A Contribution to an Image Mining Oriented Geoprocessing

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Abstract. Since its origin Geoprocessing Information Systems (GIS) are supposed to deal with structured information concerned some geographical localization. So one uses three-dimensional image representation systems in a huge database, where it is possible to insert many data about some interest domain, say, agriculture, economics, industry, demographics and so on. This article presents a new approach, which allows an integration of Geoprocessing and Image Mining not only in typical geographical subjects but also in other domains such as healthcare.

1 Introduction

Since its origin Geoprocessing Information Systems (GIS) are supposed to deal with structured information concerned some geographical localization. So one uses matrix or vector oriented three-dimensional image representation systems in a huge database, where it is possible to insert many data about some interest domain, say, agriculture, economics, industry, demographics and so on. Although maps are also an image modeling technique, Geoprocessing is not usually a theme for image processing scientific events, but for specific Geoprocessing concerned events.

Geoprocessing is a way to simplify the representation of an image, in order to subsidize posterior analysis and eventual decisions. If one remembers that any decision requires information and that images are the more concise way to present information, one can derive the linkage between Geoprocessing and decision making. But the way information is required for decision in not that one that in general comes directly from Geoprocessing. The amount of information can be too high or it cannot be adequately visible for decision makers.

In such context one can think about the benefits of Geoprocessing as a technique to process different kinds of image, not only geographical. In any case image related information generated by Geoprocessing becomes useful if it is suitably processed. Here one can detect a wide research field for image mining

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This article proposes the integration of Geoprocessing and Image Mining to support decision making in different areas, such as healthcare and other areas that allow visual information modeling.

2 Geoprocessing Paradigm

There are four abstractions levels for Geoprocessing, say, the real, the conception, the modeling and the implementation world. The real world concerns geographical data, while the other ones mean gradually stated definition ways up to final information output. These ways are strongly influenced by the features of geographical information, such as cartographic methodologies and ground use forms [1].

Geoprocessing developed itself from theoretical geographical approaches. Idiographic geography emphasizes form and place whereas nomothetic geography aims to discover general processes [2]. Quantitative Geography looks for knowledge from measurable features from different regions of the image by mainly using of Geostatistics instruments. Critical Geography sees space as systems of actions and systems of objects [3].

Information extraction from images requires all these approaches. For example, a physician works idiographically and nomothetically when he analyses lesions and abnormalities in an x-ray image. He uses Geostatistics with local visual samples to soundly conclude about existence of some disease. Critical Geography is used when he studies the influence of the functions of different organs based on its images and additional data.

A more ambitious approach for Geoprocessing systems should emphasize the relations between image objects and its dynamic variations. This way they can become effective information generation devices that allow computational knowledge extraction from quantitatively or qualitatively specifiable local contents of an image.

3 Image Mining Paradigm

Images are information mines, which car soundly support decision making [4]. Image mining extracts implicit knowledge, image data relationship, or other patterns not explicitly stored in the images [5]. Extraction of information must follow some basic hypothesis and be oriented to some purpose. For instance, an x-ray picture can provide quite different information for orthopedics and for cardiology.

Image mining can also be very efficient with two-dimensional images. It can be performed after a series gradual image processing or modeling techniques. Apparently Image Mining is not directly concerned with Image Processing, but with mining in ready images.

By introducing the unit area concept one can think of an image as a data base with a lot of data concerning every local in the image. So information extraction procedures will not work only based on pixel features. For example an image of skin with a small dark region, could be much more useful if historical data about such spot where computationally available.

4 Towards a Generalized Geoprocessing

By thinking of Geoprocessing (GP) as an image synthesizing technique and of Image Mining (IM) as an image analyzing technique, one can imagine that IM should happen after GP. Interface requirements must so be stated in order to make it useful not only for geographical imagery. An Image Mining Ontology could contribute to development of robust systems for Image Mining based on Geoprocessing [6].

A recent pressure ulcer image analysis study through Geoprocessing software Idrisi can be mentioned as an illustration [7]. Two-dimensional images were classified by means of Isoclust algorithm [8]. This is based on K-means classification that iteratively attributes classes to all pixel up to achieving some limit criteria [8] [9]. The area can be known through the pixel amount report concerning classified regions. See Fig. 1 and 2.

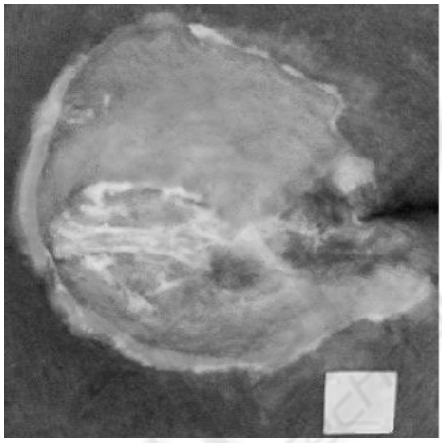

Fig. 1. Original image with 4 sq cm pattern.

Fig. 2. Isoclust classified image after convolution with 9x9 mean mask.

This is part of a proposal that was presented in 1st IMTA that aimed to provide information for medical decisions based on pressure ulcer images and patient data [10], Information extraction by Image Mining require that patients be typified and characterized by means of group analysis techniques and supervised classification.

5 Main Steps to implement an Image Mining oriented Geoprocessing System (IMOGS)

First it is necessary to gather information about image use for decision making by means of process analysis in several domains. See Fig. 3. It will so be possible to know

- decision supporting information,
- extractable information from images,
- image features,
- image processing requirements,
- sampling possibilities,
- image capture techniques, and
- the usual conventional activities to perform the whole process.

The results that the system will provide should be realistically defined. In Medicine, for example, it is yet not possible to systematize many diagnosis based on images, because they require additional knowledge. Such results will not be useful unless one has available a user-friendly interface. Here the requirements for a multiple user friendly interface must be defined.

Afterwards both image analysis techniques and image processing techniques can be selected. One should take in account form and contents the image must have to enable Image Mining. One should define procedures to transform row image data and additional data that concern area units into new images. In such context very often false colored images are built in Geoprocessing in order to enhance some desired visual information.

Input related procedures must be flexible enough to enable image analysis from different origins.

Now one has the necessary information for a prototype development that will be validated. After feed-back and introducing of necessary adjustments in prototype, IMOGS system can be developed and similarly validated. Finally IMOGS documentation is written.

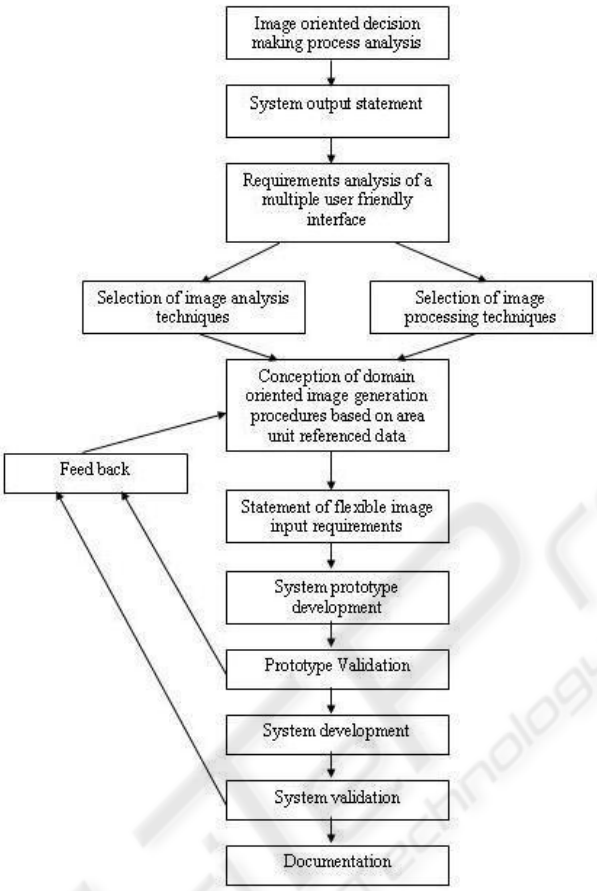

Fig. 3. System IMOGS development.

6 Final Remarks

It was not found any effort towards an integration of Geoprocessing and Image Mining in the literature. Indeed Geoprocessing systems came in 1960s years and Image Mining research appeared later at the end of 1990 decade [1] [11]. The implementation of here proposed construction of an IMOGS can accelerate the development of Image Mining tools for practical goals.

A gradual approach seems more suitable, through first including one only domain in order to acquire experience and reliable results, and so embracing more and more domains. In accordance with this our research group is meanwhile engaged on medical image mining, mainly on pressure ulcers treatment information support.

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