

TEXTURE & STRUCTURE

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In this work we intend to propose an original algorithm for texture analysis and classification, and then make a comparison with our proposal and most well known algorithm in the related literature; namely the atomic-statistic Haralick algorithm.

1. INTRODUCTION.

In the broad and diverse landscape of the existing literature on automatic pattern recognition, one often comes across the definitions which are derived by appealing to the theory of form (Gestalt), which is the theory of the "totality".

It has been said that the Gestalt is the theory of the totality of that very same totality which is necessary but not sufficient in order to define a structural analysis.

In fact what is peculiar to a structural type of orientation is an explicative attitude toward the structures.

More precisely, one is not interested in considering them simply as "emerging totalities" in contraposition to "atomic" entities, but one wants to analyze them with respect to their internal structure.

So, since the concept of structure works on all levels, one wants to consider them in terms of relations, namely as forms.

Let's go back to the dialectic between local and global or, in a more traditional way, to the "structural" understanding of the organized whole.

We can interpret a structure as a system of transformations. This implies that we have certain laws which evolve through the transformation itself and which realize themselves in the universe under consideration.

Hence a structure enjoys the following features: totality transformations and self-regulation. A further fundamental characteristic of the structures is the following: they regulate themselves, and the self-regulation determines their conservation and a certain closure.

So the transformations inherent in a certain structure do not lead outside its borders, but generate elements which always belong to the same structure and which preserve its laws. It is in this sense that the structure is closed within in itself.

This doesn't imply that it can not be part of a second structure containing it. We can then talk about self-regulation of the structure, and determination of the self-regulated structure leads us to conclude that we have arrived at a more intimate knowledge of the system.

So we have introduced two different types of magnitudes: structured and structuring and we have hinted at how the latter are bearers of information. We claim that the variations, or alterations of the structured magnitudes are the sources of the information.

2. STRUCTURED MAGNITUDE: AN EXAMPLE, TEXTURES

Two different motivations lead us to consider, in this paper, the problem of textures: the rule this plays in the entire process of perception and the problem in itself; indeed the study of textures can be considered a science in itself.

Obviously, texture also plays a determinant role in automatic image recognition and the literature contains very many articles which illustrate a great variety of algorithms dedicated to the description of classification of texture.

In spite of this, still today there is no definition, not even a coarse one, of texture, and the entire problem of its elaboration and classification has to be regarded as unsolved.

We think of a wet, or a texture, as a stationary oscillation in a domain of arbitrary dimension. The wish to formalize our idea of texture leads us to:

[1], [2]

Def. 1:

A discrete function $y=f(x,y)$ defined in a discrete two-dimensional domain is a texture if there exists at least a partition of the domain such that all partition-elements are isomorphic among themselves.

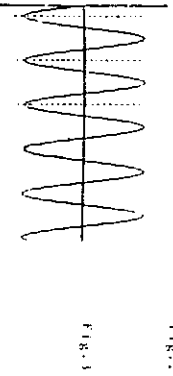
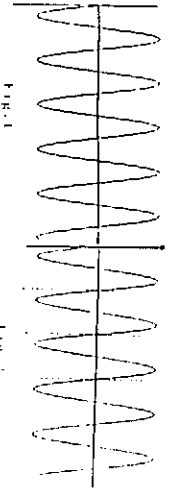
Def. 2:

The function $y=f(x,y)$, which is defined in a partition element, is called the "piece of the texture".

The following simple examples clarify the definitions given above. Let's consider the periodic function in fig.1. Such a function represents a texture since there exists at least a partition of the domain, whose amplitude equals the period of the function satisfying condition 1 (of the fig 2).

It is worthy to notice that a generic translation of the partition in the domain of the function, still satisfies condition 1.

This fact implies that our definition is invariant under translation of the partition (of fig 3).



We notice that the arguments given so far for a unidimensional periodic function still continue to be valid for any discrete function $y=f(x,y)$ defined in a discrete unidimensional domain.

Each piece of the texture can be described by a structured which might be rather complicated or not; then it follows almost immediately that a texture is nothing but the very same structure which repeats itself as many times as the number of partition-elements occurring in the domain.

One immediately notices that once the structure is determined then a correct and complete description and classification of the texture follows naturally.

The entire problem of pattern recognition and the successive textures classification can be now rephrased as it follows: "one has to determine the partition-element in such a way that condition 1 holds".

Fortunately we can easily solve such a problem; in fact it's sufficient to make use of the matrix of characteristics [2] in order to derive from it the information needed.

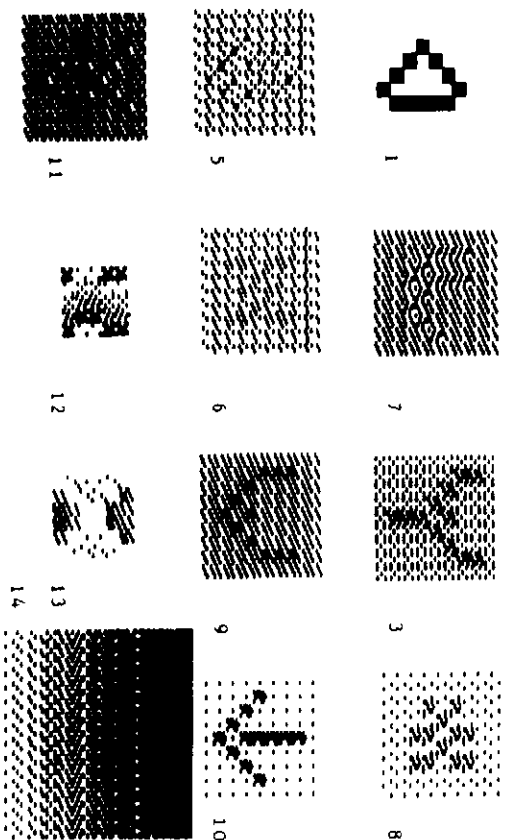
3. TEXTURE: A COMPARISON.

In this paragraph we intend to compare the algorithm that we have proposed with the most well known algorithm in the related literature; namely the atomic-statistic Haralick algorithm [3].

The author propose fourteen characteristics, suitable for a classification of a texture, even if, himself in [4] and others claim that just few of them are useful for the realization of the task proposed.

In analogy with such authors in order to evidence the proposed comparison, we'll make use of the following characteristics: homogeneity (ASM), correlation (COR) and maximal cooccurrence (MXP).

In table 1 we report the results obtained by making use of the two different algorithms and we report also the corresponding time-tables (time needed for calculation) into nine theoretic textures (1,7,3,8,5,6,9,10,11 of tab.1).



It is worthy to notice that in each of the nine textures, Haralick's algorithm provides the same results, or in other words, this algorithm is not refined to distinguish among the differences which, according to us, are rather obvious.

Table 1
Results of proposed algorithms

Number of Images	Results of Haralick Algorithms	Times of Proposed Alg.	Times of Haralick alg.
Tex. 1	ASM=0.566	COR=0.023	0'17"
	MXP=0.730		4'12"
Tex. 7	ASM=0.566	COR=0.023	0'17"
	MXP=0.730		4'12"
Tex. 3	ASM=0.566	COR=0.023	0'17"
	MXP=0.730		4'12"
Tex. 8	ASM=0.566	COR=0.023	0'17"
	MXP=0.730		4'12"
Tex. 5	ASM=0.566	COR=0.023	0'17"
	MXP=0.730		4'12"
Tex. 6	ASM=0.566	COR=0.023	0'55"
	MXP=0.730		4'12"
Tex. 9	ASM=0.566	COR=0.023	0'17"
	MXP=0.730		4'12"
Tex. 10	ASM=0.566	COR=0.023	0'17"
	MXP=0.730		4'12"
Tex. 11	ASM=0.566	COR=0.023	0'17"
	MXP=0.730		4'12"
Tex. 12	ASM=0.101	COR=0.052	0'04"
	MXP=0.110		4'12"
Tex. 13	ASM=0.071	COR=0.279	0'08"
	MXP=0.125		4'12"

Table 2

Tex. 01	ASM=0.048	COR=0.701	0'58"
	MXP=0.139		4'12"
Tex. D2j	ASM=0.013	COR=0.707	0'58"
	MXP=0.050		4'12"

In fig. 15, 16 we report two textures derived from Brodatz and scattered into 16 levels of grey by means of "c.c.d." camera. In table 2 we report the results obtained by making use of two different algorithms.

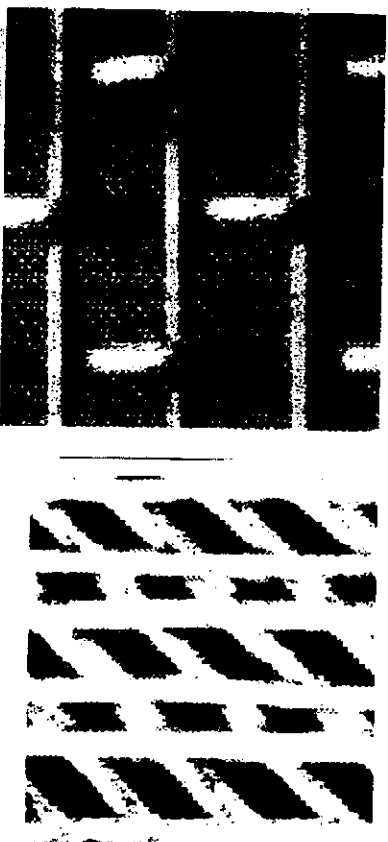
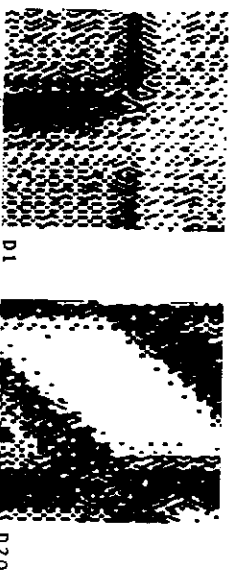


Fig. 15-16



D1

D20

CONCLUSIONS.

In this paper we have presented a different and according to us deeper application of Gestalt theory, by appealing to structuralism. In fact we think that after hard work such a direction might lead us to a different approach of images elaboration and may be, to a more intimate knowledge of problems such as figure/background, contours, etc. Particularly first application of such an approach to texture recognition and classifications, as encouraged us to continue of this research. In fact several experimental results from which just few of them are presented here and comparison with Haralick, had comforted our study a little.

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