coding and computer graphics.
We mean with the term Pattern Recognition the detection and the extraction of models from signals.
We think that the use of a good transform of signals can be essential in different phases: digitalization, pre-elaboration, elaboration of the Pattern Recognition.
In this work we intend to show only some applications of a transform of signals, proposed from us in the last years.

2. C-MATRIX

In order to show clearer what we are going to explain in the next paragraphs we can sum up the principals caracteristics of the C-Matrix.
We can send the interested reader back to our precedents works, where we have represented in detail the C-Matrix and thecriterious suitable for extracting from its the different caracteristics of the signals. (1,2,3)
Let L be a mono or two-dimensional discrete signal and D be its range. Let's make a partition of D by a subset S whose dimensions are less or equal than D's. For each element of this partition let's compute the absolute minimum and maximum that the signal exhibits within the element itself.
Let C be a matrix in which the rows indicate the dimensions of the set related to a partition and the columns of which indicate the "dynamics" of the signal.
Let's define dynamics of the signal the difference between the absolute maximum and minimum that the signal exhibits within a certain subset.
Each element of this matrix indicates the frequency, for a given dimension of the partition (row), with which the signal exhibited a certain dynamics, order of the column.
The C-Matrix is nothing but a transform of signals from which we may extract some features of the examined signal.
Some carecteristics of the signals that we can extract from the C-Matrix they are: the increment front, the decrement front, period, amplitude.
It is in a phase of progressed realization a different rappresentation of the C-Matrix and of its anti-transform.
We have already applied the C-Matrix to the purpose to classified artificial,natural texture and biomedical specimen (human chromosomes) recostruction of mono or two dimensional signals.
We show in this work other two applications of the C-Matrix, the extraction of the contour and an algorithm of segmantation.

3. EXTRACTION OF THE CONTOUR

Contours form where there are sudden changes in some gradient, color, shadow, parallel lines seen in perspective, or texture. A contour is the one-dimensional interface between figure and ground.
The extraction of the contour is an important stage of the perception or human or realized from a machine and in literature exists a lot of considerable works on the extraction of the contour from images.
Roberts (5) extract the contour computing a diagonal approximation in the local gradient and thresholding the result. The resulting edge images often produces good representation of the edge information; however, steps for thinning wide edges or connecting broken edges are often required.

Another method may be called a correlation or template matching approach, since an edge template is matched to the image and the resulting correlation value is thresholden.
The region approach is based on the fact that two adjacent regions of different properties define an edge at the adjacent boundary.
The method involves two steps-region segmantation and boundary location.
The resulting edges will be thinned, connected and closed. (7)
In this work we propose a metod for the extraction of the contour that use the information contained in the C-Matrix.
The first place of the algorithm that we propose, . it consists in the extraction of the C-Matrix from input Matrix.
We build as second step, a graphic in which on the axis of the abscissae we report the dimensions of the window -rows of the C-Matrix, and on the axis of the ordinate we report the frequency. In this space U_2 we get so many curves as are the dynamics columns, of the C-Matrix.
The curves showed in U_2 have a different development in fact some will be rising, others descending, and only some will have a development rising or descending, that means they will show a maximum.
It exists a wright technique reason on the development of every curve showed in the space U_2.
We report, for example, the graphic of image of fig.1.
From the graphic as built we determine two parameters:
a) the first curve that show a maximum, we suppose relative to the dynamics d_i;
b) the abscissa relative to this maximum, we suppose that is w_i.
The third and last step of our algorithm it consists to apply the C-Filter, from us proposed to you in one of ours precedent works, with further condition that for every windows is valid the relation:

$$M - m \leqslant d_i$$

where M,m are respectively the maximum and the minimum that the signal show for every position of the window.
We report in fig.2 the extraction of the contour of the sub-patterns for texture and in fig.3 the application of our method to a biological specimen.

4. SEGMENTATION

A stage between the most important in scene analysis is the separation of the objects

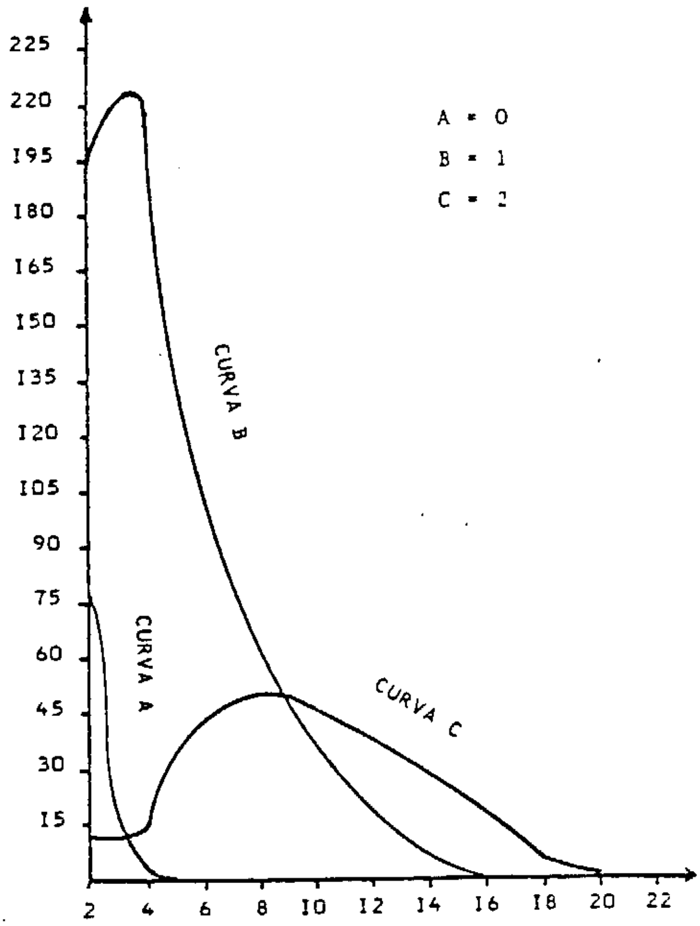


fig. 1

between them and from the ground. This phase allow us not only to perceived the patterns once a time, but also to work with matrix rather small.
The segmentation consists essentially to subdivide an image in regions that they have a certain uniformity, or better its elements to satisfy a predicate of uniformity.
There is not a strict definition of the predicate of uniformity and in the existent literature we can find some of them.
In fact for some scene is enaugh in a simple algorithm based on operations of thr shold on the choice of grey levels, while for others is not en.ugh a solution purely analytic and you can recourse to contextual informations (of texture) or syntatics or in situations particularly difficult., you can get a segmentation directed from the interpretation.
The algorithm from us proposed to you use a predicate of uniformity on submatrices that assume "true value" if the difference between

fig. 2

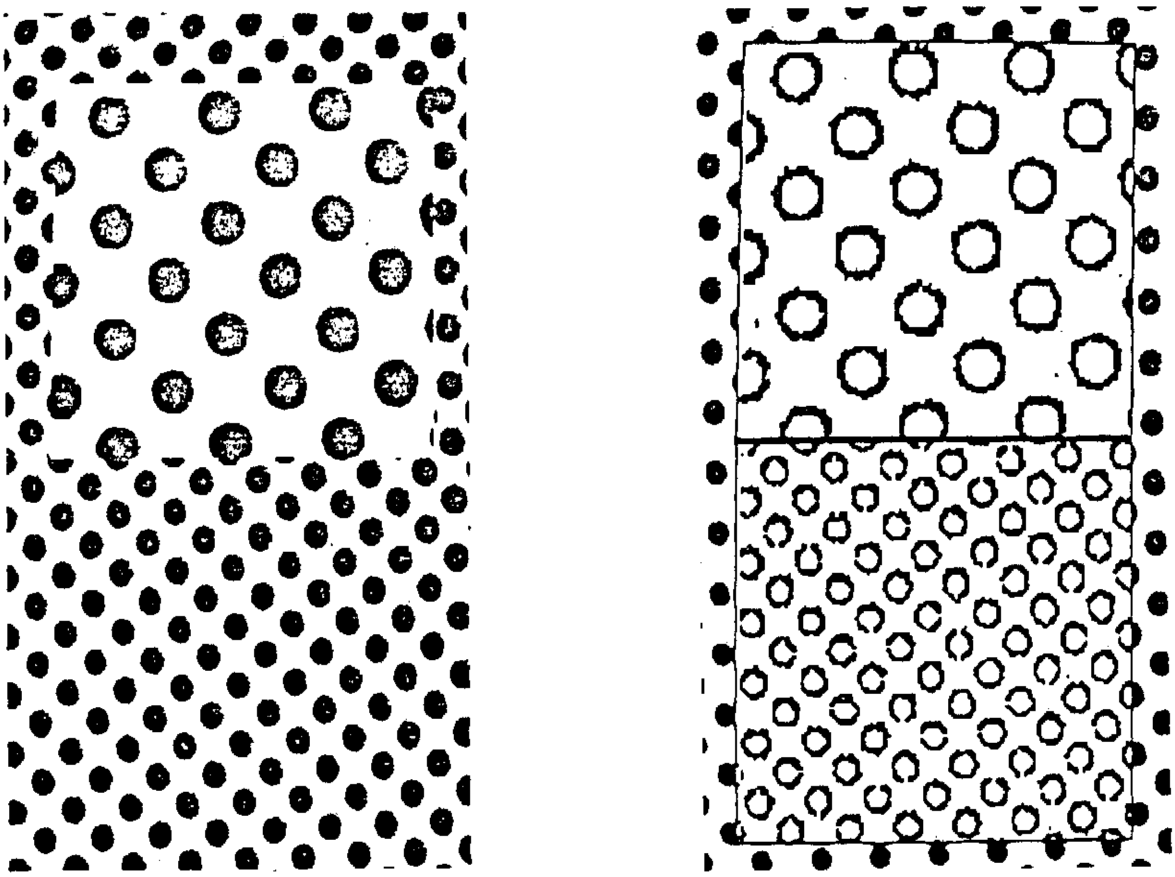
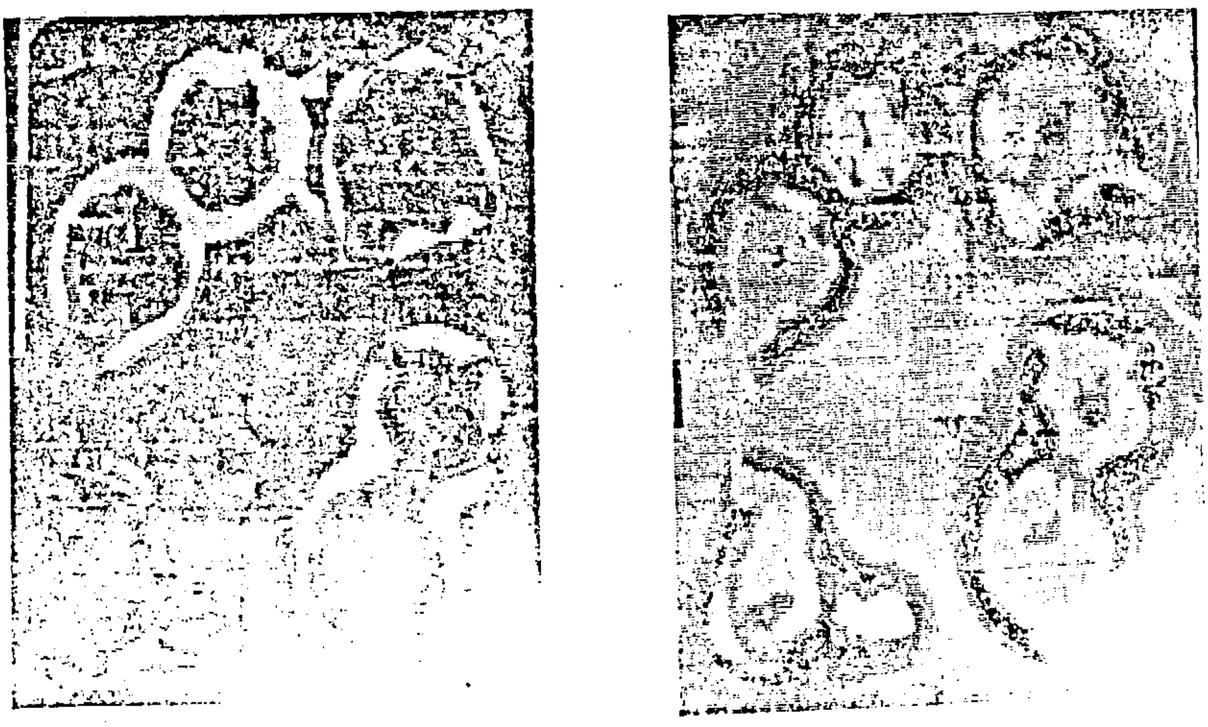


fig. 3

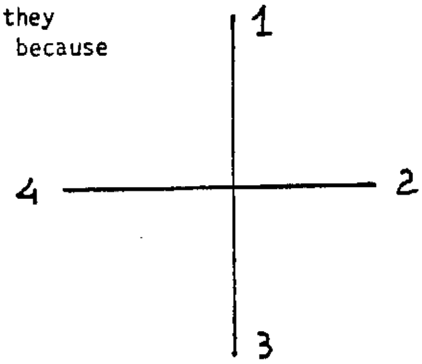


maximum and minimum in such submatrix exceed a certain threshold fixed, "wrong value" in the other way.
The dimensions of the submatrices to use for the scantion, they have in this type of algorithm, a role very important many times we can recourse to criterious of choice built on the experience or empirical methods.
In fact to cut out an object from the ground or from other objects near, we cannot effect a scantion with submatrix of very big dimensions, from the other way the use of a submatrix very small will involve a big waste of time and it could not see these differences between maximum and minimum, that concern us all.
We think about a good segmentation depends from the choice of two dependent parameters: difference between maximum and minimum and from dimensions of the submatrix of scantion.
We determine the value of the two parameters of the C-Matrix with the same criterious showed in the previous paragraph.
To express quickly our method we execute a scantion of the image with a matrix four or five times bigger than that choiced from the C-Matrix, and to every step we prove the predicate of uniformity, if on its the predicate of uniformity assume "wrong value" we go on to examine the submatrix contiguous otherwise we pause on the submatrix in examination and we execute a second scantion with a submatrix that have the dimensions of that selected from the C-Matrix.
Also for this second scantion we verify the predicate of uniformity and when it assume the true value we memorize the coordinates and we consider the submatrices to its contiguous in the directions under indicated.
It is easy to show that the four directions indicated consider all the sub-windows contiguous that form an object and that they show the minimum number of directions because that can be possible.

We go on this way untill we do not find, any more, others submatrices contiguous that they verify the predicate of uniformity.
We repeat then the procedure until is not finished the scantion of input matrix.
In fig.4 we report the artificial image and the got results applying our algorithm.
We have applied our algorithm to biological images, humans cromosomes and the input matrices was formed from a matrix 512x512 a 64 grey levels.
In fig.5 we report a piece of the input matrix and the output after having applied our algorithm.
A comparison between the method from us proposed to you and others existents in literature (8,9,10) allow us to formulate the following considerations:
i) the choice of the threshold is not done "ad hoc" but it is determinated from the C-Matrix
ii) the time of calculus asked from our algorithm is inferior to that necessary for the algorithm of the type RAG,LAG,PT.

5. CONCLUSIONS

The features that we are able to extract from the C-Matrix they have allowed us to formulate the algorithms for the determination of the contour and for the segmentation that, like we tink they show the caracteristics:
i) easy implementation on the computer
ii) choice of the threshold and of the dimensions of the windows automatically and not "ad hoc" or with empirical methods.
Experiments presented here confirmed proprerties of C-Matrix in a two dimensional case and it showed also the possibilities of applications of C-Filtering in texture classification and discrimination.



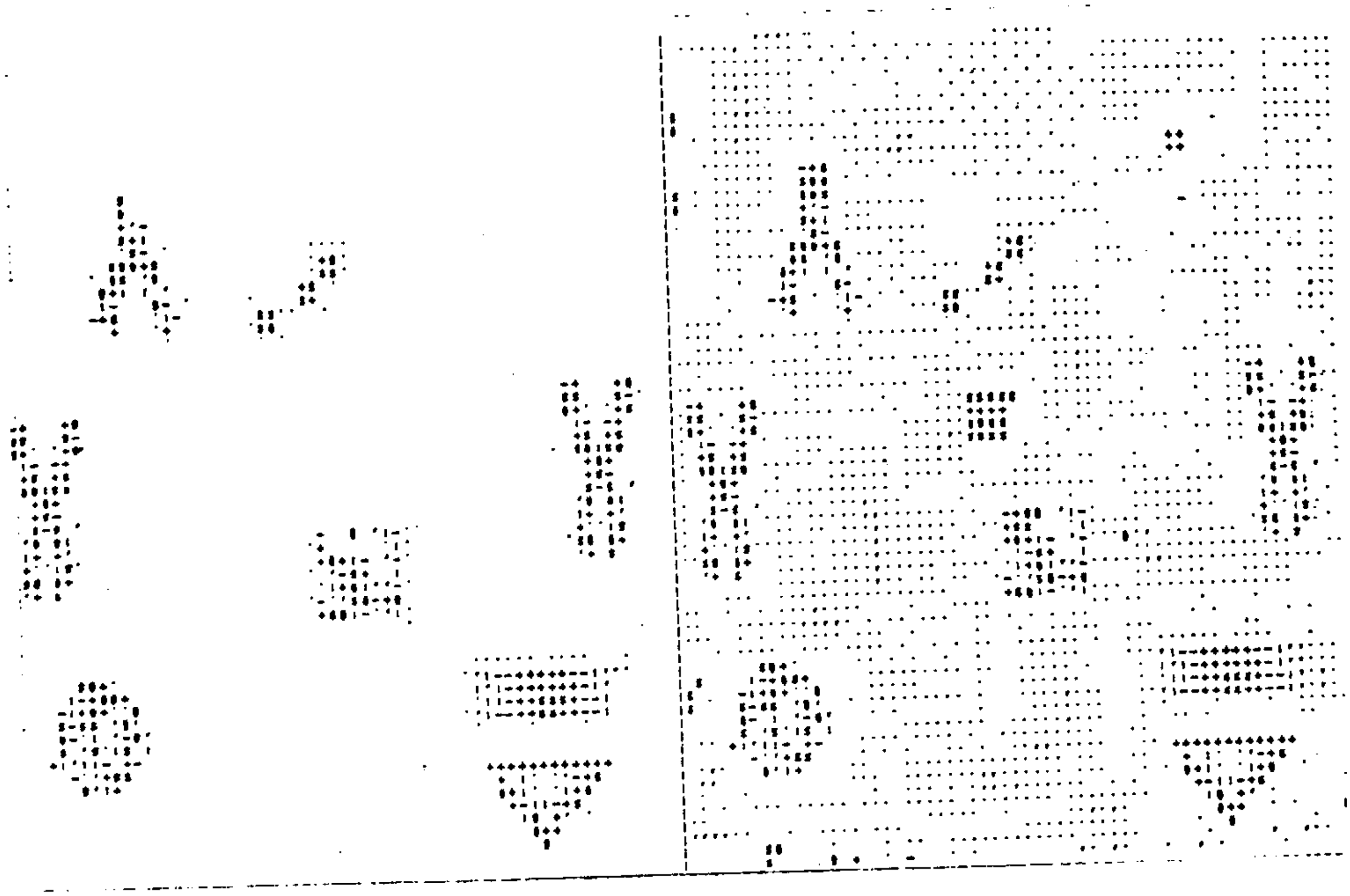


fig. 4

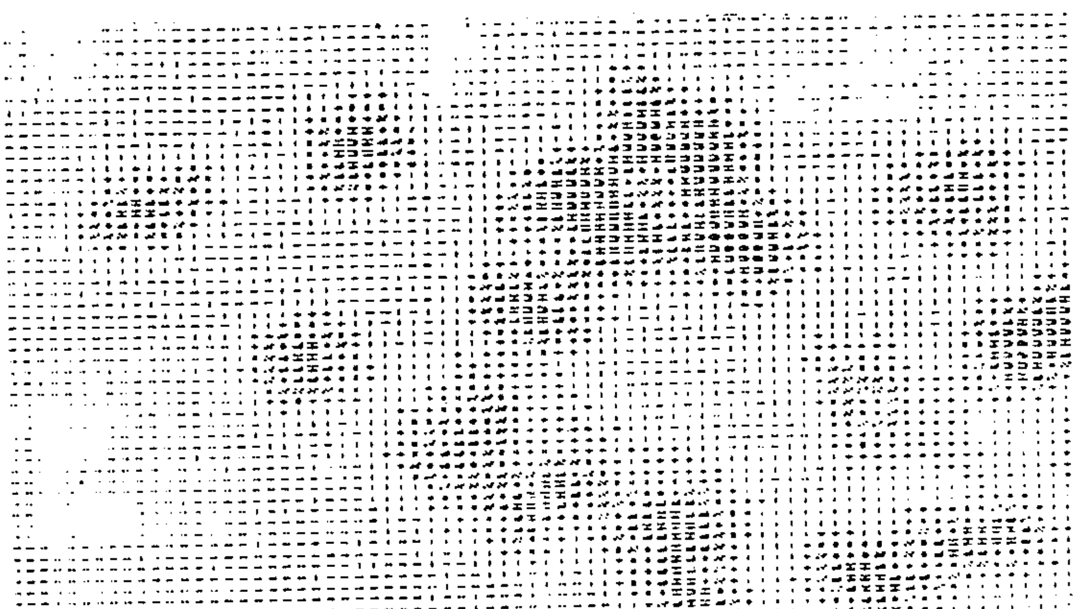


fig. 5

fig. 5

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