Internship 1.

Title of internship: *„Web-application development for GNSS network selection based on the quality analysis of RINEX files"*

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

Duration: three months

What is the research problem the intern will resolve:

Determination of global geodetic parameters and realization of the terrestrial reference frames using GNSS observations require a global, evenly distributed network of ground stations. There are several hundred GNSS stations worldwide operating as part of the International GNSS Service (IGS) infrastructure and countless permanent GNSS stations operating as part of regional and national networks. The complexity of computational processes makes it impossible to use all available GNSS stations for the calculation of global geodetic parameters. On the other hand, it is necessary to select the most representative group of stations, providing GNSS observations of the best quality (taking into account the number of available observations, measured signal-to-noise ratio, multipath analysis) and characteristics that meet the requirements of a specific task (e.g. tracking selected GNSS frequencies). The task to be completed during the internship will be to create a multi-criteria algorithm for GNSS station selection for global geodetic parameters determination purposes and the analysis of multi-GNSS data availability for receivers belonging to the IGS network.

What is the expected outcome:

Develop the algorithm in the form of an application and describe the operation in the form of a report.

Internship 2.

Title of intern: *„Monitoring of infrastructure deformations with satellite radar data"*

Contact person: dr Maya Ilieva, e-mail: maya.ilieva@upwr.edu.pl

Duration: three months

What is the research problem the intern will resolve:

Underground mining activities, in addition to rock layer changes, also affect the infrastructure directly above them. In order to minimize the risk of damage as well as to protect people using this infrastructure, such objects should be monitored. Classical surveying techniques such as levelling, total station and GNSS measurements are mainly used for this task. Nowadays really often active remote sensing techniques such as Interferometric Synthetic Aperture Radar (InSAR) are becoming used.
The goal of the internship is to investigate the deformations on the infrastructure in Upper Silesia caused by mining works conducted in the area. Differential Interferometric Synthetic Aperture Radar (DInSAR) method based on Sentinel-1 and TerraSAR-X data will be used. IGiG has a big archive of Sentinel-1 DInSAR deformation maps spanning 2016-2021 that will be the basis for this study. Thanks to the archive, the sensitive infrastructure objects will be located and time-series analyses of the development of the deformations in this time period will be analysed. The chosen infrastructure objects will be further studied with a new set of data with higher resolution, namely TerraSAR-X. They will be processed by the intern aiming to provide more detailed view of the evaluation of the deformations in the first half of 2022.
The candidate for this internship has to have good skill for using GIS software (e.g. QGIS, ArcGIS) and statistical analyses using chosen environment (e.g. Python, Matlab). Experience with knowledge of SNAP software for DInSAR processing would be advantage.
The intern will work in a close collaboration with the InSAR team of the EPOS-PL+ project involved in the creation of the Center of Research Infrastructure for Satellite Data in IGiG.

What is the expected outcome:

The outcome from the internship will be a report that will support the further DInSAR investigations in IGiG and especially the studies performed within the EPOS-PL+ project. If significant results will be achieved they could be prepared for scientific publication or presented at a scientific conference.

Internship 3.

Title of intern: *„Satellite Radar Remote Sensing 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:

The changing climate, growing population and increasing demand for food make precise and efficient agriculture extremely important. The development crops is described as phenological phases which are conventionally assessed by visual field observations. Knowledge of these phases allows the appropriate adjustment of fertilization, irrigation, prevention of disease and insect invasion, etc., which allows to achieve a sufficient crop yield. Field visits by farmers are time-consuming and are point-based. Satellite imagery that covers a large area makes it possible to monitor the changes of these phases on a large scale. Passive satellite imagery using electromagnetic radiation in the near infrared range has already proven its applicability in monitoring crop development. However, due to the presence of clouds and the dependence on sunlight, these data have a much lower real revisiting time, which makes their operational use very limited. Synthetic Instrument Radar (SAR) imaging is sunlight and cloud independent. Consequently, they are characterized by a better time resolution and have a greater potential for practical use. Nevertheless, the radar signal also depends on vegetation and soil moisture and other factors. Therefore, this master's internship will focus on testing various indicators calculated on the basis of SAR data and determining which of them have the greatest correlation with the development of crops and thus have a greater application potential.

What is the expected outcome:

The internship will result in a report/publication presenting indicators calculated from radar data, which are highly correlated with the development of crops and have application potential in precise agriculture.

Internship 4.

Title of intern: *„Automatic identification of animals in thermal images collected with the use of unmanned aerial vehicles"*

Contact person: dr hab. inż. Grzegorz Jóźków, prof. uczelni, e-mail: grzegorz.jozkow@upwr.edu.pl

Duration: three months

What is the research problem the intern will resolve:

Unmanned Aerial Systems (UASs) can be equipped with various sensors, including thermal cameras. UASs equipped with this type of cameras are used in many applications, e.g. to identify and locate objects that absorb or emit heat energy in a different way than surrounding objects. An example of objects that emit thermal energy are living animals. Thus, it is possible to identify on the thermal images obtained with the use of a drone animals that live in an environment with a temperature different than their body, e.g. to identify wild animals feeding on farmlands. The optimal solution to this task would be an automatic determination of both the number of such animals and their type (species). Due to the specificity of the thermal camera and the specificity of UAS data acquisition, this task is challenging because of several factors. The ground resolution of thermal images collected by UAS is low, so even relatively large animals (e.g. deer) will be visible in the thermal images as a group of several dozen pixels. For this reason, distinguishing the type (species) of the animal may be difficult or even impossible. The second factor is the fact that a single thermal image shows only a fragment of the area of interest and even the development of a 'thermal' orthomosaic using photogrammetric methods can make it difficult to recognize and count animals that moves. On the other hand, subsequent images taken with certain coverage may show the animal from a different angle of view, which may benefit in better recognition of the animal type and eliminating its repeated counting. The problem to be solved during the internship will consist of three aspects:

(1) developing a method of animal identification on thermal images obtained using UAS, i.e. determining which of the groups of pixels with increased temperature show animals,
(2) developing a method of analyzing a series of consecutive image taken along one flight line to determine the number of animals, taking into account the fact that the next image may show the same animals as in the previous image,
(3) testing machine learning algorithms to distinguish between different types of animals visible in thermal images. Test data in the form of a series of thermal images collected with the use of UAS will be provided by IGIG.

What is the expected outcome:

Report, code. The internships will result in a report on the analysis of test data with a presentation of the methodology used and the code. The results of the internship can be used in the future to prepare a publication and / or project proposal.

Internship 5.

Title of intern: *„Detection of displacements in the time series of coordinates determined from HR-GNSS observations"*

Contact person: dr hab. inż. Jan Kapłon, prof. uczelni, e-mail: jan.kaplon@upwr.edu.pl

Duration: three months

What is the research problem the intern will resolve:

The purpose of the internship is to conduct an experiment aiming to:

- collect numerical data required to investigate real-time GNSS PPP displacement detection algorithms based on coordinate time-series. The experiment is to simulate vertical and horizontal displacements of a given size and register them with a high-rate GNSS receiver (HR-GNSS) and an accelerometer with a GNSS receiver, in order to compare the time series from both devices, which will enable precise determination of the epoch of the simulated displacement. As a result, HR-GNSS data and accelerometer measurements will be collected, which are precisely time-correlated, thus will allow to carry out numerical tests of displacement detection, leading to the automation of detecting and reporting significant displacements from the GNSS data in real time;
- test the displacement detection algorithms described in the literature;
- consider, whether it is possible to improve the accuracy of amplitude determination and the exact epoch of displacement.

Depending on the success of the above works, they can be extended to issues related with the correctness of vibration detection with the use of HR-GNSS by simulating shocks and their simultaneous recording with the use of an accelerometer or an inertial unit (IMU).

What is the expected outcome:

A report containing work results, which will be a batch for publication, as well as a draft of publication prepared together with IGIG employees.