WROCŁAW UNIVERSITY
OF ENVIRONMENTAL
AND LIFE SCIENCES

DEPARTMENT OF GEODESY AND GEOINFORMATICS

Internship 1.

Title of internship: *„Development of an Urban-Scale Surface Displacement Prediction and Anomaly Detection Service"*

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

Duration: three months

What is the research problem the intern will resolve:

Imagine a system that monitors terrain changes in cities, detects anomalies, and predicts potential threats to infrastructure – all powered by satellite data and advanced Big Data analytics. Now, you have the opportunity to be part of its development!

During this summer internship, you will contribute to the expansion of a service dedicated to predicting and detecting surface displacement anomalies in urban environments. You will leverage cutting-edge data processing techniques to track and forecast terrain movements in areas where precise analysis is crucial for the safety of buildings, bridges, tunnels, and critical infrastructure.

Why is it worth joining?

- Real impact – Your analyses could help protect buildings, roads, and bridges from the effects of land displacement.
- Modern technologies – You will learn how to work with satellite data, process Big Data, and apply spatial analysis algorithms.
- Work with space data – Gain experience in using radar technologies for Earth monitoring.
- Unique experience – Get insights into techniques used in global projects like the European Ground Motion Service (Copernicus).

Who is this internship for?
We are looking for individuals passionate about data analysis, geoinformatics, programming, and space technologies. If you are interested in how satellite data can support urban development and infrastructure protection, this internship is for you!

What is the expected outcome:

- Satellite SAR Data Analysis – You will work with data from missions such as Sentinel-1 and TerraSAR-X, monitoring terrain movements at the city and surrounding area level. You will automate data processing using Python.
- Big Data Processing – You will develop Python code to efficiently analyze millions of measurement points, enabling the prediction and detection of infrastructure displacement anomalies.
- Enhancing Anomaly Detection Algorithms – You will use historical displacement data to predict future changes and issue warnings about potential threats, such as ground subsidence or structural deformations.
- Development of the Infrastructure Monitoring System – You will add new functionalities to the displacement monitoring and anomaly detection service: upwrinsarmonitoring.onrender.com.

Requirements:

Advanced proficiency in Python programming and knowledge of SAR data processing.

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Internship 2.

Title of internship: *„Visual localization in indoor spaces using deep neural networks”*

Contact person: Dr. Małgorzata Jarząbek-Rychard, e-mail: malgorzata.jarzabek-rychard@upwr.edu.pl

Duration: three months

What is the research problem the intern will resolve:

The internship is linked to an internal research project conducted at IGIG: "Development of Methods for Automatic Reconstruction of Dynamic Spatial Models of Building Interiors Using Deep Learning”.

The problem of indoor localization and navigation is an interdisciplinary topic that combines fields such as geoinformatics, building information modeling (BIM), and robotics. Unlike widely used and well-developed vehicle navigation based on GPS signals, we still face challenges in locating target points in various unfamiliar building complexes—such as offices, museums, or shopping centers. The widespread use of smartphones with built-in cameras, combined with advances in artificial intelligence, has led to increased interest in innovative visual localization methods based on images. Deep neural networks trained on RGB images can determine the camera's coordinates at the moment a photo is taken, thereby enabling its localization.

The internship tasks include:
a) Conducting a literature review on the given topic.
b) Implementing an existing network architecture.
c) Training the network on different datasets.
d) Preparing a report on the work conducted.

What is the expected outcome:

The application of a method that enables visual indoor localization based on real and synthetic images and the analysis of the obtained results

Requirements:

Basic knowledge of Python programming, basic understanding of photogrammetry, willingness to learn machine learning concepts and the PyTorch library, and proficiency in English.

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Internship 3.

Title of internship: ***„Application of a variational method in atmosphere profiling using GNSS remote sensing observations”***

Contact person: Dr. Paweł Hordyniec, e-mail: pawel.hordyniec@upwr.edu.pl

Duration: three months

What is the research problem the intern will resolve:

GNSS remote sensing observations using the radio occultation (RO) technique are a complementary source of data on the vertical distribution of the atmosphere, traditionally obtained from balloon soundings. Both of these datasets feed numerical weather prediction models, which describe meteorological conditions in a three-dimensional grid, along with their temporal variability. While common meteorological parameters include temperature and relative humidity, GNSS remote sensing observations provide geophysical profiles of non-traditional variables such as bending angle and refractivity. In order to transform these into standard meteorological parameters, algorithms based on variational methods are commonly employed for the purpose of data assimilation into numerical models. This process involves estimating the most probable value based on a priori parameters derived from the model. Since GNSS remote sensing observations from the radio occultation technique have very high vertical resolution, the derived humidity profiles can provide new information that might otherwise remain "invisible" by the model. This is particularly important for meteorological conditions characterized by high dynamics and developing over remote areas where traditional observations are unavailable, limiting the forecast skill of the model. A qualitative assessment of the derived humidity profiles, along with an analysis of vertical distribution variability, will be conducted in the context of atmospheric rivers. These phenomena originate over the Eastern Pacific and lead to heavy rainfall and flooding along the West Coast of the United States.

The internship is linked with the internal UPWr grant entitled „Simulations and observations of planetary boundary layer in the radio occultation technique”.

The funding is provided from the respective project N060/0001/24. This activity can be continued and extended beyond the internship as part of a master thesis in accordance with the proposed topics for the 2025/2026 academic year.

The potential to expand the scope of research to a national-scale project within the funding framework of the National Science Centre, Poland.

What is the expected outcome:

Retrieval of moisture profiles from GNSS radio occultation observations using Radio Occultation Processing Package (ROPP). Optimalization of the algorithm based on error covariance options. Testing of various configurations concerning observation and background error models. Quality assessment of retrieved GNSS moisture profiles relative to background meteorology.

Requirements:

Programming skills in preferred language, data visualization, familiarity with command line in Unix\Linux systems, proficiency in English.

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Internship 4.

Title of internship: ***„The use of digital twins (3D models) of cities in issues of communication with the socio-economic environment"***

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

Duration: three months

What is the research problem the intern will resolve:

Geodetic land utilities databases (GESUT) are an important spatial resource used in various applications, including: creating network models, investment management or creating hydraulic models of the network or its newly designed subset. Thanks to GESUT, it is possible to roughly estimate the location and course of underground networks, which allows for safe construction work and avoiding damage to the network, and as a result, a potential disaster. It is also possible to use the resource to develop a hydraulic model, which is the basis for planning and developing the network along with the increasing needs of rapidly growing cities.

Before such a spatial network model is built from GESUT data, it is necessary to first check the data in terms of geometric and topological correctness as well as mapping descriptive attributes and types of objects to the industry model. Due to the fact that the data in the GESUT resource is developed by 380 geodetic district centres by entities with different experience and skills, the occurrence of errors and inconsistencies in data representation is inevitable.

It is therefore necessary to locally supplement and improve the data geometry and semantic information presented in the form of attributes. Common errors include breaks between line sections causing breaks in the transmission network, intersecting network sections without using connecting elements, incompatible diameters of adjacent pipes preventing their connection in reality, lack of cuts at the junctions of various objects, etc.

Another element of the hydraulic model building process is the development of a generalized 3D spatial model of network elements, which will enable, among other things, analysis of pipe slopes, which is important in the case of the sewage network. It will also allow for the detection of collisions of network sections running at different levels. Ultimately, the underground network model will be visualized using 3D technology with additional layers, including: a background map, buildings, other elements of ground infrastructure. Especially for heating networks with numerous bends and places with an above-ground course – modeling must take such cases into account.

The internship will be carried out together with the company – InfoSolutions.

What is the expected outcome:

The aim of the internship is to develop tools for validating network data collected in the GESUT resource and to develop a 3D model of the underground network, and on its basis, an input to the hydraulic model of the network.

Requirements:

- knowledge of issues related to spatial modelling,
- knowledge of selected technologies (FME, ESRI, QGIS, Python and others),
- knowledge of English enabling understanding of technical documentation and scientific publications,
- CV.

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