TEACHING PLANETARY GIS BY CONSTRUCTING ITS MODEL FOR THE TEST TERRAIN OF THE HUNVEYOR AND HUSAR. L. Gimesi 1, Cs. Z. Béres 1, Sz. Bérczi 2, S. Hegyi 1, V. Cech 1. 1Pécs University, Faculty of Science, Dept. Informatics and G. Technology, H-7624 Pécs, Ifjúság u. 6. Hungary (gimesi@ttk.pte.hu), 2Eötvös University, Faculty of Science, Dept. G. Physics, Cosmic Materials Space Res. Group, H-1117 Budapest, Pázmány P. s. 1/a. Hungary.

Abstract: Geographical Information System in terrestrial databases can be applied when planetary data were collected by a lander and/or an orbiter. We made a course to follow the construction of a model planetary GIS starting at the Hunveyor university lander and on its test-terrain board. Experimental and observational data of Hunveyor and its environment were arranged in the model planetary GIS and this way not only its use but its construction was gradually learned by students.

Introduction: When groups on Hungarian universities began to construct HUNVEYOR planetary lander model [1] it was the main goal to see the main steps in experiment construction, fitting on the robotic system, on board computer data transfer and all the system connected by communication channel to the "terrestrial control computer". In a second phase the planetary model environment was constructed around Hunveyor. On this test table main rock types of our planetary system were arranged and a rover, the HUSAR (Hungarian University Surface Analyser Rover) moved and measured in this test-desert [2,3].

This year we developed a new summary of the Hunveyor-Husar lander-rovers model and their test-terrain board: the model of the planetary GIS. In an appropriate test-terrain mainly rocks are measured by lander and/or rover. Such measurements were partly carried out, too. Other benefit of GIS type geo-informatic work through Hunveyor lander and the planetary test-terrain students can study methods of retaining samples, storing information and transferring data. They can evaluate the measured results with spatial informatics methods, and e.g. they can draw the map of the rock types of the terrain.

Spatial informatics: Nowadays spatial informatics is a science dealing with one of the biggest databases. Collecting, sending on, storing and displaying data is a task demanding a significant source of power. Visual display and representation have always been closer to human thinking than interpretation of tables containing great amount of numerical data. Therefore we have used a digital model for representation, in which the measured results appear together with the environment, so the relations can be interpreted better. A digital surface model can be animated, so changes can be demonstrated e.g. as a film.

3D Digital Terrain Model: When in a 3D co-ordinate system the Z co-ordinate does not mean distance (height) but some kind of a quantity, then we get a digital terrain model that shows us what measured results belong to a given terrain co-ordinate. So other quantities can also be demonstrated by using X and Y co-ordinates.

Throughout collecting data sample retaining happen in places that are determined precisely but different in space. At the time of evaluation not only the information from sample retaining places was needed, but we had to conclude values for such places where sample retaining did not take place (or could not take place) from these.

3D Surface Model: Since we do not have data from each point of the given terrain (it is impossible to collect and store data from innumerable sample retaining places), so we have to use approximate solutions. Several solutions can be found in technical literature: statistical functions, evolutionary algorithm, neural networks, fuzzy algorithms, and fractals.

We can make a 3D surface model in order to illustrate. As an example take a look at a traditional method, at decomposition into triangles: this is the TIN (Triangulated Irregular Network). A better solution is to lay an imaginative raster network on the terrain. In this case accuracy (resolution) can be given optionally. Such a method is the inverse distance weighted method, or use ‘krieger’, which is a semi-variogram-based statistical calculation method. [4]

Neural Network: We examined a new method – rarely used in spatial informatics – to determine values. This is Neural Network (NN). [5]

![Fig. 1. Structure of a simple neural network](image)

Every network can be divided into three layers. The input and the output layer consist of as many neurons as many types of input and output data we process. The size of the hidden layer can be chosen optionally. The accuracy of the result and the running time depend on the number of neurons in this layer. Each connection of neurons has a value, which is determined by iteration through a learning phase.

The neurons of the hidden layer have three functions. At first, they summarize the data from the input, and then they transform the sum with the help of a function. (Some typical functions can be seen in the figure 1.) The neurons of the input layer just send the data, in the output layer only summarizing takes place. (Feedback is also possible in modern neural network simulating programs.) The use of the neural network can be divided into four phases: building network topology, learning phase, checking phase, usage phase. Picture 2 shows a surface model made with NN from concentration of trace element.

![Fig. 2. Surface model made with NN.](image)
Some other application fields of neural networks:
- environment science – weather forecast, risk analysis
- medical science – diagnosis, estimating chances of survival
- recognition of figure, speech and character
- economic and social modeling
- modeling, estimation, prediction
- controlling

Application of GIS methods to the test-terrain rocks:
In this local database we collected the following data of the rocks in the test terrain: chemical composition (here SiO₂ content is represented), surface texture (observed by Husar’s camera), rock type (main rock types of the Solar System [6]), and occurrence on known planetary surfaces. We show these data in a layered arrangement.

Comparison with analog sites: The rock garden analysis can be used to find analog sites in terrestrial conditions. The Martian landscape had rich and various rock garden around the Sagan Station and Sojourner could visit several samples of this rock garden in the near vicinity of the Station. Textures showed different origin of the rock types. Comparing global images (Viking, MGS) we know that floods in the Ares Valley transported these rocks cutting them from their localities along the valley of the rivers.

We also used this work to find such analogue site [7] and comparison possibility of rock samples in a pebble mine, near the Duna river, south of Budapest. There the transported rock types were identified and on the basis of their textures (with better possibility of that field work was the hand specimen collecting and thin section making). We show this analog site work of rock garden of the river in another report.

Summary: Planetary landers and its rovers may collect data on samples in the local environment. They send these data back to Earth and a planetary surface data are analysed. With the Hunveyor-Husar robotic pair working on the test-terrain students could study and model all these methods of retaining samples, storing information and transferring data. Finally they can evaluate the measured results with spatial informatics methods, and e.g. they can draw the map of the rocks of the terrain. The artificial intelligence (neural network) can be applied in other fields of space research, as well: for e.g. in meteorological measurements, remote sensing, figure recognition, robotics, controlling of learning robots etc.

References:

Fig. 3. Visual representation of the local dataset in a model GIS system for students’ works on the test terrain around Hunveyor university lander.