GAVIÃO - AN ALTERNATIVE SYSTEM FOR IMAGE PROCESSING

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ABSTRACT

This paper presents an alternative system for image processing. Developed using TURBO PASCAL, this system was conceived to attend the needs of institutions which have no resources to acquire expansive equipments. The main idea in the design process was the creation of an environment for the research and educational tasks. User friendly, the system also includes a case sensitive help.

1 INTRODUCTION

The evaluation of natural resources, attending to the most varied propositions, requires updated informations about a delimited region. For the correct establishment of those informations, is indispensable a photogrammetric survey that, among many other products, is the base for the maps production. The informations are still complemented with a field work, in according to the rigor and level of details that the project imposes.

Due their high power of geometric resolution, the aerial photographs are intensively utilized as ground truth. Once obtained a detailed survey of the area, the information updating phase is sensitively less critical. Considering his, normally, high cost, the photogrammetric survey becomes, on most of the times, prohibitive as tool for information update. The obtained images by electronic sensors located in orbital platforms - **remote sensing satellites** -, despite their low geometric resolution power and the difficulty to recognize the original terrain features, when compared to the aerial photographs, are of unquestionable validity when considering their periodicity on the data acquisition. One must consider, still, the large area recovered by those sensors that, in the brazilian case, assures total recovery of his territory, including his territorial sea.

This way, even in the preliminary phase of projects elaboration regarding evaluation or use of natural resources, the orbital images are valuable informations sources, in the absence of others more detailed ones. With the advent of microcomputing, such images have been more and more used. There are two basic forms to present those images:

1. photographic paper printing;

2. video monitor displays.

The first one implies on digital information processing series until the obtainment of the final composition, that will be registered on photographic paper.

The second form leads directly with the digital information through mathematical procedures producing many alternatives for the image

composition that will be displayed. This flexibility allows facilities that can vary from a fast sequence for the region selection to the combination of many images in different spectral regions to produce a more complex final image. The product displayed can be stored as digital data for posterior display or can be photographed, resulting on the first form described. The unitary cost of these forms is lower than the correspondent aerial photogrammetric recovery.

The use of image digital informations was, until some years ago, dependent on specific computers for the processing of those informations, resulting on the intensive use of such images printed on photographic paper. The high cost of specific equipments has limited their utilization to a little group of institutions, imposing serious difficulties to the research and digital images technology diffusion.

With the popularization of microcomputers based on Intel 8086 processor, a new environment for software development and processing became available. The graphics resources, extremely limited on the initial configurations, have been continuously increased and their prices reduced. This environment becomes also utilized for the digital image processing. Meanwhile, the developed systems for this activity require some features aggregated to the basic configuration of these microcomputers, like special graphics cards and appropriated arithmetic processors, to have the minimum environment for image processing. Despite the technical excuses, this fact, by itself, is a obstacle for many research centers.

In spite of the limitations offered by the basic configuration of a microcomputer compatible with an IBM-pc, of technical order and performance, this platform is perfectly viable as environment for research and technology assimilation.

This project has considered all the factors to propose a development of an alternative system for the digital image processing which uses, as platform, a basic configuration of a microcomputer based on the processor Intel 8086 and his successors.

2 OBJECTIVES

The creation of an stimulating and natural professional environment which provides the assimilation and development of the digital images processing technclogies. This objective was reached through the following steps:

1. Development of a modular alternative system for the digital image processing.

2. Development of a module for the automatic hardware identification, to suit the system to the processing environment.

3. Development of a module to perform arithmetic transformations on and among image files.

4. Documentation of the system structure, allowing the utilization of his modules by other computational codes.

5. Implementation of a computational code, using TURBO PASCAL, for microcomputers compatible with the IBM-pc family.

6. Development of a complete Case Sensitive Help.

7. System use diffusion in educational and research systems as well in companies which use these informations, stressing his potential not only as applicative software but, mainly, as an environment for teaching and research on digital image processing technologies.

3 METHODOLOGY

Once one has the image in its digital form, it can be processed by computers. The image representation, resulted from mathematical procedures over the digital informations, intends to recompose, with the maximum accuracy, the original

scene. There are, basically, two methodologies to produce the final image:

1. automatic, based on statistics criteria for separability and clustering of informations in distinct classes;

2. supervised, based on sampling on the image, grouping the informations in according to the user determinations (Davis 1986), (Swain & Davis 1978).

In both of them, the final image presentation results from the establishment of colors or tones for each one of the produced classes. The previous knowledge about the imaged region provides a more accurate interpretation of the informations (Estes 1983:987-1124). An hybrid methodology was proposed to lead with the two situations, with emphasis on the supervised interpretation. Once obtained an initial automatic classification, the produced image can be reclassified by the direct user interference, using elements that complement the digital information. Thus, the system allows the comprehension and use of the two methodologies, having the final product relevant applications as element to update and/or complement a existent base of visual information.

For the automatic classification, the GAVIÃO system uses histograms, accumulated or not, of the digital values that compose the image, producing the classes on the following form:

1. Histogram Slicing: this criterion intends to establish the classes in the way that the number of image points in each class be a constant.

2. Cluster Analysis: based on euclidian distance.

For the supervised reclassification, the GAVIÃO system uses the homogeneous samples principle to statistical characterization of elements recognized on the image. After the generation of desired classes, the reclassification will consist in verify in which class interval the brightness level of the pixel is inside. The classification will can make simultaneous use of many images of the same area, obtained in different spectral regions - **bands** -, increasing the separability of features. In this case, the attribution of a pixel to a class will be based in the smallest euclidian distance from his brightness level to the medium brightness level of the class (Lillesand 1987).

Image enhancement techniques can be applied on digital images, to reduce or eliminate noises that exist in the digital information or contrast enhancement, producing better visual quality. The following filters was implemented:

1. Low-Pass Filter: to eliminate noises, homogenizing the image brightness levels. For this, the filter is constituted by a square net of nine pixels, where the new brightness value attributed to the central pixel of the net will be the simple arithmetic mean of brightness values of the nine pixels (Lillesand 1987).

2. High-Pass Filter: to enhance the image transition regions - **edge enhancement** -. For this, the filter will be constituted by a square net of nine pixels, where the new brightness value attributed to the central pixel will be the weighted arithmetic mean of the brightness of the nine pixels. This operation will attribute to the central pixel the weight 5/9 and to the others the weight 1/8 (Lillesand 1987).

New images can be generated as results of arithmetic operations on or among bands.

Examples:

1. A new image will be the result of the square root of the brightness level of each pixel;

2. A new image will be the result of the evaluation of the following expression:

((B4-B3)/(B3+B4)+0.5)^0.5*100

where B3 and B4 are, respectively, the Landsat-5 Thematic

Mapper bands 3 and 4. The informations generated compose the named Vegetation Index - **TVI** - (Lillesand 1987:663).

To allow the manipulation of digital information, in this form, was created a Command Lexicon Interpreter, to provide the following arithmetic operations on each pixel: addition, subtraction, multiplication, division and potentiation. Once the results of those operations will be real numbers, one must provide a procedure to transform those numbers to another brightness scale, that can be presented under pictorial form. To do this was implemented an algorithm for linear transformation of contrast. Using this algorithm, the new brightness value of one pixel will be:

$$BL' = (UB-LB) * \frac{(BL - MIN)}{(MAX - MIN)} + LB$$

where:

BL' = brightness level in the scale

BL = brightness level in the original scale

LB = lower bound in the new scale

UB = upper bound in the new scale

MIN = minimum observed in the original scale

MAX = maximum observed in the original scale

The new brightness value will be rounded to the nearest integer (Lillesand 1987:630).

4 CONCLUSION

The GAVIÃO system is suited to the training and research in institutions with no resources to acquire sophisticated equipments, providing them the possibility to perform activities on digital image processing.

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