Automate monitoring systems for the dynamics of lands based on aerial photos assessed by artificial neural techniques

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Abstract: *This paper shortly presents a project lanced by the Computer Science Department of the "1 Decembrie 1918" University of Alba Iulia. The project is based on the increasing amount and complexity of the earth science data collected by remote sensors. This huge amount of information underscores the need for research into strategies and techniques to facilitate its analysis and understanding. In this project an application of artificial neural networks to human-centered earth science information processing is described.*

Keywords*: remote sensor, image processing, artificial neural networks.*

1. Introduction

The Information Society offers great potential in promoting sustainable development, democracy, transparency, accountability and good governance. There is also a need for a people-centered approach, one that emphasizes social, cultural, economic and governance goals. This approach must ensure that the knowledge and experience of citizens is integrated into this process as the driving force behind the new information society.

Individuals and organizations should benefit from access to information, knowledge and ideas. Notably information in the public domain should be easily accessible [1].

One of the domains of great interest in this direction is the surveillance and monitoring of lands evolution, in which GIS and Artificial Intelligence are basic keywords. The purpose of a GIS is to provide both the individual and organization with increased knowledge and understanding of spatial data. Often GIS users overlook the 'decision making' capability these systems can provide, instead, focusing on the presentation. GIS information can become increasingly more valuable for decision making when coupled to artificial intelligence (AI). When linked to GIS, artificial intelligence can be useful for evaluating, monitoring and decision-making. Neural networks, fuzzy logic, nano-technology and evolutionary computation and others are directed toward decision-making functionality. It is anticipated that many future spatial applications will incorporate elements of artificial intelligence. The neural networks have many potential applications in GIS including; land use, oceanography, forestry, consumer movement, transportation, bio-sphere studies, image analysis, environmental, entertainment, anti-terrorism, pattern analysis and health [5].

2. Project presentation

The project is based on the preoccupations of the specialists belonging to several sciences concerning sustainable development and environment. These are integrated into the concepts of sustainable development, ecologic systems, global modifications assessing and control. By its objectives and results the project has an important impact concerning food security and quality.

The core of the project is represented by **image processing achieved by an automate interpreting system** (independent software), which returns data to the specialists from the above mentioned fields of interest (e.g. modification of vegetation, soil, waters, prognosis, land survey etc.)

The main directions of the project are:

A. Design and implementation of the acquisition system and the image pre-processing.

This means the establishment of data sources depending on the given situations (aerial photographs ordered by the land surveyors, various satellite images provided through Internet and the images obtained by our own acquisition system), fig. 1.

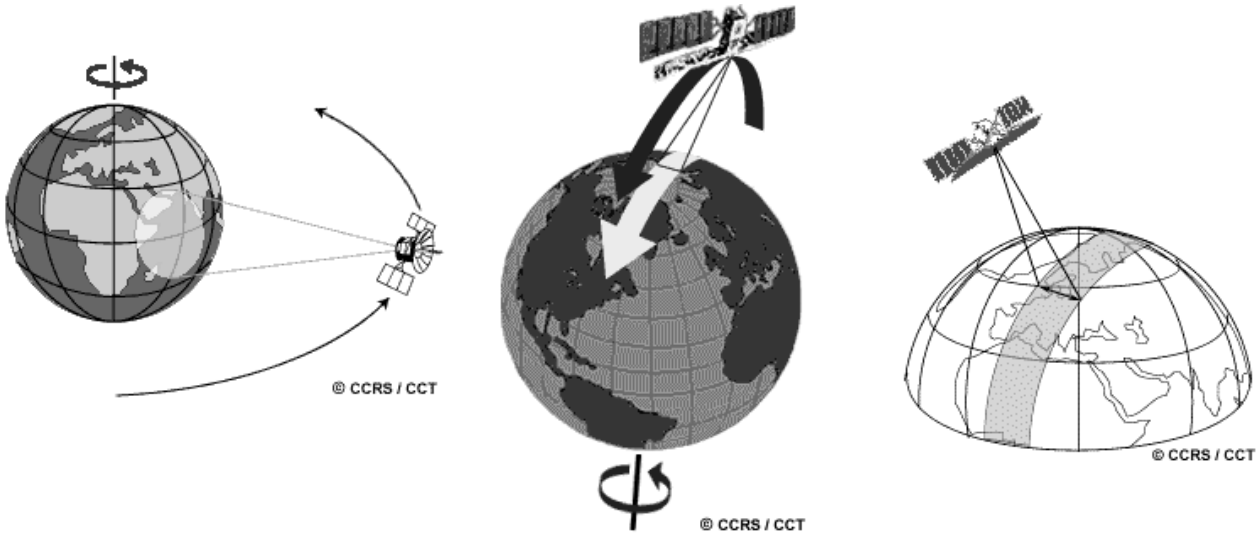

Fig. 1. Different remote sensing situations

The relational database will be designed as background for the GIS which will be offered to the specialists (pedologists, farmers, land surveyors etc).

The team's main target is to achieve: **pre-processing** and **classification** of the obtained data by using specialized software (IMAQVision, Matlab-Simulink) or software designed in our Computer Science Department.

This is required both for the further processing in the framework of the automate interpreting system and for the data standardization taking into consideration GIS standards and Internet technologies (SVG- GML).

B. Design of an automate image processing system based on artificial neural networks.

ANN have been successfully used in the modeling of phenomena and processes for which a mathematical description does not exist (black box model).

Artificial neural networks have several advantages when used as classifiers of complex geographic and remotely-sensed datasets. They normally require no assumptions on the data distribution and can be trained with relatively small sample sets. Further, they are robust classifiers that require little data preparation prior to use; however, the selection of a suitable architecture and the subsequent lengthy training time of the network have often been perceived as a disadvantage to the acceptability of such classifiers [3].

There are a great number of of ANN types but in this area the most used were the multilayered Perceptron (MLP), fig. 2. The MLP classifier's operation is covered in detail in German & Gahegan (1996). In brief, an input vector is placed on the input nodes and is propagated to the output layer via the weight connections and the hidden-layer. This is done for each vector in the training set (one *iteration*). Each node in the hidden and output layers transforms the sum of its inputs via an activation function, normally a sigmoid one [3].

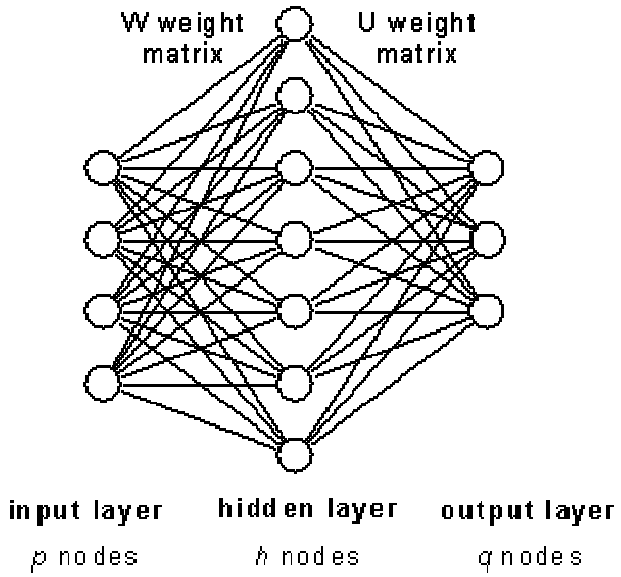

Fig. 2. A simplified MLP network architecture. Source [3].

In the study of geo - morpho - climatic phenomena the classical mathematic model (statistical approach) gives poor results therefore there is an intense worldwide preoccupation for finding means and approaches which use Artificial Intelligence (AI). The authors of the project have realized several ANN's to model geo-morpho-climatic phenomena [2], [4].

The automate interpretation system accomplished by neural networks will be trained and tested with the existing data recorded in the database and with other GIS (ESRI which provides powerful tool by ArchView).

For system validation we will use data referring to Alba Department, provided by The Romanian Water Department Alba, The Districtual Agricultural Department, The Forestry Department, The Environment Protection Agency etc.

The automate interpreting system is designed for:

- generating classification (land management),

- assessing modifications in land management, color and nuances modifications (state of vegetation, water evolution in soil, presence of pests, erosion, natural disasters).

The ANN will be trained for the rejection of erronated input data (with big deviations) which have not been selected in the pre-processing phase in order to avoid miss interpretation of data and false diagnosis.

Once the automate system will be tested it will be used for solving existing problems in several geographical areas.

The system will have an upgrading component which will allow it to learn new sets of data.

Our goal is to implement this type of system with **emphasize on image interpretation** by means of neural networks and possibly of other AI tools.

The team has specialists in following areas: Cadastre, Pedology, Image processing, AI (neural networks, evolutionary computation, expert systems)

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