# THE FIRST COURSE OF REMOTE SENSING AT THE UNIVERSITY OF REGGIO CALABRIA

Vincenzo Barrile and Rossella Nocera
DIMET University of Reggio Calabria - Italy
Phone: ++39 965 875200, Fax: ++39 965 875247, e-mail: barrile@ns.ing.unirc.it
Phone: ++39 965 875200, Fax: ++39 965 875247, e-mail: nocera@ns.ing.unirc.it

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## ABSTRACT

The Remote Sensing can be defined as a set of techniques and tools that allow to improve the capacity of the human eye giving the observer information about the quality and/or the quantity of objects placed far from the next ambient.
The course " Remote Sensing and Diagnostic Electromagnetic and Remote Sensing" which was held at the University of Reggio Calabria is for civil and electronic engineers. The principle aim of the course is to teach the basic elements useful to operate in this new field which has big potentiality, with particular attention to the environmental aspect.
During the course an exercise was done with the students. The exercise reports an analyse of variance of data base coming from photographic sensores. The principle aim is to evaluate the differences of data obtained with different sensores and at different times during the day.

## 1. THE COURSE

In the last years the Remote Sensing had, everywhere and also in Italy, a big development and nowadays is still increasing because of the vastity of the discipline and the big and heterogeneous number of experts who work in this field.
The course " Remote Sensing and Diagnostic Electromagnetic and Remote Sensing" which was held at the University of Reggio Calabria is for civil and electronic engineers. The principle aim of the course is to teach the basic elements useful to operate in this new field which has big potentiality, with particular attention to the environmental aspect.
The part of the course taught to the civil engineers can be divided into three principle sections:

- Interaction Material-Electromagnetic Energy
    * Phisical laws radiation
    * Radiometry, Photometry, Colourimetry
    * Spectral Response
- Tools
    * Photographic tools
    * Scanner Systems

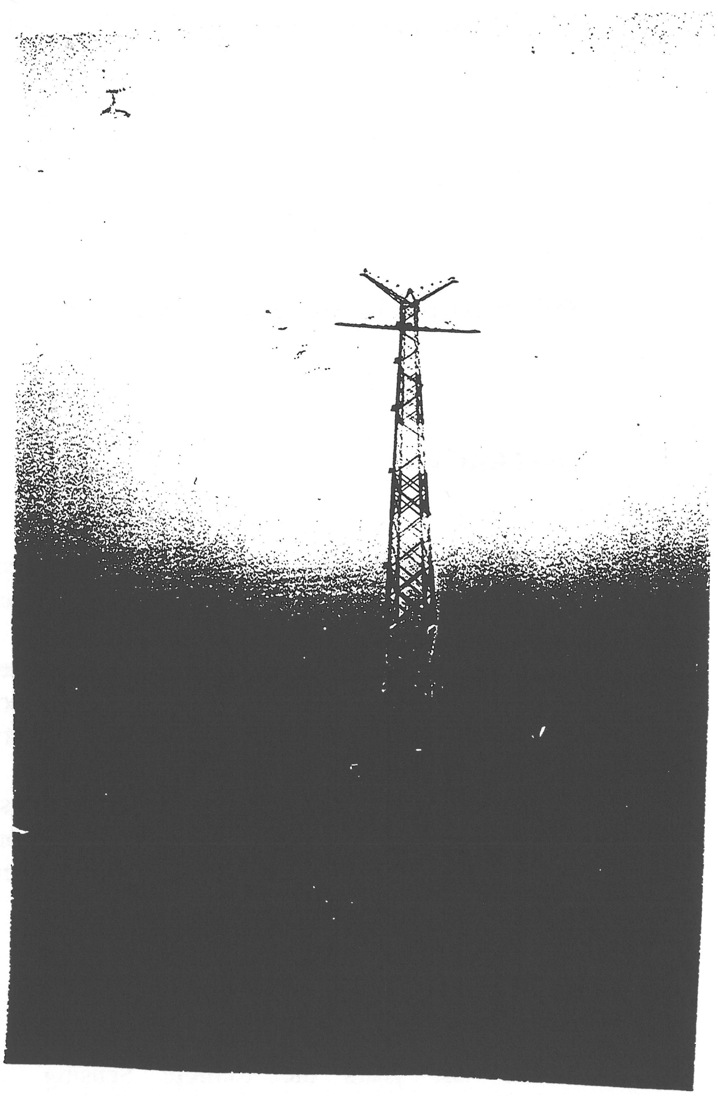
* Radar Systems (SLR, SAR, Interpherometric SAR)
* Satellite foe earth's resources (Landsat, Spot)
* GPS Systems

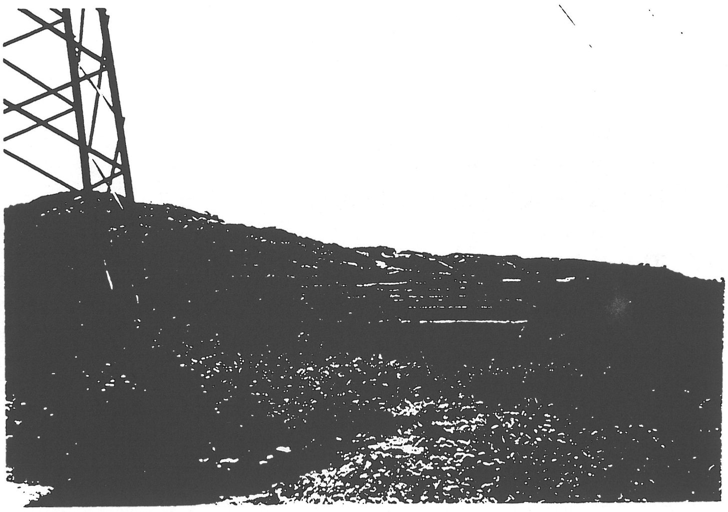
- Technique to elaborate the images and techniques to treat and to interpret the caught data:
  * Analysis and continuos elaboration of images
  * Space sampling, quantization and binary codify.
  * exploring technique (histograms, scatterograms, Density....
  * Emphasizing technique:
  * Contrast Stretching, LUT, Relations among Spectral bands, Colour Representation
  * Local Spatial elaboration, expansion of grey levels scale, low pass filter and high pass filter.
  * Analysis, interpret and classify of images.

After the description of the arguments of course we go on describing an exercise we did with the students during the course. The exercise reports an analyse of variance of data base coming from photographic sensores. The principle aim is to evaluate the differences of data obtained with different sensores and at different times during the day.

## 2. ANALYSE OF VARIANCE

A data base subdivided into regions and/or into epochs is a set of data, which can be collected together into two-dimension or three-dimension cells.
The information into the cells is represented by a statistical multi-dimension variable whose elements are the values of the attributes of the information itself.
In the technique of the analyse of variance the variance is considered as the sum of two components, layer-variance and residual variance, which are perpendicular.
The principal aim is to maximise the layer-variance (which describe the phenomena following the layer model) respect to the residual variance which, on the contrary, describes the statistical nature of the data).
Four different photographic sensors are available (treatments), so there were made some photographs of objects located in four different places (blocs) which are situated along distances becoming always bigger. The photographs were made in six different times of the day (layer).

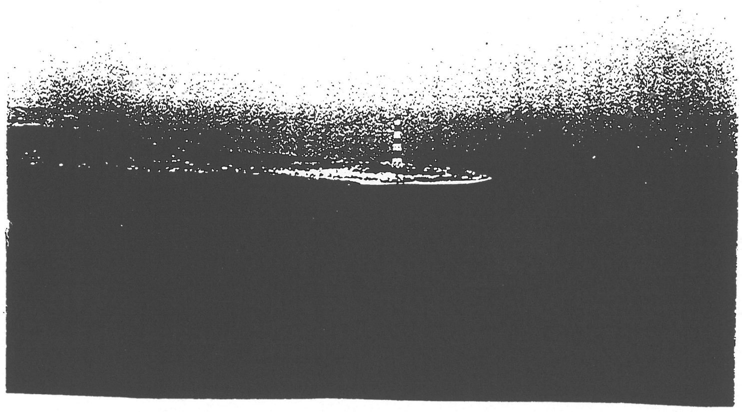




In this way there are available 80 images. For each of them there are evaluated the things which are visible in relation to that really present on the ground (10 things for each image) and so the following tabulate is obtained.

| | | Repetition | | | | |
|---|---|---|---|---|---|---|
| | | 6 | 9 | 12 | 15 | 18 |
| A | | | | | | |
| | I | 5 | 7 | 8 | 9 | 6 |
| | II | 5 | 6 | 7 | 8 | 6 |
| | III | 3 | 4 | 5 | 3 | 2 |
| | IV | 4 | 3 | 4 | 4 | 3 |
| B | | | | | | |
| | I | 5 | 7 | 8 | 9 | 7 |
| | II | 5 | 6 | 6 | 8 | 6 |
| | III | 3 | 3 | 5 | 4 | 3 |
| | IV | 3 | 4 | 4 | 4 | 3 |
| C | | | | | | |
| | I | 5 | 7 | 8 | 8 | 7 |
| | II | 6 | 6 | 7 | 8 | 6 |
| | III | 3 | 3 | 4 | 4 | 3 |
| | IV | 3 | 3 | 5 | 4 | 2 |
| D | | | | | | |
| | I | 5 | 7 | 8 | 9 | 6 |
| | II | 6 | 6 | 5 | 6 | 7 |
| | III | 3 | 2 | 4 | 3 | 2 |
| | IV | 3 | 3 | 4 | 4 | 3 |

This is a tabulate for an Analyse of Variance. Than was developed the model.



### 3. THE MODEL

The following model is developed:

$S_{ijk} = a + a_i + a_j + a_k = S^{o}_{ijk} + Y_{ijk}$

$\forall i = 1, I$ — I = Treatments

$\forall j = 1, J$ — J = Blocs

$\forall k = 1, K$ — K = Layers

$a$ = general mean of data

$a_i$ = parameters which must be evaluated to explain the different behaviour of data for each treatment

$a_j$ = parameters which must be evaluated to explain the different behaviour of data for each bloc

$a_k$ = parameters which must be evaluated to explain the different behaviour of data for each layer

The total of observations are:
m=IJK

and the total of parameters are:
n=I+J+K+1.

Because of the overparametrization due to non linear unknown quantities, it's also necessary to consider the following constraint equations:

$$\sum a_i = 0$$
$$\sum a_j = 0$$
$$\sum a_k = 0$$

The estimation of the parameters, of the deviation and of the variance are obtained solving the system of observation equations with least squares method following the steps reported in the figure, and than (with an opportune propagation) we obtain the variance of the observations too. From the estimation of the parameters we obtain the layer variance related to the values of the Treatments to the Blocs and to the Layers so as used the model.

$$\sigma_T^2 = \sum_{i=1}^{I} a_i^2 / (I-1)$$
$$\sigma_B^2 = \sum_{j=1}^{J} a_j^2 / (J-1)$$
$$\sigma_L^2 = \sum_{k=1}^{K} a_k^2 / (K-1)$$
$$\sigma_R^2 = \sum_i \sum_j \sum_k v^2_{ijk}/v$$

where v = degree of freedom =

I*J*K-(I-1)-(J-1)-(K-1)-1

Under the hypothesis of absence of interactions and from the expected values for the variance, there were made the test Ho above the mean of the treatment, of the blocs and of the layers to evaluate (under the level of 5%) the quality of the image. The parameter is the level of visibility of the features in every image. This parameter is influenced by the type of camera, by the distance of the object and by the time of the day.
So it's valid that:

$$Ho^T\ (a_i^1 = a_i^2 = a_i^3 = a_i^4)$$
$$Ho^S\ (a_j^1 = a_j^2 = a_j^3 = a_j^4)$$
$$Ho^L\ (a_k^1 = a_k^2 = a_k^3 = a_k^4 = a_k^5)$$

The correspondent Fo, which is calculated using the least squares method, is an extraction of F (of Fischer)

$$Fo = \sigma_S^2 B/\sigma_R^2$$

$$Fo = \sigma_S^2 T/\sigma_R^2$$

$$Fo = \sigma_S^2 K/\sigma_R^2$$

where:

$$\sigma_S^2 B,\quad \sigma_S^2 T,\quad \sigma_S^2 L,$$

are the expected values of the layer variance of Blocs, Treatments, Layer.
So for each case the critical value $F\alpha$ ( at established degree of freedom and under the significant value of 5%) is calculated and than it is compared with the value Fo.
If $Fo < F\alpha$, than Ho will be accept, if $Fo > F\alpha$ than Ho will be refused.

## 4. RESULTS AND CONCLUSIONS

From our data was obtained the following situation:

*Treatments*

$Fo < F\alpha$ ⟶ $Ho^T$ is ok ! ⟶
equal means.

There aren't significant differences between treatments, that means there aren't significant differences between cameras.

*Blocs*

$Fo > F\alpha$ ⟶ $Ho^B$ is not ok ! ⟶
different means.

There are important differences between the blocs. That means there are significant differences among images at different distances.

*Layers*

$Fo > F\alpha$ ⟶ $Ho^L$ is not ok ! ⟶

different means.

There are significant differences among layers. That means there are significant differences among photographs done during different times in a day.

In conclusion we can say that this exercise is very simple but it's a good example to evidence how the photographic sensores are influenced by a lot of external elements; for example: the distance of the object, the different conditions of the light, wet weather etc. during the different hours of the day.

**REFERENCES**

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