AN IMAGE TRANSFORM USING "C-MATRIX"

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ABSTRACT

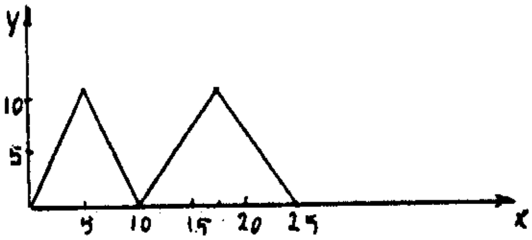
In the paper some results of investigation two dimensional transform, C-matrix and filtering of textures are presented. We present also some results of the application of C-matrix to a segmentation technique.

C-MATRIX

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 S be ordered set of the element of a partition, thus S is a string of quadruples whose first two elements single out the element of the partition over the signal range, and the second pair indicates the absolute minimum and maximum of the signal within the element itself. In other words S is nothing but a possible description of our signal and this one is as rougher as larger are the dimensions of the element of partitions.
Let C be a matrix in which the row 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.
In the successive sections we'll illustrate the rules for extroting the features of a signal from C-matrix.

FEATURE EXTRACTION FROM THE C-MATRIX

The increment front of the signal is represented in the C-matrix by a set of points, say S_1, that we determine by the following rules: for each row of the C-matrix we consider the element $c_{h,k} \in C$ so that $c_{h,k} > 0$ and K=max.
The decrement front of the signal is represented in the C-matrix by a set of points that we'll call S_2; the element $s_2 \in S$ are extracted from C-matrix by the following rule: for each row of the C-m we consider the element $c_{h,k} \in C$ such that $c_{h,k} > 0$ and K=max and $S_1 \neq S_2$.
The constant zone of the signal is represented in the C-m by a set of points that we'll call P; the elements $p_j \in P$ are extracted from C-m by the following rule: let $p_j = c_{h,k} \in C$, to which a zero dynamics corresponds, the element $c_{h,k} > 0$.
The last element of the ordered set P provides us the dimension of the constant zone of the signal.
If the increment and the decrement fronts of the signal are equals we may extract from the C-m a set of points that we'll call D; the element $d_j \in D$ are extracted from C-m by the rule: let $d_j = c_{h,k} \in C$, let's consider for each column K of C-m the elements $c_{h,k} : c_{h,k} > 0$ and h=max.
Other features of the signal can be easily extracted from the C-m and in the following we'll give a example of it.



0	1	2	3	4	5	6	7	8	9	10	11	12
1												
2		72	47									
3		10	13	60		35						
4				23		71			23			
5				10		36		36	23			11
6						23		23	23	24		22
7						10		23	13	23		45
8								20	3	23		67
9								10		23		79
10										20		91
11										10		100
12												100

Fig. 1

SOME APPLICATION OF C-MATRIX

a) TEXTURE ANALYSIS

Texture is a term for the outlook of a surface. It is one of the essential characteristic features of ojects. Texture is considered here as having approximately a regular spatial disposal of its elements, which are roughly the same and moreover most of them are included in the visual field too.

In this paper we propose to use the shape of the piece and spatial frequency of it in the visual field in order to classify texture.

As we have shown in the earlier paragraph we are able to extract from the C-m many features of the signal, for instance: shape, amplitude, simmetry, period, etc.

It should be particulary interesting to note that we make the scantion of the visual field area by area than, our method, is not related to the directions of scantion but it depends only on the shape of pieces and spatial frequency.

For instance we consider the artificial texture in fig.2 from its C-m is possible to extract the shape of the piece, the amplitude and the period. Moreover if we change, in artificial way, the spatial frequency of pieces in the visual field we obtain a new texture and a different C-m, see fig.3. Let's compare now the C-m of fig. 2,3 it is possible to observe that the shape and the amplitude of the pieces are absolutely the same but the period increase changes as well as the spatial frequencies do.

In our previous work we just introduce the C-filter that is able to discriminate signals which differs in frequency or having different amplitude causes in a natural way that C-filter is used for extracting areas covered by a specified texture. By an appropriate selection of the size of a window it is possible to obtain by C-filtration only areas covered by this texture. Ability of extracting object from textured background by C-filtering is illustrated in fig.4. Average greyness of this pencil and the texture is nearly the same.

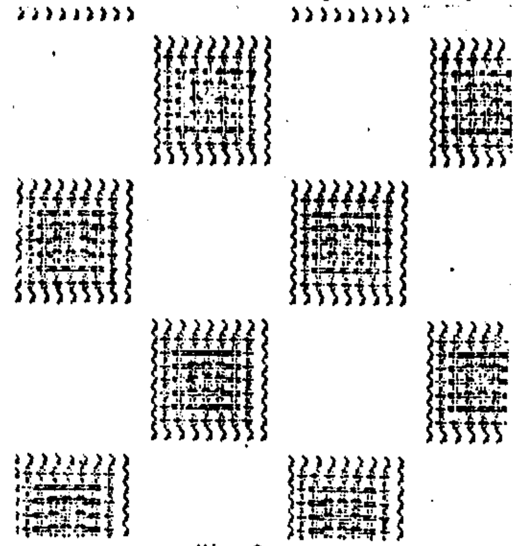


Fig.2

	0	1	2	3	4	5	6	7	8
2	3420		3600						
3	2628		1452		2773				
4	1788		1536		1299		2063		
5	900		1656		1301		1311		1457
6	444		1296		1357		1277		1323
7			876		1485		1279		1289
8			432		1127		1353		1255
9					781		1391		1257
10					350		1100		1265
11							690		1359
12							340		1605
13									670

	0	1	2	3	4	5	6	7	8
2			3600						
3			708		2773				
4					1299		2063		
5					581		1311		1357
6							1164		1323
7							561		1188
8									1124

fig.3

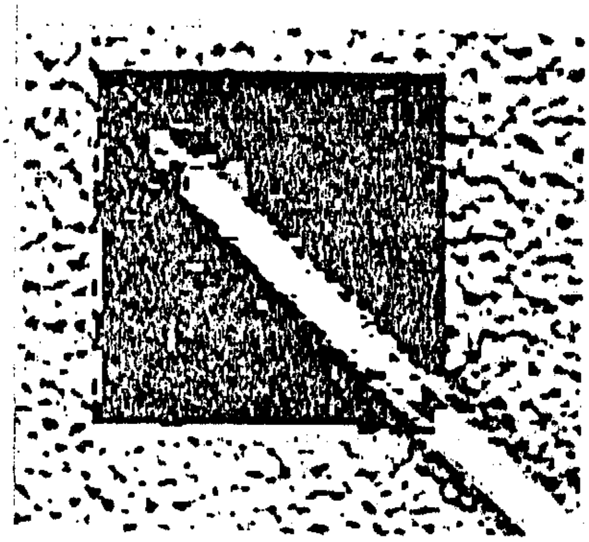


Fig.4

b) SEGMENTATION

The method that we propose consits in a predicated of uniformity on the windows, that it assume "true" value if the dynami cs of the signal on the windows exceed a certain threshold "wrong" value on the other way.

The dynamics we retain more interesting is that relative to the contours of the objects.

In fact we consider such dynamics as thre shold for our method, to choise this dyna mics we use the C-transform.

For this reason we represent the C-m in a space V where on the x-axis we report the dimension of the windows and on that of the y-axis the frequency. On this space we will so many curves as are the dynamics showed from the signal in examination. Between these only some of them have a ma xime, while the others have a trend growi ng or decreasing.

We choise as threshold the value of the first curve that show a maximum. The x of the maximum show the dimensions of the wi ndow on which to execute the scantion.

We execute a horizontal scantion with con tiguous positions of the window as long as we dont prove the predicate of uniformity. When this is proved we execute a scantion from that point, on the four directions. It is easy to show that the four directi- ons we talk about allow us to consider all the submatrices contiguous that makes an object and that they show the minimum num ber of directions because that will be possible. The algorithm allow us to selec' the object from the ground to know their positions in the matrix, and the number of the objects we found in the matrix. As example we report a digitized matrix 512x512 to 64 grey level from which throught an algorithm, showed in an othe work, we have extract a mithoses fig.5. In fig.6 we report the graphic of the C-m and in fig.7 the final result.

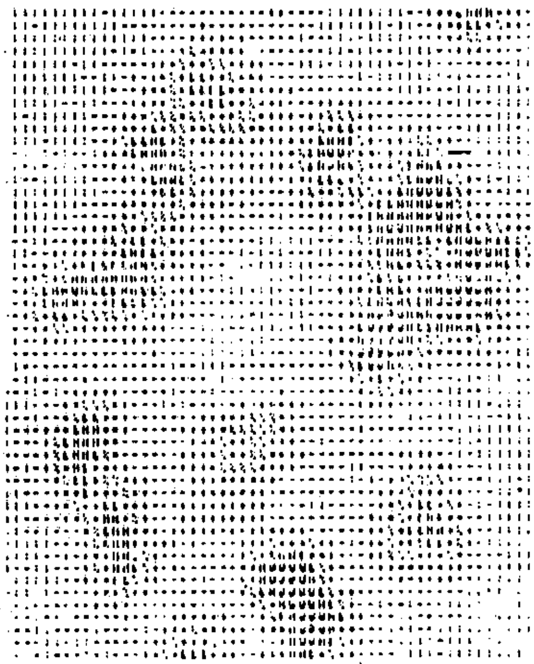


fig 5

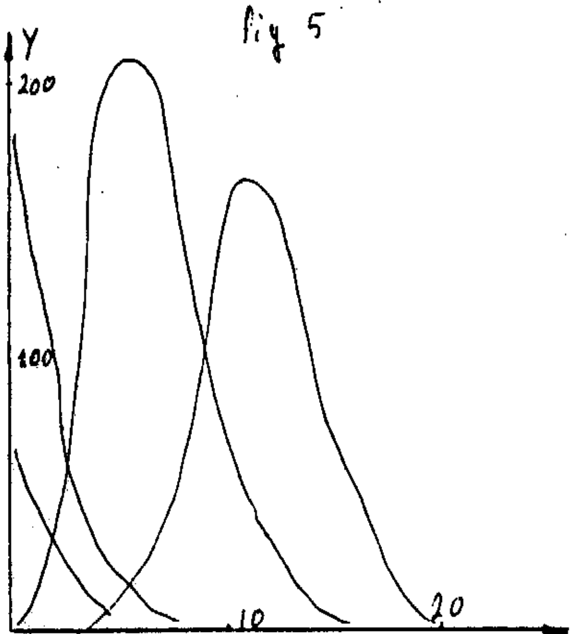


fig 6

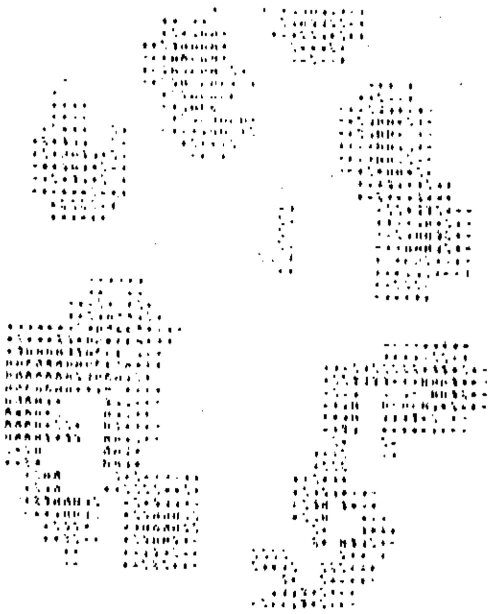


fig.7

CONCLUSIONS

Experiments presented here confirm properties of C-m in a two dimensional case and it showed also the possibilities of application of C-filtering in texture classification and discrimination.
Some interesting possibilities also sets up the application of C-filter to extraction of human mithoses and segmentation technique.
Preliminary results seem very encouraging and more detailed analysis of this application of C-filtering is under research.

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