Internship 1.

Title of internship: *„Improvement of the geo-referencing computation model for DInSAR deformation maps"*

Contact person: dr inż. Paweł Bogusławski, e-mail: pawel.boguslawski@upwr.edu.pl

Duration: three months

What is the research problem the intern will resolve:

A common problem of the basic InSAR post-processing is solving the randomness of the datum of the generated unwrapped deformation maps. This is a consequence of the uncertainties of the number of phase cycles and the applied phase-unwrapping algorithm. A widely used approach is to use one stable point and reference all deformation maps to this location. In this manner all maps will have a common zero point. This approach is acceptable for the studies of the deformations caused by big earthquakes for example. In the case of IGiG studies over the mining area of Silesia, this solution is not applicable due to the densely distributed deformation zones with smaller dimensions, as well as the densely vegetated surroundings, that lower down the quality of the maps. In order to overcome this problem another methodology was developed. It is based on the quality of the data, expressed by the coherence of the interferometric pairs. The most coherent and stable pixels over a year time-span are chosen and a trend of the displacement is calculated based on the pixel displacement. The trend surfaces are used to unify the displacement maps. This method was presented for the first time in Ilieva et al. (2019). With the development of the DInSAR studies in IGiG it was found that this basic method has to be developed further taking into account more variables, like the time-span and season factors, deformation and vegetation zones. Additional statistical analyses have to be performed in order to study the influence of the applied method of interpolation. The candidate for the internship would have the task to support the post-processing of the DInSAR products by developing a Python code for application of the proposed methodology and to support the statistical analyses aiming to improve the approach. The applicant needs to have good skills on Python programming and image processing.

Ilieva, M.; Polanin, P.; Borkowski, A.; Gruchlik, P.; Smolak, K.; Kowalski, A.; Rohm, W. Mining Deformation Life Cycle in the Light of InSAR and Deformation Models. Remote Sens. 2019, 11, 745. https://doi.org/10.3390/rs11070745

What is the expected outcome:

The outcome of the internship will be a code of improved InSAR data post-processing methodology. This will contribute to the entire processing flow within the EPOS-PL+ project and to the further DInSAR studies in IGiG. The improved deformation maps will be used as inputs to the mining deformation modelling and prediction methodology, currently under development within EPOS-PL+. The results of the internship - improved geo-referencing methodology of the DInSAR deformation maps, will be published in co-authorship with the DInSAR and AI teams of EPOS-PL+ Task 7. In case of successful accomplishment of the task, the intern could continue the collaboration with IGiG within the EPOS-PL+ project, working on the improvement of the deformation modelling methodology and integration of the products from Task 7 (InSAR) and Task 8 (LiDAR).

Internship 2.

Title of intern: *„Finding the repeat times of the multi-GNSS constellation"*

Contact person: mgr inż. Radosław Zajdel, e-mail: radoslaw.zajdel@upwr.edu.pl

Duration: three months

What is the research problem the intern will resolve:

"Finding the repeat times of the GPS, GLONASS, Galileo and BeiDou constellations." Spurious signals in the GNSS-based time series are strongly related to the orbital periods and repeat cycles of GNSS satellites with respect to the ground network. The task to be conducted by the student will be to analyse the orbit repeat cycles of different GNSS satellites based on the broadcast and precise orbit products. A basic knowledge of satellite geodesy and details of the existing GNSS constellation is not required but will be an asset to help analyze the results of the task. Depending on the contractor's preference, the task may involve adapting existing scripts written in Fortran for the GPS constellation to the new GNSS product/data standards and multi-GNSS constellation characteristics or developing new computational scripts (Python is the preferred programming language).

https://link.springer.com/article/10.1007/s10291-006-0038-4

What is the expected outcome:

Summary report with description and graphical presentation of the results; source code written in Python or Fortran

Internship 3.

Title of intern: *„Implementation of the human mobility model in Python"*

Contact person: mgr inż. Kamil Smolak, e-mail: kamil.smolak@upwr.edu.pl

Duration: three months

What is the research problem the intern will resolve:

The trainee's task will be to convert and partially develop the mobility model, created at the Institute of Geodesy and Geoinformatics, into the Python programming language. The model in its current form was published in the Computers, Environment and Urban Systems journal in an article entitled Population mobility modelling for mobility data simulation and has a very large development potential, which should be fully used. However, its current implementation in the QGIS software limits the further development of the model. Therefore, it is necessary to convert the tool to the spatiotemporally enabled Python environment.

As part of the internship, the trainee will convert the model based on its current implementation. The effect of the internship will be part of the HuMobi programming library for the analysis and processing of motion trajectories, which is currently being developed at the Institute. Additionally, the trainee will develop the model by extending one of the model modules, responsible for simulating the nature of the temporal movement. By carrying out the task, the trainee will have the opportunity to:

- develop programming skills to a high degree, especially in the field of algorithm design,
- learn the details of the Python language, especially in terms of the implementation of programming libraries,
- get acquainted with the tools of spatial-temporal analysis,
- get to know the QGIS programming interface.

What is the expected outcome:

The internship will result in a developed HuMobi programming library for analysis and processing of movement trajectories, which is currently being developed at the Institute of Geodesy and Geoinformatics at the Wrocław University of Environmental and Life Sciences. A new, mobility models module will be added to the library. The module will be designed by the trainee in a way that increases the ease of its extension in the future, which will significantly accelerate the works on human mobility modelling and contribute to strengthening the position of the Wrocław University of Environmental and Life Sciences in the arena of human mobility analysis.

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Internship 4.

Title of intern: *„Satellite radar images for precise agriculture"*

Contact person: dr inż. Kamila Pawłuszek-Filipiak, e-mail: kamila.pawluszek-filipiak@upwr.edu.pl

Duration: three months

What is the research problem the intern will resolve:

Climate change, population growing, and increasing demand for food make precise and efficient agriculture essential. The development of the crops is described as phenological phases which are assessed by visual field observations. Knowledge about phenological stages allows to adjust fertilization, irrigation, disease and insect infestation, etc. to achieve sufficient crop yield. Field inspections conducted by farmers are time-consuming and are selective. Satellite imagery that covers a large area allows to monitor the development of phenological phases on a large scale. Passive satellite imagery in the near infrared spectral band has already proven its applicability in monitoring vegetation development. However, due to the presence of clouds and the dependence on sunlight, these data have a much lower real-time resolution, which makes their operational use very limited. Synthetic Aperture Radar (SAR) images are sunlight and cloud independent. Consequently, they are characterized by better temporal resolution and have greater potential for practical use. Nevertheless, the radar signal also depends on vegetation water content, soil moisture, and other factors. Therefore, the subject of this master internship will be to test various indicators calculated on the basis of SAR data and determine which of them are characterized by the greatest correlation with the development of crops and thus have a greater application potential.

The internship will result in a elaboration/publication which will present indicators calculated from radar data, which are highly correlated with the development of cereals and have application potential.

Internship 5.

Title of intern: *„Satellite radar images for mining"*

Contact person: dr inż. Kamila Pawłuszek-Filipiak, e-mail: kamila.pawluszek-filipiak@upwr.edu.pl

Duration: three months

What is the research problem the intern will resolve:

Underground extraction of raw materials causes significant changes to the terrain surface, which should be monitored to prevent the negative effects of mining activities such as buildings and infrastructure monitoring. Terrain deformation monitoring by conventional geodetic methods such as levelling or total station are highly time-consuming and are point-based measurements. Remote sensing methods using Synthetic Aperture Radar (SAR) with a temporal resolution of a few days provide perfect opportunities for monitoring these areas on a large scale using satellite radar interferometry. Different satellite missions with different radar wavelengths have different accuracies as well as deformation detection capabilities, different sensitivity to atmospheric artefacts as well as different temporal and spatial resolution. Therefore, the topic of this master internship will be the integration of data from various satellite missions to determine high-resolution and accurate maps of land surface deformation, which will be beneficial for the mining sector especially in the urbanized areas.

What is the expected outcome:

The internship will result in a elaboration/publication presenting an integrated map of deformation in mining areas from various radar missions together with a map of buildings and infrastructure in hazard caused by mining exploitation.

Internship 6.

Title of intern: *„Artificial intelligence and remote sensing data for landslide susceptibility mapping"*

Contact person: dr inż. Kamila Pawłuszek-Filipiak, e-mail: kamila.pawluszek-filipiak@upwr.edu.pl

Duration: three months

What is the research problem the intern will resolve:

Landslides are one of the most common geohazards in the world and which pose a serious threat to human life as well as building and infrastructure. Therefore, their identification as well as the identification of areas prone to landslides is extremely important. Landslide susceptibility modelling is made on the basis of various landslide conditioning factors, which influence the formation of a landslide, e.g. slope, lithology, slope aspect, proximity to geological structures, roads, rivers etc. These master internships are aimed at building a model of landslide susceptibility on the basis of various data with particular use of airborne laser scanning data and remote sensing images. Landslide susceptibility modelling will be performed using artificial intelligence to ensure the highest accuracy.

What is the expected outcome:

The internship will result in an elaboration/publication presenting a map of the likelihood of landslides in a given area.

Internship 7.

Title of intern: *„Measurement system for the functioning of the trackway”*

Contact person: dr inż. Izabela Wilczyńska, e-mail: izabela.wilczynska@upwr.edu.pl

Duration: three months

What is the research problem the intern will resolve:

Each of the geodetic measurement methods of railways has advantages and disadvantages, therefore it is worth proposing our own measurement system solution adequate to the functional and accuracy needs. The project concerns the implementation of a measuring device for collecting geo-information of the railroad geometrical condition with the accompanying software. The aim of the project is to develop a multi-sensor device and a method for collecting and processing spatial data, as well as assessing the possibility of using them when determining the technical condition of railways. The student's task would be to propose a method of integration and data presentation.

The main stages of work are:
- inertial data processing,
- direct georeferencing of data from a terrestrial laser scanner,
- development of the railhead analysis algorithm based on scans and data visualization.

What is the expected outcome:

The effect of the internship will be primarily report containing the concept of data processing and analysis algorithm.