Geoinformatics Study at the Czech Technical University in Prague

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SUMMARY

At the TU Prague, there is a long tradition of master degree courses in geodesy, geodetic surveying and cartography. Taking into account the fast development of information technologies during last decades we have decided to prepare a new study program that would combine the computer science with the background of geodetic and cartographic know-how. Apart from other sources, our plans were inspired and influenced by report Review of Education Needs by Stig Enemark (Prague 1998) and our experience from several Virtual Academy workshops.

We have decided to call this program "Geoinformatics" to emphasize the role of computer technologies in collecting, analyzing and exploiting the information about our planet. Within this presentation we would like to explain the basic ideas behind our new study program and emphasize its features that distinguish it from classical geodetic or cartographic courses. We would like to mention the connection between our new study program and several geodetic and software projects running at our institute - software development for real-time GPS applications, cooperation with the Astronomical Institute University of Berne on the development of the so-called Bernese GPS Software, GNU project Gama for adjustment of geodetic networks etc.

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1. WHAT'S IN A NAME?

> What's in a name? That which we call a rose
> By any other word would smell as sweet.[1]

We dare disagree with the great poet. The name of a study program could be important for students finishing their high school and deciding which university they want to apply for. Let us make a tiny linguist excurse. According to [1] the Geodesy is the scientific discipline that deals with the measurement and representation of the earth, its gravitational field and geodynamic phenomena (polar motion, earth tides, and crustal motion) in three-dimensional time varying space. The second branch of our traditional courses, the Cartography, is (according to [1] again) the study and practice of making maps or globes. We find the definition perfect, however, does it reveal, that the computer science and informatics play nowadays a key role in our discipline? This question could be important for young people deciding about the direction of their future professional carrier.

There is a new word, Geomatics, fairly young, apparently being invented by B. Dubuisson in 1969. It is the discipline of gathering, storing, processing, and delivering of geographic information. This broad term applies both to science and technology, and integrates several more specific disciplines (including the geodesy, cartography, and, last but not least – the geographic information systems). We were tempted to call our study program "Geomatics", however, at the end we voted for another new word – Geoinformatics.

Informatics (or Information Science) is studied as a branch of computer science and information technology and is related to database, ontology and software engineering. It is primarily concerned with the structure, creation, management, storage, retrieval, dissemination and transfer of information. We understand the "Geoinformatics" as a science that synthetizes the achievments of informatics with principial knowledge of geodesy and cartography. In geodetic courses we want to teach our students the mathematical and physical backgrounds of the geodesy as well as the practise of surveying – the techniques of gathering of measurements and their processing. Within the geoinformatics study we want to teach our students the theoretical principals of geodesy and many things about the computers and information technologies.

[1] Romeo and Juliet (Act II, Scene II)

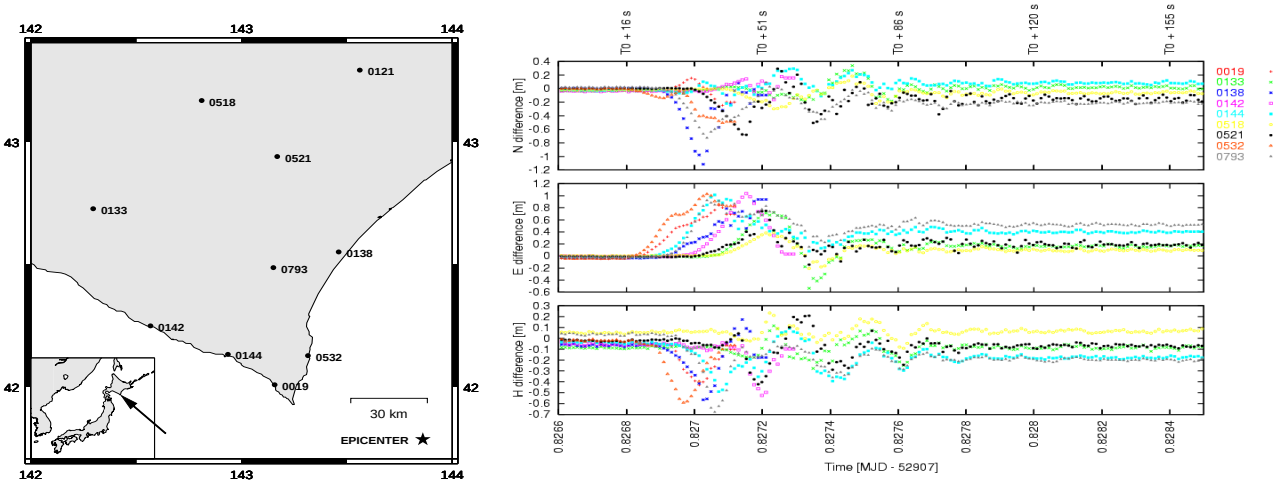
2. OUR PROJECTS – GEODESY AND COMPUTER SCIENCE IN CONCORDANCE

Protest my ears were never better fed
With such delightful pleasing harmony.[2]

We have studied geodesy and we like sitting at the computers writing our own applications. Could we bring these two things in concordance? We are deeply convinced, we can. We would like to present some projects of us to demonstrate the thin line between geodesy and informatics.

2.1 Real-Time Monitoring of GPS Networks

The first project is related to our work for the company GPS Solutions, Boulder, USA. Within the contract between the GPS Solutions and the Japanese Geographical Survey Institute (GSI) we take part in the development of a program system for real-time processing of GPS data with the highest possible accuracy [8]. Together with our American colleagues we have prepared a software system consisting of a server that collects data from many GPS receivers and a processing program RTNET (Real-Time NETwork) that computes very accurate positions of GPS stations in real-time. The system is primarily designed for the real-time processing of date stemming from the Japanese network GEONET (GPS Earth Observation NETwork) – a unique network consisting of 1200 permanent GPS stations. One of the main purposes of GEONET is the monitoring of seismic deformations. Understanding the character of seismic waves and the laws of their propagation may help to design earthquake-resistant buildings or even to establish an alert system that could save human lives. The left-hand side of the following figure shows a map of several GEONET stations located at the southern coast of the Hokkaido Island. The right-hand side shows the motion of these stations during the so-called Tokachi-Oki Earthquake on September 26th, 2003 computed by our RTNET software.

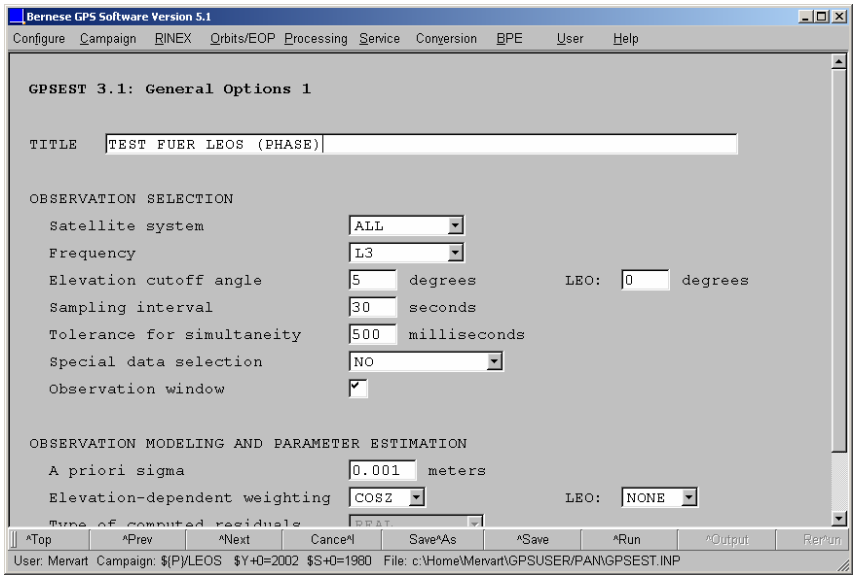


[2] Pericles, Prince of Tyre (Act II, Scene V)

We find it fascinating to see the huge seismic shocks revealed by GPS measurements. The plot clearly shows the propagation of seismic waves – stations closer to epicenter sense the waves earlier than the more distant ones. The time delay between the so-called primary and secondary seismic waves can be observed by comparing the horizontal and vertical components of station motions.

2.2 Bernese GPS Software

We are very proud to have an opportunity to take a part in the development of the so-called Bernese GPS Software. This software package has been developed at the Astronomical Institute, University of Berne, Switzerland since 1980's. It is used at many institutions round the globe for post-processing GPS data with the highest accuracy and for various purposes – the software is capable to estimate a large number of different parameter kinds: station coordinates, earth rotation parameters, satellite orbits, parameters of the atmosphere etc. The software is recognized for the quality of its mathematical model that ensures the accuracy of the results. It is the know-how of geodesy and celestial mechanics that stands behind the software's success. However, we are convinced that the technical quality of the program, its availability on different computer platform, and a given level of user-friendliness are of a major importance, too.



At the figure above a window of the Bernese menu system is shown. The Bernese GPS Software is an example of the concordance between a science of geodesy and informatics. It is becoming a custom today that many mathematical achievements find their "materialization" in sophisticated software projects.

2.3 GNU Gama and other Free Software projects

Talking about software development, as one of the possible fields we want our students to get involved into, we would like to underline one very specific software area, which is the Free Software. If you want to learn more about the phenomenon of Free Software, selected essays of Richard M. Stallman is probably the best starting point (or you can read the interview [7]).

Our first major free software project GNU Gama is dedicated to adjustemnt of geodetic networks. It was presented on various FIG meetings several times ([3], [4]), so we need not to describe it in detail here. The beginning of Gama project was influenced by our experiences from Virtual Academy meetings where it was firstly presented as a project aimed to motivate our students to get involved in software development and international collaboration.

Our geodetic study program at CTU Prague has traditionaly good and intesive contacts with the department of theoretical geodesy at Slovac TU in Bratislava. We have been organising short term exchange visits for our PhD students during recent years. It was very intersting to follow the lecture given last December by Marian Kovac (STU Bratislava) on the subject of general software for geodetic observation processing and to see how his work was influenced by the experience with the Gama project, he had learnt about the previous year.

Another example of our free software projects was presented last year on FIG Working Week in Athens [5]. The software part of this project was the GPS observation database written by Jan Pytel in close collaboration with prof. Kostelecky and this year we are going to extend our collaboration to the project of adjustment of combined solutions from various observation techniques (GPS, VLBI, etc).

We believe that the new curricula of geoinformatics, with intensive focus on the theoretical background, will help us to attract more talented students which would be able to collaborate on the software projects of the scientific nature as described above.

3. FUTURE OF GEODETIC SCIENCE

To-morrow, and to-morrow, and to-morrow,
Creeps in this petty pace from day to day.[3]

Obviously from the Macbeth's point of view the time passed slowly. Nowadays we know the relativistic effects: for people planning the future of their educational facilities it may run faster than wished. Our today's knowledge may appear insufficient for tomorrow's needs. How should we deal with this situation? What knowledge will our students need in several years when they finish their study? What should we teach them? It is not an easy question. Taking into account our incapability to estimate the precise needs of future, we are convinced that we have to concentrate on teaching methods, the ways of thinking, and general theories instead of specialized topics. Our students should primarily be able to gather and analyze the information. And this is actually the bottom line of geo-informatics. Without the knowledge of our primary science – the geodesy – the most breathtaking informatics achievements are

[3] Macbeth (Act V, Scene V)

useless for us. But vice-verse: our discipline (as any modern science) cannot develop without the sophisticated processing of information. It cannot live without informatics.

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BIOGRAPHICAL NOTES

Leoš Mervart receives his first PhD (in Astronomy) from the University of Berne, Switzerland and his second PhD (in Geodesy) from the TU Prague. 2002 he has been appointed a professor of geodesy and cartography at the TU Prague. He is a head of the Department of Geodesy at the Faculty of Civil Engineering and has lectures on geodesy, global positioning systems and adjustment theory. Leoš Mervart is interested in the development of software systems for processing GPS data. He is a co-author of the Bernese GPS Software and a program package for real-time monitoring of GPS deformation networks.

Ales Cepek is a professor of geodesy from 2003, working at the Department of Mapping and Cartography, Faculty of Civil Engineering, Czech Technical University, Prague, Czech Republic (since 1992). Started his professional career at the Research Institute of Geodesy, Topography and Cartography (VUGTK), Zdiby (from 1980 to 1991) where worked on research projects, programming, analysis and implementation of data structures for cadastral programs, co-author of programs for adjustment and analysis of geodetic networks; later at geodetic observatory observations with circumzenithal (astrolab), project for estimation of parameters of local quasigeoid. At present conducting research in the field of applications of XML and object-oriented processing of geodetic and cartographic data.

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