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Abstracts of papers send for 2016 Baltic Geodesy Congress (Geomatics) - as of 1st June, 2016.

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Dear Participants of the Baltic Geodetic Congress (Geomatics)

We are pleased to say thank you to all the participants, special guests, invited speakers, co-organizers, partners and sponsors who have joined us during the Baltic Geodetic Congress. We hope that the Congress will turn out as a revealing and a beneficial event and will lay the groundwork for a future successful cooperation of academic and economic entities working with the latest geodetic and cartographic technologies.

We are particularly grateful to be given the opportunity to host this special event. Especially, due to the fact that our Department of Geodesy is the oldest academic department in that field in Poland and it continues the tradition of the Department of Surveying and Cartography, established in 1904 at the Königliche Technische Hochschule zu Danzig being an ancestor of the present-day Gdansk University of Technology. Nowadays, the Department of Geodesy still develops new specializations related to civil structure, marine surveying or smart cities.

The Congress has coincided with the changes of the Faculty authorities, and therefore, we both, the current Dean and the just elected future Dean, wish you a successful scientific meeting with many fruitful discussions, an exchange of experiences and new ideas, but also just to enjoy the congress events and to spend a good time among friends.

Krzysztof Wilde

Elected Dean Faculty of Civil and Environmental Engineering Gdansk University of Technology

Ireneusz Kreja

Dean Faculty of Civil and Environmental Engineering Gdansk University of Technology Book of Abstracts - Geomatics 2016

Dear Participants of the Baltic Geodetic Congress (Geomatics)

First of all let me express my profound gratitude for your participation in our common and recent event. Since the Geomatics Conference 2010, which took place in 1-2 July 2010, organized by the Department of Geodesy of the Technical University of Gdansk, we have proceeded to regular meetings of scientists and researchers involved in geodesy and related contemporary disciplines.

"Golden era" of Surveying and Remote Sensing is about to begin. Your articles indicate that the continued interest in the detailed measurements has many supporters. The wide variety of topics covered in your publications, indicates that there is no place in modern science and technology where widely understood geodesy does not leave an impact. Fashionable and popular topics like GIS and spatial analysis are constant and strong representatives of the geodesy in many fields of human activity. Detailed measurements conducted using special cameras and scanners allow you to detach the true nature of things without direct contact with them, means - the remote sensing breaking into our everyday lives as a broad wave. Transportation, surveying engineering, medicine, security, and even artificial intelligence become the arena where modern geodesy testifies that, without it the scientific and technical progress will not be possible. We are giving to You the book of abstracts, which is an expression of your accomplishments and your enormous contribution to the development of modern geodesy. We wish You a pleasant reading.

The full texts of papers that have passed through a very demanding review system and will be presented during 2016 Baltic Geodetic Congress (Geomatics), will be sent to the IEEE Xplore, and submitted to the indexation in the global scientific databases (including Web of Science and Scopus). Authors whose papers will be published, deserve special words of appreciation, since less than 57% of submitted papers were initially accepted for full publication.

Marek Przyborski Head of Department of Geodesy Gdansk University of Technology Book of Abstracts - Geomatics 2016

ACCURACY OF VISUAL EGO-MOTION ESTIMATION – A BIKE MAPPING SYSTEM CASE STUDY

Jakub Kolecki¹, Agnieszka Moskal², Elżbieta Pastucha³

This paper describes first tests of mobile mapping system prototype designed for bike, concentrating on the accuracy of estimation of trajectory parameters using purely visual approach. The concept of visual ego-motion estimation, known also as visual odometry, is a major area of interests within the field of photogrammetry and computer vision. It can be defined as the motion estimation of the system using only information acquired by the system optical sensors. In general acquired imagery data can be arranged in the convenient form of image sequences assigned to a single or multiple cameras [1]. As a result of the automatic image orientation process the trajectory parameters (coordinates and angles) are provided. If the ego-motion estimation takes place in the real time, it can be referred as a visual navigation. Visual odometry has become a key concept in the field of mobile robot navigation as it appears to be very attractive when compared to other navigation methods. The visual approach involves sensors that are much cheaper than high-class inertial devices. This type of navigation is independent of satellites so in contrast to GNSS-based navigation can take place inside the buildings as well as in the urban canyons. Investigating the visual approach to ego-motion estimation is of fundamental importance for performance of low-cost mobile mapping systems that are not equipped with high-class GNSS/INS system.

Conducted tests aimed to estimate the drift of coordinates and angles for different acquisition scenarios, involving different camera geometry. Besides, the tests were assumed to verify the completeness of data registration and performance of system control and synchronization. Addressed experiments are the continuation of previous studies [2] concerning the development of the algorithm for automatic motion recovery of image sequences acquired form bike.

The mapping platform is equipped with two cameras synchronized using the GNSS receiver PPS output. Other devices such as a laser scanner, IMU and additional cameras are supposed to be fully integrated in the future. During the tests three sequences of over 200 images were acquired along with GNSS real-time measurement. Data acquisition was carried out in the test field equipped with a number of control points, coordinates of which were determined in the national coordinate system PUWG 2000/21. After the data acquisition the reference trajectory parameters were estimated using a classical photogrammetric approach involving ground control information. Subsequently the estimation of the trajectory parameters has been conducted according to the conditions typical to the mobile mapping campaign. The adjustment of image sequences has been performed in the closed-loop and opened-loop scenarios, in both cases applying only a limited number of control points necessary for the comparison purposes. The differences between the reference trajectory parameters

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and estimates for the opened-loop and closed-loop configuration has been calculated.

The results show that the drift of the trajectory coordinates reaches the level of decimeters, occasionally exceeding half of the meter. For all three sequences and for each camera a higher drift is developed in the opened-loop sequence. The same phenomena is observed also for roll, pitch and yaw values. Additionally the coordinates of the trajectories estimated using purely visual approaches were compared with those resulting from GNSS measurements, showing also a high drift in the opened-loop scenario. However in this case the results are supposed to be highly disturbed by GNSS measurement errors. Conducted tests and obtained results show that the system performs well. Data completeness has been successfully verified. Accuracy analysis provides reference data for testing the performance of the image based motion estimation being currently under development.

Key words: mobile mapping, ego-motion estimation, bundle adjustment, image sequences

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A METHODOLOGY FOR MAPPING AREAS POTENTIALLY UNSTABLE. APPLICATION TO THE REGION BEJAIA, ALGERIA

Bendadouche Hocine¹, Merabet Smail², Khemmoudj Kaddour³

Planted on land made of hillsides, the coastal town of Bejaia is subject to many landslides. Observations show that these events are due to excessive overload of the land, the presence of water and poor soil quality.

To minimize the socio-economic impact of the landslide, we opted for a GIS (geographic information systems) as a tool for decision support on the choice of assignable building-sites and preventive measures to reduce risks.

A first database was compiled from existing documents, surveys and a campaign investigation of the soil. Various existing maps (topography, geology, settlements...) are digitized and organized in the GIS to be superimposed on each other. It is very easy to understand the spatial organization of different objects.

The purpose of this paper is the mapping of various instabilities and their ranking according to degree of potential.

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Key words: lithology, instability, cartography

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A MODERN APPROACH TO AN UNMANNED VEHICLE NAVIGATION

Pawel Burdziakowski¹, Marek Przyborski², Jakub Szulwic³, Artur Janowski⁴

A traditional approach to manned vehicles navigation uses a data combined form a variety of navigation sensors like satellite, inertial and time-of-flight. With support of operators perception, chart and sensor, data are analyzed and navigation decisions are made. An unmanned platforms navigation needs an operators support, who is supervising a platforms decision process, basing on navigation data obtained via variety of electronic sensors. Majority of unnamed platform are equipped with a single visible light camera, in order to transmit an actual information on platforms surroundings. It helps operator to react on dynamically changing navigation situation. That fact lead us to a thesis, that a visual data generated by a single nonmetric camera can be a good source of navigation information for plotting own platform trajectory and support an autonomous navigation process. The paper describes an evolved navigation process based on a visual data form a single non-metric camera. The navigation process has been implemented and experimentally tested.

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Key words: navigation; UAV; photogrametry; SLAM; unmaned; plaform

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ANALYSIS OF HIGH RESOLUTION POINT CLOUDS AS A SOURCE OF BIOMETRIC DATA

Katarzyna Bobkowska¹, Artur Janowski², Marek Przyborski³, Jakub Szulwic⁴

The article presents the analysis devoted to of human face data which were obtained by means of precise photographic scanners. Acquired (using this scanners) point cloud were used to make high precision meshes of human face. In particular its construction brings a vast amount of information that may be the subject of biometric analysis, eg. for *person* identification, emotion classification or diagnosis of genetic diseases. The essence of these studies is the comparison of relative features as well as the comparison of absolute models which requires as precisely as possible matching of face models. The article focuses on the analysis of various parts and the selected points of the human face, relative to that you can execute matching of models using translation, scaling and rotation for the purpose of the transformation of local coordinate systems of the face. In order to visualize the accuracy of registration process of selected models under various assumptions, the map of deviations between the models has been created.

Key words: biometrics, stereo image processing, human factors

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ANALYSIS OF THE USEFULNESS OF LIDAR DEM TO UPDATE THE RIVER NETWORK IN THE TOPOGRAPHIC DATABASE

Sylwia Szlapińska¹, Radosław Piskorski², Krystian Pyka³

Examinations described in the article were undertaken in order to check whether it is possible to automatically improve the quality of presentation of river network on topographical maps in the scale of 1:10 000. Examples of the Digital Elevation Model (DEM) application in the modelling of the flow of waters and creating on this base of hydrographical network are well-known for literature [2]. However this task is simpler than the update of the drainage network on existing topographical maps. The update requires accommodating itself to the conceptual model according to which for years topographical and cartographic approach. A fact is implementing additional complication, that at present topographical maps are only a visualisation of objects gathered in the database. Thus improving the quality of the river network must take into account both the conditions set by the Digital Landscape Model (DLM) and Digital Cartographical data in the drainage network was posed if high-altitude data became accessible from the airborne laser scanning (ALS, Light Detection and Ranging - LIDAR), which towards data of the older generation constitute the completely different quality.

The modelling of the hydrographical network has sizeable methodological possessions [2]. Solutions being aimed at a detection of waterway networks reach the beginning of the 80's [3]. For the last decades they were constantly improved and fitted to accessible numeric data and universally implement in GIS software packages [1, 2, 5]. Rarely results of the modelling have been used for the purposes of updating topographical maps. One of the reason was the above-mentioned difference of conceptual models. The second reason was the relatively low quality of elevation data – there were available gridded DEM which cell size was about 10-30 meters. It is particularly important for areas with low height differences, where the results obtained on these data were very low and their accuracy decreased with increasing the size of the grid's cell [4]. In recent years, in many countries, including Poland, are available ALS data. On the basis of LIDAR point cloud, a regular grid DEM achieved with a 1 meter's resolution and the value of average error of Z (elevation) coordinate on the level of 0.20 meter. Such data was used in examinations and as test area of the part of Pogórze Środkowobeskidzkie was chosen. This region is characterized by variable landform and notable elevation differences.

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In analyses an ArcGIS software was used, with algorithm D8 [3] built in into it, for appointing maps of the water accumulation and flow direction. Apart from DEM's resolution on the level of 1 m was generated secondary regular grid of 1-, 2 - and 5 meters' resolution. Various methods of the interpolation of grid were applied, moreover some of them were being subjected to smoothing. As a result of conducted experience it was noticed that from a point of view of the put purpose of research it was possible to achieve far more better results from DSM about the smaller cell size, fitting only a rate of the water accumulation to the capacity of the area. In addition, there were significant discontinuities in the course of the river network when using a grid with a resolution of 5meter. This fact explained why the old generation DEM didn't prosper. After all recommendations were formulated in using the automation for the power supply and the update of the topographical database BDOT10k. Determined in which cases automation can replace the operator, when it is helpful for the operator to manually drawing axis of the river and when it is not able to replace the human.

Key words: flow direction, river networks, regular grid DEM, LIDAR, ALS data

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ANALYSIS OF THE VARIABILITYOF THE MOTORWAY ON AGRICULTURAL LAND AS AN EXAMPLE A1 MOTORWAY SECTION

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The developed innovative method for estimating the motorway impact on agricultural land allows specifying all the losses associated with the directions of this interaction. The basis for determining losses is the analysis of variability of land use and quality classes and arrangement of access roads to the land along the axis of the planned motorway. The adopted measure of the multi-direction motorway impact on agricultural land is a specified change in the value of land, at which determination only the diversity of the land suitability for agricultural production was taken into account. To conduct an analysis it is necessary to determine the variability of soil quality on the route of the motorway, location of road and motorway lane, parameters of layout of the plots cut by the motorway and the location of the protective green belts. The above data serve as the basis for determining the variability of these characteristics of land under the influence of motorway construction. These features determine land production suitability and are used to estimate the overall impact of motorway construction on agricultural land.

The method for estimating the motorway impact on agricultural land, allows to estimate the impact of the motorway on agricultural land including the loss of land taken under the road belt, the reduction of the production capacity of land located near the motorway and deterioration of the farm layout cut by the motorway. Thanks to the simplified nature of the used method, its workload has been greatly reduced, which allows its use in assessing the various options of the motorway route, yet at the stage of the preliminary design. The calculation procedure was automated using a program written in Visual Basic, which used for Microsoft Excel spreadsheets.

To determine the parameters, it is necessary to draw the axis of the planned motorway on the cadastral map. Along the axis of the motorway should be marked and numbered points, in which classification or use of land change. Intersections of the motorway axis with access roads to land should be taken into account as well as all access roads to the land including those, which have been classified as agricultural land and are important for the local transport.

The resulting sum of the road sectors lengths running through highlighted land and their quality classes allow to estimate the differences in the type and quality of land along the lane motorway. It is important to estimate the lengths of the areas supported by the given road, which can be accessed through the motorway. The product of the length and width of the area is equal to area, to which access requires crossing the motorway lane. The number of plots cut by the axis of the motorway and the characteristics of their layout enables to estimate the impact of the highway on the shape and size

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of plots.

On the basis of information about the presence of the protective green belts the area occupied under construction is calculated and the scale of the reduction in the value of land located near the motorway. While on the basis of the study of variability of quality of land located along the axis of the motorway it is possible to estimate the quality of land located in the zone of influence of the motorway.

The developed method of the determination of the motorway impact on agricultural land is shown on the example of the planned motorway section.

The construction of one kilometer of the motorway section will reduce the value of agricultural land on average of 1500 cereal units. Taking over the land for the motorway construction and its negative impact covers about 85 % of the total loss of value of agricultural land. The remaining 15 % of the loss of the land value is associated with the increase of the transport and deterioration of the plots layout.

Key words: value of agricultural land, the impact of the motorway, farm land layout

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ANALYZING THE GEOMETRY OF THE TURNOUTS AND THEIR ADJUSTMENT BASING ON THE TACHEOMETER MEASUREMENTS

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This dissertation confirms the validity and presents the specific method of carrying out the geodetic measurements and analysis of the track system geometry. The structures, which require particular, expert knowledge in terms of both inventory surveying and diagnostic tests are railway turnouts and railway crossings. Frequently, they create complicated track systems and are a part of station throat. The complex study of turnouts took into account both determining the parameters mentioned in Sheets for technical inspection of turnouts and analysis its geometry and spatial location.

The article presents the results of the precise tacheometer measurements along with the description of data processing and analysis. Field measurements and further calculations were realized for station throat located in Słomniki station (railway line no. 8: Warszawa Zachodnia – Kraków Główny). The conducted analysis, described in this dissertation, included verification of location and geometry of the turnouts and crossing. In this case, at the beginning, the selected turnouts geometry parameters, including their length and ratio were analyzed. Additionally, obtained data were developed for the verification of the correctness of location of the analyzed turnout in the station throat. To complete the geometrical characteristic there was calculated the location of the parts of station throat in relation to the geodetic railway network point (track machine guidance - TMG spigot control). This analysis element enables to examine the spatial placement of the analyzed structure.

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Key words: geodetic measurements of the railway infrastructure, turnout, station throat, design the layout of the track geometry

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AN ARCHAEOLOGICAL - ARCHITECTURAL DOCUMENTATION BASED ON CLOSE RANGE PHOTOGRAMMETRY

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Wisłoujście Fortress is a historical defensive object located on the southwest coast of the Gulf of Gdańsk. Fort Carre, Eastern Sconce and Ravelin are parts of this postmediaeval fortification.

In view of planned regeneration of this fortification complex, at the initiative of the Gdańsk History Museum and Institute of Archaeology and Ethnology of the University of Gdańsk it was decided to perform a documentation of one Fortress object. Authors decided to report the three-dimensional documentation to perform a series of detailed analyzes of this historic building. Photogrammetric methods was selected as the most effective and less time consuming in preparing documentation.

In the article, authors present the possibility of using close range photogrammetry to create historic buildings documentation, point out the limitations of this method and present the capable accuracy in this type of studies.

Key words: Wisłoujście Fortress, close range photogrammetry, archaeological measurements

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A NEW APPROACH TO GEODATA STORAGE AND PROCESSING BASED ON NEURAL NETWORK MODEL OF THE BATHYMETRIC SURFACE

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The current spatial data are stored in the form of vector and raster. Vector data are stored in the form of three basic models of spatial - point, line and surface. Where a continuous surface, the model can possess the structure of TIN and Grid. TIN is a vector model, and Grid is a raster model. Currently, in standardized navigation maps basic vector models are used. According to hydrographic S-57 standard, bathymetric data can be encoded as soundings, depth contours and depth areas. The newest hydrographic publication of S-100 series brings other possibilities of data storing in the form of gridded data.

Bathymetric information is very important in navigation process, thus any navigational system should deliver them in as much as possible accuracy and completeness. Despite the progressive development of navigation systems, bathymetric data are still stored in the discrete form as vector or raster models. Such situation results in creation constant empty areas in the map with the lack of bathymetric information. The proposed approach solves this problem by applying a model that is spatially continuous and enables meshless data processing. This property gives practically big possibilities in modelling bathymetric information and its subsequent use, especially in connection with navigational systems like ECDIS (*Electronic Chart Display and Information System*) or ECS (*Electronic Chart System*).

In the study was proposed artificial neural network model [2], which allow for bathymetric data processing in different structure. Application of this model changes the method of geodata processing and storing. It should also be noted that neural model have essential advantages. The first is surface reconstruction without the need of application additional techniques used in interpolation methods like methods parameters setting, data points searching techniques or quantity of points used in calculations [3]. The second advantage is data reduction. One of ability of neural network is its structure adaptation for expected solution. Generally, it is related to the number of hidden layers and neurons. In the research was stated that artificial neural model can reduce data even up to 95 % in relation to output error.

Results of implementation of this model showed, that computation of depths is very quick for small data quantities. Computations time increases with number of processed data. Calculations can be accelerated by the selection of faster algorithms and proper organization of data in computer memory which allows minimizing the time of read and write data on a mass storage device. Moreover, due to perform the same operation on different data presented method is suitable for parallelization of operations, through the use of available in the computer processor cores. It is also possible to use for

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this purpose graphics processor, which may have up to several thousand cores and is currently available on each computer.

By application of neural model of bathymetric surface data can be processed in any structure (regular or irregular). Exemplary applications of proposed neural model can be associated with data processing for ship voyage planning tasks, anti-grounding functions or depth data points generation. Presented studies have confirmed the applicability of neural model of bathymetric surface for data processing and storage. Due to the functionality of the method, it also can be further developed or improved. For the purposes of implementation should be carried out further research in order to minimize computation time for bigger quantity of data.

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Key words: Digital Terrain Model, Neural Networks, Electronic Navigational Chart, Hydrography

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APPLICATION OF GEOFENCING TECHNOLOGY FOR THE PURPOSE OF SPATIAL ANALYSIS IN INLAND MOBILE NAVIGATION

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The main purpose for using each and every on-water navigation systems is to improve user's ships safety as well as safety of other traffic participants. Because these systems derive from GIS solutions many of their features base on spatial data analysis. In inland water navigation systems spatial data is both very diverse and detailed at the same time due to a combination of precise navigational layers (e.g. bathymetric data) with topographic, touristic and even social information [1]. Theoretically this gives a lot of possibilities for systems developers to create a variety of tools that provide user with a wide range of spatial analysis. Practically it all comes down to implementation limitations, especially if taking into account that a lot of data is dynamic and the analysis need to be conducted in close to real time mode.

MOBINAV system is a semi-professional solution dedicated for inland recreational units which is being developed currently by Marine Technology. It combines marine achievements in fields of advanced ECDIS systems with inland and leisure specifics needed to ensure complete picture of navigational situation. MOBINAV uses various vector data sets converted and integrated on server side of the system, in accordance with a dedicated Mobinav Data Exchange Format (MODEF) model. The final spatial data sets for each specified geographical region are later provided to mobile users in GML format and converted into a map in the mobile application. Server side also enables users to share information they found interesting. Starting from custom Point of Interest (POI) and ending with emergency information like Man Over Board (MOB) alarm. Additional navigational data is provided by other obtainable sources either on board (eg. GPS receiver, echosounder, AIS receiver, weather station) or embedded in the mobile device used by the system (geolocation, compass, barometer etc.). Other additional information may be acquired from accessible online services or other users input.

Most analysis commonly implemented to support navigation are related to routes. Other simple analysis base on selection of attributes and measurement of a distance to a selected object. But there is a temptation to use complex spatial analysis to support or fully automate application features for inland navigation [2]. The core of all of them is proximity analysis To conduct such analysis the distance on the map must be calculated and in many cases geometric buffers of existing objects must be created in additional layer. Then vertical analysis (intersection of overlapping geometry on different layers) can be carried out. It is possible to measure proximity between static objects as well as dynamic objects. It does not change the main approach to the analysis, but rapidly increases the number of times in which proper calculations must be performed. Because most of the functionalities use dynamic own ships object as base of the analyses, many details (classes of analyzed objects,

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intervals between calculations, spatial range of the analyses) need to be determined before each analysis, which can be performed very often. That brings serious implementation issues in developing a mobile application.

Geofencing is a technology that uses geolocation in mobile system for spatial analysis to check if current own location is inside or outside of a described area[3]. There are two main reason for using geofencing. First one is the architecture of mobile operating systems. In the mobile systems, application works when is visible on the screen (it is in foreground). When application is not visible it is suspended. Each application can have background tasks which works when it is suspended, but in background tasks not all operation are available, including access to geolocation services, but geofencing is available. The second reason for using geofencing is efficiency. In Android system about hundred geofences can be monitored at once, in Windows thousand can be monitored without significant performance degradation. Currently, one of the biggest limitation in geofencing is that geofences only can have a circular shape – they form a circular buffer around point object of known location.

In this paper we analyze geofencing technology in inland mobile navigation systems. We present implementation issues related to proximity analysis used for safety and informational purposes (Fig. 1a). This includes warnings and alarms generated when approaching a navigational hazards. Geofencing logic and management is described (Fig. 1b). Additionally we provide an analysis of a case scenario which showcases the advantages of geofences aplication.

Key words: inland navigation, geofencing, spatial analysis, proximity analysis

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Fig. 1. MobiNav user interface with activated warning geofence (a) and MobiNav geofencing logic (b)

APPLICATION OF REGRESSION LINE TO OBTAIN SPECIFIED NUMBER OF POINTS IN REDUCED LARGE DATASETS

Wioleta Błaszczak-Bąk¹, Anna Sobieraj²

The development of technology and the automation of measurement processes result in obtaining a large amount of data in a relatively short period of time. LiDAR measurement and multibeam sonar measurements are examples of such technologies. They provide a large datasets which are a reliable source of information about measured object, however such datasets are sometimes difficult to develop. Therefore, the algorithms for reducing the number of such sets are incorporated into their processing [1, 3]. Algorithms efficiently reduce the number of points in the measuring set, without losing important data, however the degree of reduction depends on the value of selected parameters introduced by the user. In the algorithm using the Douglas-Paucker's method), area of tolerance triangle (in the algorithm using the Visvalingham-Whyatt's method). The choice of the values of parameters, and in results the number of points in the reduced set, is one of the key step in the algorithm works, and what is the relationship between the values of these parameters and the final number of points in reduced set. This aspect can be verified by means of various techniques. One of them could be the regression analysis.

In this paper authors decided to explore the relationship between the different values of the tolerances and the number of points in the reduced set using regression analysis. The tolerance range is the parameter used in reduction algorithm based on the Douglas-Paucker's method [4]. This method iteratively removes points which do not fulfill the a priori criterion – the tolerance range κ . Besides the κ parameter, a basic line must be defined. Basic line is a line defined by the first and the last point in the searching belt. If the distance between points and the basic line is smaller than κ , those points are removed from the data set. The tolerance parameter κ is strictly related to the desired generalization level.

Test data is the fragment of the measurements of Swinoujscie - Szczecin channel, carried out by the Maritime Office in Szczecin in 2005. Measurements were conducted by means of multibeam echosounder integrated with DGPS. Obtained coordinates B and L and measured depth H were transformed to the XYZ Cartesian system. This large dataset was the subject of various analyses presented in [2]. In this study the test set consists of 9013 points. The analyses were conducted on data processed by means of the reduction algorithm based on the Douglas-Paucker's method [4]. The

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searching belts of various width and various ranges of tolerance were adopted. Obtained results were the basis to determine the regression coefficients and creating the regression lines. It was also examined whether the regression equation, established on the basis of only two extreme values, differ significantly from the regression based on the larger number of values of parameters. The percentage changes in the regression coefficients for both cases were presented. The regression lines may be used to determine (predict) the tolerance ranges what allows to obtain reduced set with required number of points.

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Key words: large datasets, reduction, regression

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APPLICATION OF RSSI BASED NAVIGATION IN IN-DOOR POSITIONING

Joanna Janicka¹, Jacek Rapiński²

Nowadays people have increasing demands regarding positioning. Traditional satellite positioning systems based on the GNSS observations satisfies the need for localization in the outdoors environment. However this is not enough in modern world. People want to know their position not only outside of the buildings but also inside. The traditional satellite positioning systems cannot be used in such places. But there are some new technologies that allow for indoor positioning. The alternative in those places can be for example inertial measurement systems INS or pseudolite positioning systems. Furthermore, there are also other technologies, which allow performing indoor positioning. In the last few years the concept of the RF ranging technology is developed. Positioning with the use of this technology can be based on the distance measurement (range-based positioning), or on the radio signal strength indicator. The widespread availability of wireless networks (Wi-Fi) has created an increased interest in harnessing them for other purposes, such as localizing mobile devices. Due to the ubiquity of this type of equipment, especially in public buildings, the concept of using wireless networks to determine the position inside objects was created. For this purpose, two types of devices are necessary, one that emits signals and the devices that receive the radio waves. These radio waves can be received by any compatible receiver placed in a pc, a mobile phone or a tablet.

One of the option of the indoor positioning is Wi-Fi localization using RSSI. The two main methods for Wi-Fi localization are: triangulation and fingerprinting. Triangulation involves mapping signal strength as a function of distance. Wi-Fi Fingerprinting creates a radio map of a given area, based on the RSSI data from several access points and generates a probability distribution of RSSI values for a given (x, y) location. This method was chosen to perform the test.

The authors performed measurements on existing infrastructure located in the building of Warsaw University of Technology. On the basis of measurements the signal strength map was created.

Key words: indoor positioning, RSSI, classification

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APPLICATION OF SENTINEL-1 IMAGES FOR SHORELINE EXTRACTION IN THE PRODUCTION PROCESS OF ELECTRONIC NAVIGATIONAL CHART

Jacek Lubczonek¹

Remote sensing images are one of the basic materials used for map creation. The basic elements of topography are the land and the water area, which are separated in natural way by shoreline. Laboriousness of development of the shoreline in the vector format is not only the matter of the size of the area. In some cases, the shoreline is highly has very irregular shape, which also has an impact on mapping time.

In order to increase the efficiency of obtaining the shoreline, can be applied various image processing methods. By using them process of the extraction of shoreline can be automated. For this purpose different types of images can be applied, registered in visible, infrared and microwave electromagnetic radiation range. In recent times dynamically is developed satellite and airborne microwave remote sensing. The spectrum of radar images applications steadily is increasing, especially due to the new remote sensing platforms (UAV), better image spatial resolution and popularization of this kind of data.

Extraction of shoreline is currently the subject of many studies. On the basis of analysis of literature for this purpose can be used various types of images. Due to increasing spatial resolution of the microwave images, it is possible to get a more detailed vector model of the shoreline. However, taking into account other characteristics of microwave compared to visible band, it is important to analyze possibility of shoreline extraction.

The study was conducted on a variety of Sentinel-1 products. The first stage involved an assessment of the potential of interpretation of radar images, with particular attention to identifying shoreline. The correctness of the identification of the shoreline allows defining the specific cases that may have an impact on the actual shape of shoreline. Effect on it can have the type of shore, the depth of the water, the proximity of land objects or sea conditions. In the next stage, was carried out studies related to the extraction of the shoreline. For that purpose was studied the possibility of image classification by using various methods and further image processing in order to obtain the shoreline in the vector form. In order to extract the shoreline were tested methods such as thresholding and classification. Research at this stage come down to the selection of appropriate parameters of methods, which are able to divide the image into a set of pixels representing the area of water and land. The analysis assessed the correctness of classification of these two objects. Also were discussed the advantages and disadvantages of each method.

After classification, the images were further processed. Using a variety of methods of mathematical morphology, classified image was generalized, and further was converted to vector

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model. Using the above operations was obtained shoreline in vector form. The final stage of the study was to assess the accuracy of the resulting shoreline.

Key words: Radar sensor, image processing, shoreline extraction, map production

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APPLICATION OF TERRESTRIAL LASER SCANNING FOR EVELUATION OF HIGH-RISE BUILDING

Alicja Byzdra¹, Artur Janowski², Jakub Szulwic³, Patryk Ziółkowski⁴

The paper presents an insight into surveying methods used to measure high-rise buildings (slender structures) by Terrestrial Laser Scanning (TLS). Data obtained from Laser Scanning might be used for structure monitoring purposes with particular reference to the verticality assessment and shape deformation of existing structures. Moreover, original solutions to an analysis of structural verticality and masonry deformation (including reinforced concrete elements) have been indicated in this paper. Interpretation of the reflectance intensity level of the laser beam allows conducting studies on structural health and identification of material properties. The sensitivity of this parameter is connected with hue, texture and humidity of scanned surface and allows conducting dissect, in which for example, identifying of building humidity. The additional information concerned on material properties is provided by texture from photographs. In this paper authors collected, evaluated and presented state-of-the-art surveying methods. This method has been divided into two groups due to fully cover this subject.

Key words: eveluation deformation, slender structures, TLS

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AUTOMATION OF THE TERRAIN ASSESSMENT CLASSIFICATION DUE TO PASSABILITY FOR THE NEEDS OF CRISIS MANAGMENT

Krzysztof Pokonieczny¹, Marek Wyszyński²

One of the primary goal of crisis management, was to assured broadly taken public safety during, often violent and variable crisis situations. In order to successfully prevent them, it is necessary to consider actual terrain situation, because most of rescue actions have spatial character. It was commonly connected to aspects of men and equipment dislocations between two localizations, which often carried into the roadless track.

Taking this into consideration, the article describes the methodology of terrain map preparation for crisis management. The study was based on Polish military agreement NO 06-A015:2012. Due to high variability of crisis situations, it is reasonable to perform this maps in quasi real-time. Therefore, in this research the problem of automation of the military analysis process with ArcGIS software, has been undertaken.

The source data for analysis were collected in the database, which has been described in the military agreement. It consists of: digital terrain elevation data (DTED), vector smart map level 2 (VML2) as well as civil and military raster maps in different scales. This data set was used, to perform a variety of passability maps for the area of 653 sq. km. On generated maps were marked areas, where movement of specific type of vehicles is possible.

The usage of a modern GIS systems and above mentioned database, allowed to perform shorttime and efficient analysis. Whose development, according to the conventional methods, took up to several days. Preparation time, in the case of use GIS systems for the same analysis, allowed to accomplish this task within several hours. Automation of carried operations with advanced GIS tools, according to the methodology presented in the article, allowed to condense time needed to perform terrain evaluation up to few hours.

Results of the automation process were comparable to the results obtained by the classical methods. This article showed an original solutions of many problems related to numerous inaccuracies and ambiguous notations in the Polish military agreement and disadvantages of military spatial data. The use of developed methodology and automation algorithms of terrain evaluation by passability is characterized by universalism. This indicates that the algorithm can be used on any region (not only analyzed area and for any spatial data (in analysis VML2 can be replaced with BDOT10K).

Key words: military terrain assessment, terrain classification, GIS, spatial analysis, crisis management

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BENEFITS OF COMBINED GPS+BDS PRECISE KINEMATIC POSITIONING

Jacek Paziewski¹, Pawel Wielgosz²

The integration of multi GNSS observations both in precise relative and precise point positioning is nowadays the subject of extensive studies of scientific community. Recently several strategies allowing for optimal combining multi GNSS and multi frequency observations in a single functional model have been developed. Two commonly applied techniques are loose and tight combining. The first one can be easily applied for any selected signals and frequencies from used GNSS systems. This approach utilizes separate pivot satellites for in-GNSS system double differenced observables. The latter approach assumes creating double-differenced observables between system, thus single pivot is applied irrespective of number of GNSS systems. This methodology requires, however, modelling of additional biases such as receiver Inter System Biases (ISB) and corresponding frequencies in both GNSS systems.

Utilization of Chinese BeiDou Navigation Satellite System (BDS) signals in satellite positioning is under extensive development due to its rapid expansion. Since 2011, the BDS system has been regionally operational and by the 2020 it is expected to attain its global coverage. Many research groups examined applicability of BDS signals both in PPP and RTK positioning. Initial assessment of the BDS positioning examined performance of the BDS and BDS+GPS RTK positioning. Most of these studies were based on single baseline solution, but on the other hand in geodetic, surveying and navigation practice, RTK positioning is more reliable in multi-baseline approach. This paper presents our initial results application of Chinese navigation satellite system to support medium range multibaseline GPS-RTK positioning. To better distinguish the potential impact of the additional BDS observations to RTK, the computations were performed in instantaneous (single epoch) approach. The results confirm that multi GNSS observations increase the reliability of the solution, especially in the obstructed environment.

Key words: GNSS, BDS, RTK

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BUILDING DATA SEMANTIC SIMILARITY ANALYSIS: OPENSTREETMAP AND THE POLISH DATABASE OF TOPOGRAPHIC OBJECTS

Joanna Nowak da Costa¹

At an early stage of crisis development, a data with immediate availability is often used. OpenStreetMap, a free open world map, is an example of such data. Could OSM, proven to be of high level of detail and good positional accuracy, provide reliable building thematic data?

Before being able to produce a geographic data quality assessment where the quality elements such as attribute accuracy and feature completeness are involved, or for a comparative analysis of two spatial datasets, the semantic relationship of both must first be known. Today, Volunteered Geographic Information (VGI) further complicates spatial data semantic analysis because academics agree that the differences in the manner in which crowdsourced geodata is collected, especially related to the freedom that volunteers have with respect to feature conceptualisations, modelling and classifications and their skill level create the conditions for a melting pot of inconsistent semantics and heterogeneous data quality [1 - 5]. What is more, they are dynamically changing.

This paper concentrates on the integration of classification schemes for official data such as the Polish Database of Topographic Objects (BDOT10k) and VGI data available from the OpenStreetMap (OSM) project. Since there is usually not a one-to-one correspondence between attributes of matching features in both datasets, the author first ensured a common level of these data. It was done by introducing the new, more general and abstract level of spatial and attribute data classification.

This work presents the creation of semantic correspondence rules for each attribute of interest and the attribute similarity analysis between building thematic data from both databases. The tasks required proposing a user oriented approach to tackle three specific issues:

- Language OSM building data is in English whereas the Polish National Mapping Agency data is provided in Polish;
- Data completeness OSM attribute completeness is relatively low and therefore many of the corresponding feature pairs between BDOT10k and OSM needed to be excluded from the thematic similarity analysis;
- 3. Data abstraction discrepancies between the building polygons and their degree of abstraction made the similarity analysis process difficult.

The results of the similarity analysis are presented separately for urban and rural test areas due to differences in the sets of the common building key values used. In general, a relationship was found between the VGI quality characteristics and the location of the building, i.e. urban centre or rural area.

Key words: OpenStreetMap, semantic similarity, correspondence rule

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COASTAL CLIFFS MONITORING AND PREDICTION OF DISPLACEMENTS USING TERRESTIAL LASER SCANNING

Paweł Tysiąc¹, Aleksander Wojtowicz², Jakub Szulwic³

Coastal cliffs are very sensitive to degradation caused by erosion and abrasion. Thus, it is very important to monitor susceptibility of the sea cliffs in terms of slope angles and ground fall resulting from vertical morphology of the cliffs. The results could be used for example to establish the boundaries of the safe investments zone or retreat infrastructure buildings in case of real threat such as degradation of the objects of interests, by creating a warning system from collected data.

What is more, the world challenges constantly change and besides classic monitoring and prediction of degradation of the cliffs, it is very important to examine the state of the cliffs with coastal infrastructure in case of potential anthropogenic threat, e.g. war or terrorist attack. The use of technical means to protect objects has now become a common procedure and use of optoelectronic systems like laser scanning could secure strategic places which are coastlines with infrastructure also providing data that are easy to interpret by people who are not very familiar with laser scanning itself. [2]

As the exemplary object of interest, the authors chose the fragment of cliff in Gdynia Redlowo called "Cypel Orlowski" (the exact location of the measurements is the vertical wall of the southern side of the cliff, the most extended and exposed to the sea). The authors chose that particular side of the cliffs because of the winds that appeared in studied area. Based on provided information the strongest winds come from north- eastern direction causing the highest waves, remaining one of the greatest threats to the sea cliffs (mean speed of the wind reaches the values ranging from 10 to 15 m s⁻¹ and consecutive waves from 80cm to 160cm). The second one is the change of rain water volume which gets into the splits of the cliff. Those two factors mainly cause the earth masses to tear off from the studied cliff. Considered element of the cliff consist commonly with density clay and has the tearing off character. It creates the opportunity for using the proposed monitoring and prediction method not only in reference to cliffs in Gdynia, but also for other types of cliffs and hills to better understand

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ground or rockfall phenomena in studied areas. [4]

To achieve and improve the understanding of cliff degradation, authors used the terrestrial laser scanner technology. Combining high precision and accuracy, the Light Detection and Ranging (LiDAR) techniques are commonly used in engineering environment. For the need of this paper authors used Riegl VZ-400 topographic scanner provided by the Apeks Company, based in Gdansk. In reference to this article, based on the results of the field measurements (very high resolution point cloud) the authors created the 3D model of the objects of interest. It could be used in different applications related to cliff monitoring such as calculating clay masses, comparison of the geometry from two different periods of time, or to predict places on the cliff where the possible degradation could have taken place. The workflow of data acquisition and processing included following main steps: 1) data acquisition and topographic survey for georeferencing laser data. 2) post- processing data- link and adjust scan positions and filtering data 3) creating 3D mesh 4) further 3D mesh analysis. 5) presents and discuss the results. [3,5]

The main goal of this paper is to propose the accurate and cost-efficient application for cliff monitoring and degradation prediction places by using the example of the part of the cliff in Orlowo, Gdynia, while the results clearly demonstrate that the proposed approach could be very useful in creating area development plans, valuation of risk by coastal erosion or preservation of highly appreciated landscape. In addition, the authors see the possibility to further investigate, in terms of the object of interest, the climate and its influence on cliff degradation. The researches find their input helpful in creation of a long-term coastal security strategy.

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Key words: coastal cliffs, terrestrial laser scanning, Riegl, mesh, photogrammetry, 3D modelling, degradation monitoring, LiDAR, point cloud filtering

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COMPARISON OF SELECTED MACHINE LEARNING ALGORITHMS FOR SUB-PIXEL IMPERVIOUSNESS CHANGE ASSESSMENT

Wojciech Drzewiecki¹

The paper presents the comparison of nine machine learning algorithms for sub-pixel impervious surface area (ISA) change as-sessment. Following prediction algorithms were researched: Cubist, Random Forest (RF), stochastic gradient boosting of regression trees (GBM), k-nearest neighbors (kNN), random k-nearest neighbors (rkNN), Multivariate Adaptive Regression Splines (MARS), averaged neural networks (avNN), support vector machines with polynomial (SVMp) and radial (SVMr) ker-nels.

Sub-pixel imperviousness mapping was done based on multidate Landsat images for the Upper Raba catchment (i.e. Dobczyce Reservoir watershed), south Poland. Time periods for ISA mapping were chosen to match acquisition times of available high-resolution images needed for preparation of reference data. Digital aerial orthophotomaps from mid 1990s and 2009 were used as the reference. Every tested algorithm was used to ISA mapping for both individual time periods. Then the results were differenced to obtain ISA change assessment.

All predictive models were trained using the caret package [1] in R environment [2]. Model parameters were tuned using

10- times repeated 5-fold cross-validation. To enable the comparison of model performances, the indexes of the training and test datasets for each cross-validation fold were the same for all models and both time periods. The performance of tested machine learning algorithms was analyzed based on both cross-validation results and results obtained for validation dataset.

A paired t-test was used to determine if the differences between model accuracies are statistically significant.

The outcomes of the presented research show that in case of imperviousness mapping for individual time periods the regression trees based models outperformed other ones. The methods of this kind gave the best results both for cross-validation on calibration dataset and for validation dataset. The Cubist algorithm seems to be the best performed one. It is the only one constantly present in the group of the best performed methods, regardless of the measure used for performance evaluation on cross-validation dataset. This approach gave also the highest accuracies for validation dataset.

In case of ISA change assessment the Cubist algorithm was surpassed by other ones. However, the best method cannot be un-ambiguously pointed out based on the results of this research. Rather, it is possible to indicate a set of machine learning

models which performed the best according to different performance measures. Random Forest

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gave the lowest RMS errors both on cross-validated calibration as well as for validation datasets. Random kNN (rkNN) approach was the best one according to MAE measure and its RMSE values are not significantly different from RF ones. Random Forest results gave the highest mean value of the R2 measures from cross-validation folds. Although, SVMr model performed equally well in crossvalidation and gave the highest value of the coefficient of determination for validation dataset.

Presented study showed that in case of sub-pixel change assessment based on differences of individual fractional coverages the most accurate change assessment may not necessarily be based on the most accurate individual assessments. It is possible that approaches giving less accurate results for particular time periods may give better assessment of change. This is due the fact, that the error of imperviousness change calculated as a difference between two imperviousness layers depends not only on their individual errors but also on the level of correlation between these errors.

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Key words: impervious surfaces, Landsat, change assessment, machine learning, Raba River catchment

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COMPARISON OF SELECTED REDUCTION METHODS OF BATHYMETRIC DATA OBTAINED BY MULTIBEAM ECHOSOUNDER

Marta Wlodarczyk-Sielicka¹, Andrzej Stateczny²

The publication presents a comparison of various methods to reduce datasets obtained by multibeam echo sounder. Depth determination is a fundamental task for a hydrographer, which requires specific knowledge of the medium, of underwater acoustics, of the plethora of devices available for depth measurement, of complementary sensors for attitude and heave measurement and proper procedures to achieve and meet the internationally recommended standards for accuracy and coverage as articulated in IHO publication S-44 5th Edition [1]. The most rigorous conditions for accuracy and coverage are on critical areas like berthing areas, harbors and critical areas of shipping channels [2]. The general scheme of processing of bathymetric data is shown in Fig. 1.

Data reduction is the process of minimizing the amount of data that needs to be stored in a data storage environment. Data reduction makes data easier and more effective for the purposes of the analysis. One of reduction methods is to transform a large amount of samples into a single, common value. From statistics, it can be found that single value are: mode (the point that appears most often in a set of data), mean (the average: sum of the values divided by the number of values), median (the number separating the higher half of a data population from the lower half) and nearest to mean (the point closest to the mean) [3]. Another method is to remove a given quantity of instances from a large set, while maintaining its overall suitability for the analyzed population.

Frequently, hydrographic systems generate a GRID (based on "square" cells) by using means, weighted means or minimum value. The authors decided to compare selected reduction method used in hydrography. GeoSwath Plus software and BathyDataBASE software were used. GS+ software is developed by GeoAcoustics and it is a part of hydrographic system. It is based on the correlation procedure. The calculated grid value is computed based on adjoining values. Each adjoining value takes part in establishing the value of the grid after reduction as a percentage of its value – weight. The weights of particular values are registered in the form of a relevant matrix [4]. BathyDataBASE software is produced by Caris and it use 3D Double Buffering method to reduce bathymetric data. 3D Double buffering is like rolling a ball over the given surface at an interval determined by the surface's node resolution. The radius of the ball is determined from the map scale (radius = 1/100 of map scale). As the ball is rolled over the surface, the surface is smoothed. The received surface is buffered again, this time in the opposite direction. The final surface is the surface after reduction [5].

Data used in the course of research was collected within the Szczecin Harbour, near the Babina canal. Because of its large volume XYZ data preparation for tests have been "clipped" to a smaller area. This area is visible on Fig. 2. The data is a collection of irregular and includes 1638170 samples

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with a specific geographic position and depth.

For research purposes, as the scale of the final product was adopted 1: 2000. Having processed the measurement data during reduction using GS+ GRID file was created and submitted to further study. As a methods of generating a grid, the mean was used. The bin size value was set at 1 meter and additionally, the spike filter was set to 1 meter (default system setting). The GS+ system's main parameters associated with the process of reduction are matrix size and centre weight. The default values are respectively 3 and 8 and these values have been adopted for tests. During reduction of data using BDB, in first step point cloud was imported to Caris software. Then TIN was built and with it the final surface has been created. In the middle of it the method of linear interpolation and resolution equal to 1m were implemented. The next stage of research was reduction process of resultant surface using 3D Double Buffering method. At this stage, the scale of final hydrographic product has been determined and – according to the operation method – radius of the circle and the resolution. The authors have adopted the following parameters: radius of the circle equal 20 meters and the resolution equal 1 meter.

After reduction in selected systems two different GRIDs were obtained and each is consisted of miscellaneous dataset. In next step, the surfaces were created. In the last step these surfaces were compared and detailed analysis was conducted.

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Key words: bathymetry; multibeam echosouder; reduction; processing

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Fig. 1. General scheme of processing of bathymetric data (a) and test area (b)

CONSIDERATIONS ON INDOOR NAVIGATION BASED ON CHEAP MOBILE DEVICES

Artur Janowski¹, Michał Bednarczyk²

Nowadays, almost everyone has their own portable computer in the form of a smartphone. It usually gives the ability of positioning and navigation using GPS signal. This method is not usually effective indoors. For navigation in buildings, other technologies based on completely different solutions should be used. There are many indoor navigation solutions available, based on the additional devices usage. They are effective, but require the purchase of additional hardware. Meanwhile, the user is most interested in the possibility of positioning using the same equipment both inside and outside. The authors of this article, noting this issue, decided to refer to the problem of positioning using Bluetooth signal, which the module is built into every modern cell phone. Attempts were made to determine the possibility of building a network of transmitters for positioning were also performed. For this purpose, experiments were conducted on the test object, where four Bluetooth transmitters and one receiver - a mobile phone with Android were used. The signals were recorded using a suitably designed application and then analysed. Considerations here described, are a part of studies to develop an effective indoor positioning system using various technologies available in today's mobile phones.

Key words: indoor navigation, indoor positioning, mobile devices, bluetooth signal-based positioning

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CULTURAL HERITAGE IN SPATIAL PLANNING

Krzysztof Rząsa¹, Marek Ogryzek², Marcin Kulawiak³

The cultural heritage objects of each country should have a major impact on the development of space. Unfortunately, most often the investment needs prevail and only the most precious historical objects are protected. Thus often a monument is preserved, but its surroundings (which put it in context) are lost forever. This article addressed the issues of cultural heritage in relation to the spatial planning system in Poland. The legal bases for the protection of monuments and their compounds are discussed along with statutory requirements for space planning. On selected examples located in Warmia and Mazury (voivodship located in is the north-eastern part of Poland), an analysis of the planning records connected with the protection of cultural heritage is also presented. The authors refer to the effectiveness of these records and their actual executive power, as well as indicate the needed legal changes leading to historical objects having a real impact on the change in land use planning.

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Key words: cultural heritage, spatial planning, protection of monuments

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DETECTING FOG AND STRATUS IN MODIS DATA

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The paper presents the results of MODIS images analyses focused on detection of fog and Stratus. The areas of the phenomena were distinguished in high resolution images by means of visual analyses of single spectral channels, differential products and color compositions. Brightness temperature data and reflectance diagrams were used to assess the internal structure of the observed objects and their properties.

The initial phase of satellite images preparation includes raw data processing for further analyses. Images acquired by the MODIS spectroradiometer are the basic source of data for the research described in the paper. The multispectral scanner is installed onboard of the Terra and Aqua polar orbiting satellites of the Earth Observing System program. The second phase of the images analysis for fog and low layer clouds areas detection is related to selection of spectral and spatial features characteristic for the meteorological phenomena. High spatial resolution data available in 36 spectral channels provide enhanced capabilities of fog and low layer clouds detecting as well as of determining the relations between the objects' features and the processes creating them. Multispectral analyses of the MODIS data, based mainly on the visible channels during the day time and on the infrared ones during the night time, use single spectral channel images, differential images and colour compositions.

Daytime analysis – November 4, 2015, 9.30 UTC. The area of Poland was influenced by a high pressure ridge enhancing north to central parts of Scandinavia. Fog and mist developed in the warm polar maritime air mass over the central part of the European continent.

Analysis of the MODIS images in single spectral channels acquired on November 4, 2015 at 9.30 UTC together with reflectance and brightness temperature profiles along selected line segments facilitates distinguishing the objects from cloudless areas and clouds in the upper levels of the troposphere (Fig. 1a and Fig. 1b). The fog/Stratus is observed as smooth areas of higher values of reflectance as compared with the cloudless areas and lower reflectance values with respect to clouds reaching the moderate and high levels of the troposphere (Fig. 1b). Characteristically significant value of the brightness temperature difference between the 3.75 μ m and the 11.03 μ m spectral ranges for the objects is also observed (Fig. 1a). The changes of shades in the images related directly to the changes of reflectance or brightness temperature seem to contain the majority of information

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concerning the analyzed phenomena. However, the texture, size, shape and relations between the objects' elements occur to be equally important characteristics for the analysis. Fog and Stratus are imaged as layers of regular contours or contours compliant with the relief in hilly areas. High resolution of the MODIS data enables to analyze the features in detail for unambiguous detection.

The ability to distinguish defined patterns in images is of crucial importance for interpreting color compositions. Two RGB products are proposed in the paper for day time analyses (Fig. 2). One of them (RGB Ch7 (2.13 μ m) / Ch2 (0.86 μ m) / Ch1 (0.64 μ m)) is based on reflectance in three spectral ranges varying with the size, number and physical state of the particles of the clouds. Fog and low layer clouds have similar albedo in all the spectral ranges used for the composition. They are composed of water droplets which results in increased reflectance in channel 7 (2.13 μ m). Due to increased absorption of radiation by ice crystals, the channel may be used for distinguishing between clouds composed of water droplets and ice crystals. The latter are presented in the characteristic for the composition blue color while fog and Stratus are white with pink shade.

In the other proposed composition (RGB Ch2 (0.86 μ m) / Ch7 (2.13 μ m) / Ch20 (3.75 μ m)), the properties of the 3.75 μ m spectral range are used along with the information related to reflectance in the 0.86 μ m and 2.13 μ m channels. The amount of radiation recorded in this channel depends on the dimensions and physical state of the cloud particles. Since fog and Stratus are built of small water droplets, their brightness temperature has significant values. These elements are presented in this composition as light smooth areas (Fig. 2) and they are clearly distinct from ground (dark blue) or moderate and high level clouds (shades of orange).

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Key words: fog, Stratus, satellite imagery, MODIS



Fig. 1. The MODIS satellite images of November 4, 2015 at 9.30 UTC indicating the thermal properties of fog and Stratus (a) and the MODIS satellite images of November 4, 2015 at 9.30 UTC indicating the reflectance of fog and Stratus (b)



1. Fog/Stratus 2. Mid-level clouds 3. Land



Fig. 2. The MODIS color compositions of November 4, 2015 at 9.30 UTC

DETECTION OF GROSS ERRORS IN THE ELEMENTS OF EXTERIOR ORIENTATION OF LOW-COST UAV IMAGES

Michał Kędzierski¹, Anna Fryśkowska², Paulina Nerć³, Damian Wierzbicki⁴, Aleksandra Grochala⁵

In recent time we can observe growing interest of the photogrammetric products, which were made with using imagery acquired from low altitudes with the use of unmanned aerial vehicles (UAV). Due to the lower costs of UAV photogrammetry flight missions they are often attractive from the point of view of photogrammetry. In realization of photogrammetric flight missions at low altitude so far not completely resolved are too small accuracy of registration approximate exterior orientation of acquired images. The second very important aspect of accuracy of studies is fact, that software is not resistant to errors in the estimated elements of the exterior orientation parameters. The article presents a method of pre-adjustment gross errors detection in the measurement of projection centers. The method is largely based on the analysis of the results of two independent approaches: theoretical results of exterior orientation and alignment as a result of bundle block adjustment.

Key words: digital image, ilmage processing, Stereo image processing; unmanned aerial vehicle; bundle block adjustment; gross errors; pre-adjustment analysis of measurement

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DEVELOPING TOOL FOR IMAGE-BASED STOCKTAKING: PALACE PENA CASE STUDY

Jakub Kolecki¹

Architectural stocktaking is a major area of interest within the field of terrestrial photogrammetry. Over the past decades the Department of Geoinformation, Photogrammetry and Remote Sensing of Environment at the AGH University has taken part in many interesting measurement campaigns concerning important architectural monuments. In nineties the software for image-based stereo digitization (Video Stereo Digitizer) was developed allowing transition from analog to digital photogrammetry. In the last 15 years the rapid development of photogrammetric technology was observed. Using the digital cameras with various lenses, images taken from various stations – almost arbitrary arranged, and at the same time expecting high accuracy and almost full automation of measurement processes demands developing new tools for image based 3D modelling. The Bundlab, software being currently under development [1], preserves well known solutions such as stereoscopic observation, staying at the same time open to the new multi-view methods. It is also fitted with image orientation algorithms designed for automatic measurements. The great opportunity to test the recently developed tools was a survey campaign in the Pena Palce in Sintra that took place in August 2013 [2].

This paper reviews the recent works on developing photogrammetric tools for image based 3D modelling and architectural stocktaking. Describing the case study of Pena Palace in Sintra in Portugal some important aspects concerning image orientation algorithms and stereo restitution will be discussed. At first the general photogrammetric workflow is shortly addressed and then some mathematical aspects related to orientation of close range images are provided. Within the measurement campaign the 12 images were acquired using Nikon D5100 SLR camera with the 20 mm lens. One of the images is presented in the figure 1. Geometrical configuration of images is shown in the figure 2. Six of the images were captured from the ground level. Two of them, the rightmost and the leftmost are looking towards the middle part yard façade. Further four images were acquired from the first floor. The camera was situated inside the arcade. Two topmost images were acquired from the roof stations. For the 6 lowest images the sampling distance was approximately 1.0 mm. For images captured from arcade and from the roof the sampling distance was around 1.7 mm. Captured images were formed into a single block of 12 images according to the procedure given in 2.2. The block was transformed to the object coordinate system using control points. Then the bundle adjustment was calculated obtaining the following RMSE of control point coordinates: 0.9, 1.2, 1.2 mm: X, Y and Z respectively. The RMSE of image coordinates was 0.19 pixel. Conducted calculations yield the external orientation parameter of images. After performing the image orientation the 3D digitization of the facade was carried out in using the Bundlab tools. Obtained CAD drawings can be used to make the complete view of the facade according to the rules of architecture.

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Tools designed for photogrammetric architectural stocktaking, implemented within the Bundlab software seem to produce satisfactory results. The obtained level of details of the drawing is hardly to achieve by any other survey technology so that it would be difficult to evaluate its accuracy. Some problems that arose during the drawing were caused by imperfections in image acquisition. Developing software for image based modelling allows to have insight into the implementation details and applied algorithms providing great potential in conducting researches in the field of photogrammetry and its architectural applications. Further works will extend the possibilities of generating new products such as point clouds.

Key words: architectural stocktaking, bundle adjustment, close-range photogrammetry, stereo-digitization

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Fig. 1. One of the images of the Palace Pena courtyard.



Fig.2. Configuration of the images.

ELABORATION AND MODELLING OF THE RAIL INFRASTRUCTURE USING DATA FROM AIRBORNE AND MOBILE LASER SCANNING

Bogusława Kwoczyńska¹, Wojciech Sagan², Katarzyna Dziura³

In recent years there has been an increase in the importance of digital photogrammetry. There are different methods on the market that allow precise obtaining remote information about the appearance and the shape of the terrain without direct contact with the object of the study. The airborne laser scanning is one of the technologies that are developing very quickly and have more and more new applications in many fields. The second technology with the enormous potential is a mobile laser scanning.

In this paper, the authors present the capabilities of these technologies both in surveying and modelling of railway infrastructure (Fig. 1a, 1b). First of all, they presented the possibility of using the laser scanning technology and in particular mobile laser scanning in terms of data collection and analysis for the tasks associated with the elaboration and diagnostics of railway infrastructure. For the mobile laser scanning the object of the study was the railway station in Słomniki, on a section of the railway line No. 8, and length of about 550 meters. The cloud of points together with the photographic documentation was obtained using Riegl VMX - 450 system. The research was available thanks to courtesy of The Department of Geoinformation, Photogrammetry and Remote Sensing of Environment AGH University of Science and Technology. Data from the airborne laser scanning included two different fragments of the railway line. The first one is located in Strzałkowo in the Wielkopolskie Voivodship (railway tracks along with the station building), and the second one in Bochnia in the Malopolskie Voivodship. The section in Strzałkowo was about 470m and in Bochnia 302 m. For the elaboration two different parts of the railway line were used, because it was intended to present the differences in the processing of data characterized by clouds of points with different density. The cloud of points in Strzalków consisted of 752 735 points (10 points/m²), while in Bochnia 622 759 (17 points/m²). These data were obtained from the TMC in Krakow (for Strzałkowo) and from mentioned above Department of Geoinformation, Photogrammetry and Remote Sensing of Environment AGH (for Bochnia).

Key words: mobile laser scanning, airborne laser scanning, rail infrastructure, scanning density

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a) b)

Fig. 1. The railway station terrain before the elaboration (a) and after (b).

EVALUATION OF VEHICLE ROUTING PROBLEM ALGORITHMS FOR TRANSPORT LOGISTICS USING DEDICATED GIS SYSTEM

Krzysztof Bruniecki¹, Andrzej Chybicki², Marek Moszynski³, Mateusz Bonecki⁴

The development and research related to decision systems that support logistics and fleet management is of high interest among many industrial and scientific entities. Cost reduction related to optimal distribution of transportation resources, appropriate scheduling, deployment of vehicles and personnel leads to economical, fiscal savings and allows for indirect and direct cost reduction [1]. Recently, large amount of industrial, scientific projects and theory has been developed with respect to problems stated above i.e. [2 - 4].

In the context of technical implementation of ICT systems for effective fleet management, the problem can be divided into two basic areas: theoretical background and technical implementation. The first area is related to the problems of discrete optimization that can be included to the class of so called "NP-hard" problems, which are generally characterized by exponential complexity. This makes them hard to resolve in reasonable time, particularly for bigger input datasets (i.e. consisting of over 200 nodes). In consequence, much scientific effort is put in order to reduce the complexity of NP-hardness using approximations or simplification of the problem.

The second aspect is the technical implementation of the solutions presented above. There are several commercial systems that support fleet management and solve specific VRP problems. Generally, these solutions are difficult to analyze because of the tendency to keep the company's methods and algorithms undisclosed. However, on the basis of individual reports provided by leading corporations in the industry, it can be said that the process of assimilation of the latest algorithms developed by the world of science is slow. For example, in one of the reports, one of the main leaders of the industry, the Ortec company, admits to use as a basic algorithm, solutions developed and published as much as 35 years earlier. The same report, however, determines how many issues, very important for potential customers, such as forbidden combinations of goods in transport, different definitions of capacity vehicles, various types of vehicles, requirements for unloading, customers favored, assign vehicles and drivers to the regions etc. is largely ignored by the world of science. With a certain degree of accuracy, it can be assumed that commercial solutions primarily use well-known, proven, but largely obsolete algorithms adapted to the needs reported by customers.

In the paper, the process of design and implementation of the dedicated system for optimization

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of fleet management is presented. On the basis of carried out research, some general conclusion regarding cost obtained by particular algorithms can be observed. Although it cannot be stated unequivocally, in both cases it can be concluded that the approach that uses meta-heuristic (GLS and tabu-search) generally can be considered best to cope with the test cases discussed.

In the context of the use of heuristic algorithms, upper limit for the duration of the search solution is important. It must be stated that for instance with the number of nodes not exceeding 200, relatively good solution is found after approximately 5-6 minutes. Further browsing through the space of feasible solutions allows for some improvement of obtained solutions (amendment order of 0.1 % - 0.5 %)

In the context of general conclusions about troubleshooting in VRP, it can be said that the best technique to find (sub)optimal solution is to apply parallel computing architecture to solve the test case with the use of several different instances of the algorithm (both heuristic and meta-heuristic) and then, select the best solution in terms of a specific criterion, i.e. the total cost of transport.

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Key words: GIS; logistics; routing; shortest path; transport; VRP

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EXAMPLES OF APPLICATIONS OF COMMON BALTIC SEA DATUMS IN ANALYZES OF EXTREME SEA LEVEL CHANGE

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Users of navigational information, hydrographers and oceanographers confirm difficulties in interpreting bathymetric charts of the Baltic Sea and in presenting sea level oscillations in storm surges. This is due to the absence of one common geodetic reference system for sea level observations in individual states of the Baltic region. Due to requirements of e-navigation, coastal engineering, construction of harbour infrastructure and configuration of other spatial data, a unification of vertical reference systems and their zero datums became necessary. In June 2005 the International Hydrographic Organization and the Baltic Sea Hydrographic Commission established a Chart Datum Working Group for the harmonization of reference levels of Baltic Sea charts. The Baltic Sea Hydrographic Commission had analysed geodetic networks of individual Baltic states and found that respective sea levels should be referred to one datum, that is Normaal Amsterdams Peil (NAP), which is the reference level in the EVRS (European Vertical Reference System) [1 - 3].

This work demonstrates the examples of application of common reference datum NAP, within the EVRS for the Baltic Sea. They are mainly visualizations of parameters of extreme sea levels: distribution of maximal and minimal sea levels, amount of storm surges, distribution of theoretical water, short term deformation of sea surface, differences between sea level observation data and model data. Material research included hourly sea level observation data from 49 gauges stations located along the Baltic Sea coasts from the period 1960-2010. Hourly sea level data were corrected to the single vertical datum which is NAP in the practical realization of the EVRS system called EVRF 2000 (The European Vertical Reference Frame 2000). Basic calculations were done using the Coordinate Reference Systems in Europe (CRS EU) portal with simultaneous consultations of the relevant institutes of Baltic countries. Common reference datum allowed for setting the geographical pattern of occurrence of extreme sea levels in the Baltic Sea. North-eastern Baltic coasts exposed to the western air masses are vulnerable to extreme hydrological events (Gulf of Finland, Gulf of Riga and Gulf of Bothnia). On the contrary, Swedish coasts of Central and Northern Baltic are the least endangered by extreme sea levels. South-western coasts of the Baltic Sea (Bay of Mecklenburg and Bay of Kiel) embrace the basins of the most frequent and the most severe storm falls and extremely low sea levels. Demonstration of the of Baltic surface deformation during a storm event is another example of NAP usage. The elevation of momentary height difference between north-eastern and south-western coasts during storm surge situations amounted to more than 3 meters, what was a result of a negative pressure impact (water cushion) induced by a dynamic and deep low pressure system crossing the Baltic Sea [4].

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Key words: Baltic Sea, datum sea level, storm surge

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FREE PUBLIC GEODATA SERVICES – THEORETICAL STUDIES OF APPROACH IN LITHUANIA AND POLAND

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Public availability of the data allows to apply it for educational purposes. University students both in Lithuania and Poland use public services provided by geoportals to tackle different spatial tasks. Evaluation of services provided by geoportal.lt and geoportal.gov.pl has revealed that some information in the Help section is missing, while in different cadastral registers data discrepancies were detected. The quality and availability of free geodata services of the Lithuanian geoportal were positively evaluated by 48.68 percent of Lithuanian students, negatively – by 37.57 percent, 13.76 percent of students had no opinion. The quality of spatial data and services by the Polish geoportal were appreciated by 50.30 percent of Polish students, negatively – by 28.31 percent, 14.81 percent had no opinion. It can be concluded that free public spatial data services are readily available to users, easily understandable, adaptable to students' practical activities and applicable in a variety of tasks.

Key words: Geographic information systems, Database systems, Portals, Web services, Management information base

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FREE SATELLITE IMAGERY FOR MONITORING RECLAIMED SULPHUR MINING REGION TARNOBRZEG, POLAND

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The aim of the paper is the analysis of new free satellite images of mining area. Test study is located in south-east Poland near Tarnobrzeg city, where in the past sulphur was intensively mined on the large area. Sulfur was developed in open-pit mine Machów and by using drilling technology in Jeziórko. During the mining activities, soils on the mining area were polluted by sulfur. Moreover, it has changed water conditions due to the continuous drainage of the area around the mine. As a result of reclamation the plant succession can be observed. Since 2006 when the drainage was stopped, the groundwater flooding occurs in large area. Application of the new satellite images, nowadays free of charge, for the vegetation succession and flooding process monitoring was analyzed. New and archive satellite images were obtained (Aster, Landsat, Sentinel) and few indices were tested for monitoring and for delimitation of flooding area.

Key words: River Earth Observing System, Hyperspectral imaging, Hazards floods, Groundwater flooding, Mining area, Landsat8, Sentinel2, Aster, NDVI

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FULL IMPLEMENTATION OF THE RIVER INFORMATION SERVICES OF BORDER AND LOWER SECTION OF THE ODER IN POLAND

Andrzej Stateczny¹

During 2015 year functional-utility program of full implementation of River Information Services (RIS) of border and lower section of the Oder in Poland was developed by consortium of Marine Technology Ltd. and Lemtech Consulting Ltd.

The technical part of functional-utility program, made by Marine Technology Ltd., presents the concept of the construction of the system allowing for the achievement of assumptions resulting from analytical works, including the results of the pilot implementation, the expectations of the Inland Water Authority and own analyses and experiences.

The aim of full implementation of the Odra RIS is designed to introduce river information services in a wider area compared with the pilot implementation base on technologies checked in the pilot implementation, which will allow in particular to increase the ergonomics of the system. In the article the aim and the assumptions of the Odra RIS implementation, the location and spatial scope, legal and formal conditions, hardware and software functionality and infrastructure connected with the acquisition and transmission of data and the provision of services are presented.

RIS (River Information Services) is a set of harmonized information services for the purpose of traffic and transport management in inland navigation, realized via one or more harmonized IT systems. The main purpose of introducing RIS is to make inland navigation a clear, effective, flexible and easily accessed means of transportation, able to compete with other ways of transporting cargo. Another important aspect is to improve the safety of inland navigation.

The pilot implementation of the RIS system for the lower part of the Oder was completed in 2013. It was the first River Information Services implementation in Poland. During implementation process of pilot stage in 2013 all so-called key RIS technologies were introduced. Were produce and make available inland electronic navigational charts (Inland ENC), provide notices to skippers services (NtS), make available hydrometeorological information and monitor navigation situation on fairways mainly carried out by AIS, DGPS and VHF technologies and supported by surveillance cameras and radars. Marine Technology produced in this stage first Inland ENC in Poland.

The RIS river information system for Lower Odra implemented during pilot stage was covered the waterways of the lower Odra river from the town of Ognica to Szczecin. This stretch of water has been classified as Vb waterways. Total length of the waterways is 97.6 km.

Marine Technology Ltd. developed in 2015 technical part of functional-utility program of full implementation of River Information Services (RIS) of border and lower section of the Oder in Poland.

Pilot implementation was limited to the waters in which its introduction was mandatory.

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In practice, it means not quite 100km of waterway in the area of the lower section of the Oder [1].

As a result of the analysis of the influence of fulfilment of possible area variants, so-called optimum variant being a compromise between the increase of the territorial scope of the full implementation of RIS and the optimization of the costs of the project in relation to the achieved benefits in the form of launched services was chosen. This variant assumes the increase of the RIS area by 117km upriver up to the motorway bridge in Świecko. The total length of waterways is 242.9 km.

The paper presents the results of river information services implementation on the RIS Lower Odra area during pilot faze and planned implementation during extension stage of Odra RIS. During pilot stage the first RIS system was installed in Poland. There is the most sophisticated RIS sensors network in Europe. The experience gained during Odra RIS planning and implementation could be useful for other RIS implementation in Poland especially along Wisla River.

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Key words: River information Services, Inland ENC, sensors, inland navigation

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Fig. 1. Schema of existing and planned RIS sensors (a) and data transmission network (b)

GIS BASED APPROACH TOWARDS ASSESSING THE WATER STRESS AT REGIONAL SCALE

Kirti Avishek¹

Jharkhand is the 28th state of India that provides 40 % of the countries mineral resources. It is a region housing 28 ethnic tribes, multi religious and cultural groups, multi industrial sectors within its vast deciduous forest expanse. The annual rainfall in the region is 1500 mm, yet the region is facing acute water crisis. The objective of the work is to assess the factors such as soil drainage, geomorphology, geology, precipitation, ground water table and irrigation potentials. Water Accounting has been conducted at regional scale and results have been obtained. GIS has been used as a tool to assess the water status across the region. Results show that more than 70 % of the region in naturally unsuitable for water recharge, although the water demand is under safe category yet the natural factors accompanied with water demand has resulted in water stress in the region.

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Key words: multispectral analysis, GIS, water conditions

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GLOBALIZATION AND THE INFRASTRUCTURE FOR SPATIAL INFORMATION

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Exceedingly important feature of globalization has become establish of a global information system. Its main link is the network of global information technology (IT), especially the Internet system providing comprehensive possibilities of communication between companies, people and state. Internet allows to obtain and provide information on a variety of commercial, financial, tourist, cultural and educational activities. It can be argued that the creation of a global computer networks, especially the Internet, mobile services and digital television decisive for the awarding of globalization the nature of the integrated and compatible process. the development of the Internet is also possible to access to a wide range of geospatial information.

This article presents the development of infrastructure for spatial information as a result of the globalization.

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Key words: globalization, infrastructure for spatial information, computerization

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IDENTIFYING THE EFFECTS OF SELECTED ROAD AND ROADSIDE PARAMETERS ON ROAD SAFETY USING GEODETIC TECHNIQUES

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In the last decade nearly 65,000 people were killed and more than 700,000 were injured in Poland's road accidents. Each year more than 70,000 road users fall victim to road traffic. World Bank experts estimate that each year Poland loses 2.7 % of its GDP due to road accidents. Despite a clear reduction in fatalities in recent years, about 3,000 people are killed in accidents on the entire road network. With a demographic rate (number of fatalities per population) of 10, Poland is the EU's worst performing country.

There are many factors that influence accidents and their severity. They can be grouped within the system of man, vehicle and environment. To ensure a better understanding and identification of road factors that may cause accidents, road safety models are required.

Road safety models must be built on reliable accident and casualty statistics, road, roadside and traffic data. Road factor data are very difficult to collect, in particular in the area of road geometry. These include road way width, parameters of horizontal bends and road curviness and profile parameters (grade, waviness). In addition, roadside data are required such as the clearance to side obstacles.

The data that is missing from Polish models is horizontal bends and vertical alignments which may have a significant impact on road safety measures. While many of the models include variables that contain road geometric parameters, there is nothing there to identify how they affect road safety.

A number of publications suggest that there is a direct relation between the parameters of road geometry and profile. Yet because of the difficulty of obtaining the data, they are not used properly in Poland's road safety models.

Considering the fact that in the last 10 years about 10 % of all road accidents that represent about 14 % of all of Poland's fatalities happened on horizontal bends, the problem is serious and requires an in-depth examination. Horizontal bends are a special element of the road network, with not just speed and trajectory of movement but also the dynamics of movement playing a major role.

The paper will present techniques that can be used to obtain data on road alignment and profile including the roadside. In-the-field and simulation studies have helped to develop mathematical

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models that integrate vehicle position data. The experiments were conducted in a virtual environment using the software ArcGIS that reflects the actual roadside conditions. The site tests were made using a purpose-built device which integrates a system for accurate satellite positioning and photogrammetric apparatuses. The tests covered selected sections of national and regional roads in the region of Pomorskie.

The results will be helpful with building mathematical models that describe the effects of geometric parameters (with a special focus on horizontal bends) on road safety and will consequently help to apply the right measures to improve road safety.

Key words: traffic safety, curve radius; horizontal curves, accident modification functions

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INTEGRATION AND VISUALIZATION OF THE RESULTS OF HYDRODYNAMIC MODELS IN THE MARITIME NETWORK-CENTRIC GIS OF GULF OF GDANSK

Jerzy Pyrchla¹, Marek Kowalewski², Martyna Leyk-Wesołowska³, Krzysztof Pyrchla⁴

Ensuring the security of the coastal area, makes seaside countries research in the field of infrastructure spatial information of environmental data. The paper presents the results of the work on integrating an electronic navigational chart with orthophotographs of coastal areas as well as numerical data from weather and hydrodynamic models. Paper focuses on a problems associated with creating an environment that integrates data distributed in different formats with particular attention to the NetCDF format being developed by the Association UCAR (University Corporation for Atmospheric Research).

NetCDF format allowes in an easy way to introduce geospatial data from numerical hydrodynamic model into Geographic Information System (GIS). Using appropriate conventions of metadata recording and completion of lacking elements through own IT tools allowed for easy visualization of spatial information. The result is the map that integrates multiple layers of thematic issues were related to the location of a maritime accident. The possibilities of using so prepared applications were tested by comparing simulated results in GIS environment with ones obtained during experiments in the real world.

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Key words: Search and rescue (SAR), Geographic Information System (GIS), Electronic Navigational Chart (ENC), hydrodynamic models, Gulf of Gdansk in Baltic Sea

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Fig. 1. Visualization of the wind field combined with multiple basemap layers (orthophotographs and ENC map) in the GIS system.



Fig.2. The surface currents in the Gulf of Gdansk predicted in the hydrodynamic model and imposed as an additional layer in the sea-land map in GIS.

INTEGRATION OF SPATIAL DATA FROM EXTERNAL SENSORS IN THE MOBILE NAVIGATION SYSTEM FOR INLAND SHIPPING

Grzegorz Zaniewicz¹, Witold Kazimierski², Izabela Bodus-Olkowska³

Mobile navigation as a concept and as a system can be considered as rapidly developing branch of technology. The introduction of mobile devices and miniaturization of sensors stated also new questions and tasks for data processing and geodata visualization. Thus, the navigational system for mobile devices has to include methods for gathering, processing and presenting of information in the way suitable for parameters of these devices and to fulfil the requirements of mobile devices users. An example of such a system, dedicated to recreational inland waters users is MOBINAV – mobile navigation system for inland shipping, developed in the research project in Maritime Technology Ltd. The goal of the system is to provide complex and required information to touristic users in inland waters, as it is in road navigation systems for drivers. The main scientific goal of the project is developing of geodata processing methods for the needs of mobile cartographic presentation and for effective navigation in inland waters. The system is intended to join the requirements of this specific group of users and modern methods and technologies used in mobile devices for data gathering, processing and visualization.

In the field of visualization of information, mobile cartography appeared as an answer to a requirement of presenting data and information in mobile devices. The new methodology based on the concept of geocompositions, cartographic events and geovisualization windows is presented for example in [1] or [4]. In the field of data processing, classical methods used in stationary systems with some optimization in the aspects of data size are used and for data gathering. Usually the scope of inner sensors in mobile devices are used [3], however these are not always sufficient and use of external sensors can be proposed [2].

Any navigation system relies on data derived from sensors. The basic one is position sensor, which can be inner, but there are many other important sources of information which may significantly influence navigation process. In case of inland shipping these factors include for example bathymetric information, weather information or information about other ships. All these information may be delivered to the navigator in various ways including using of sensors mounted on own ship as well as outsourced information from shore installation or other vessels. In case of obtaining data from various sensors the problem of their integration appears.

The paper presents two approaches to external sensors information integration in the system of mobile navigation for inland shipping. The first approach is based on sensors in direct correction with the user application. All sensors are located on the water craft where the data is distributed via Wi-Fi

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connection. The data from sensors provide a lot of information used to conduct safe navigation on the water area. The main information for user are geographic position and course over ground. In this case sensors like GNSS receiver and accelerometer mounted in the mobile device are proposed. Additional information can be the traffic data from AIS (Automatic Identification System), the meteorological information or actual depth below boat, which is especially important for safe and efficient following the route. All of these data can be transmitted in the NMEA sentence and displayed in the user interface. The sensor platform simulating a recreational craft has been built in the project. The sensors are connected via serial ports and all information are gathered with NMEA format. They are then integrated and sent for presentation in mobile device via Wi-Fi link.

In the second approach the authors propose a method based on the solution used in the GIS systems. The Sensor Observation Service (SOS) is an OGC-standardized web service to exchange sensor data in real time. There are three main segments of this services. The first one is the sensors segment, the second is geoserver segment and the last one is visualization and analysis segment [5]. In this approach to integration the raw data from sensors deployed on the water area are sent to main geoserver. In the next step the data is processed according to the implemented schema and received by user mobile device. Full functionality of this method can be achieved only in the case of mobile network or WIFI access. In this method the AIS data can be achieved without professional devices mounted on board but only from shore sensors via SOS web service. It can be reached via details entered in user application. The name of boat, her position and course can be sent out to other users of SOS server. This solution in contrast to the first one replaces external devices such as AIS device or meteorological sensor and can be extended with data from external servers (e.g. water level data from River Information Service). The concept is presented in details in full paper.

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Key words: mobile cartography, inland navigation, sensor integration

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INVESTIGATION OF DISPLACEMENT DUE TO GEOPHYSICAL EFFECTS BASED ON GPS OBSERVATION DATA IN INDONESIA

Arisauna M. Pahlevi¹, Kosasih Prijatna², Irwan Meilano³, Ibnu Sofian⁴

Global Positioning System (GPS) Positioning has several error sources. To produce accurate positioning is necessary to eliminate or correct those errors. One of the errors contained GPS positioning is an error caused due to Geophysical Effects (GE). Currently, there are global models to correct such errors, one of which the model that was agreed in International Earth Rotation and Reference Systems Services (IERS) conventions 2003 developed by McCarthy (2004)[1]. Global models are developed by considering global characteristic of the earth using global data. This paper aims to investigate the displacement (horizontal and vertical) due to Geophysical effects based on GPS data in Indonesia. We use a year data in 10 stations in major island in Indonesia. The name of stations are: BAKO; CBAL; CBIT; CBKT; CCLP; CPKL; CPON; CMAK; CUKE; SAMP. Data processed using Kinematic Precise Point Positioning (KPPP) method.

From the processing result, displacement due to geophysical effects on vertical component, three times larger than its horizontal component. Every station has a different displacement. CBIT station has the largest tidal range in NS component with tidal range value is 0.3263 meters, and the smallest value is in CPKL station with the value 0.2144 meters. In the other hand, CPKL station has the largest tidal range in EW component with tidal range value is 0.3611 meters, and the smallest value is in CBAL station with the value 0.2641 meters. CCLP station has the largest tidal range in the vertical component with a tidal range of 0.9877 meters. CBAL station has the smallest tidal range in vertical component with a tidal range of 0.5933 meters.

The most affected of tidal harmonic in the vertical component is semi-diurnal phenomena, namely M2, the highest power in CCLP station. In the NS component, the most affected is diurnal phenomena, namely P1, the highest power station CBKT. Then in EW component, the most affected is the semidiurnal phenomena, namely M2, the highest power in CPKL station.

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Key words: Geophysical Effects; Kinematic Precise Point Positioning; GPS permanent station data.

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Fig. 1. Geophysical Effects time series from GPS observation data CPKL station



Fig.2. Geophysical effects Signal in Spectral Domain on CPKL station. Blue: NS, Magenta: EW, Green: UD

MEASUREMENT SYSTEM BASED ON ELECTRONIC INCLINOMETERS IN THE RESEARCH ON THE DEFORMATION OF THE RAILWAY TRACK LINE

Michał Strach¹

The measurement of the geometry of railways is performed frequently during diagnostic tests determine the technical condition of the track [1]. The geometry of the track is also determined during the construction and modernization of railway lines. Currently used multi-system, efficient measurement trolleys [2], [3]. They enable the acquisition of information about the geometry and position of the track in both horizontal and vertical plane. The latest solutions in the field of mechatronics allow the construction of systems expanding measurement capabilities of the railway infrastructure [4].

The paper presents an original measurement system. It was built on the basis of inclinometers. The device can be used to measure the grade line and the cant of the track and mileage [5]. It is an alternative to the classical height measurements of rail track. The system complements the currently used multi-sensor measuring trolleys.

The article presents the results obtained on the basis of measurements taken constructed system. Observations were used to prepare diagnostic reports concerning the geometry of the track in a vertical plane. They were determined geometric parameters such as: cant, twist, unevenness for each of the rails. Additionally it has been defined geometry and deformation of grade line on the measured distance. Conducted constructed system measurements were verified with the results obtained with classical precision leveling. Based on a comparison of the values of both measuring methods it demonstrated the benefits developed in the use of the system.

Key words: diagnostics, surveying geometry of the track

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METHOD OF PARAMETER REDUCTION IN THE TRANSFORMATION OF OBLIQUE PHOTOGRAPHS AND PROPOSAL OF ITS IMPLEMENTATION IN UNMANNED AERIAL SYSTEMS

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In this publication, the authors present a different method of calculating rotation angles, based on rigid body mechanics. In addition, factors associated with the shift in coordinate system are eliminated in the initial phase of calculation. Based on the rules of momentum, the displacement of the coordinates and then the angles of rotation (Tait-Bryan) are calculated by which rotation matrix is determined. This shows that, in space to space transformations (where one is oblique relative to the second), it is sufficient to have at least two control points that are registered in both spaces, but are located on the axes of the primary system or three any-located points. This method was validated in a laboratory and field. A series of surveys using an electronic total station in an oblique system was conducted, gaining (sub)centimetre accuracy. Following this, the possibility of its implementation in unmanned aerial systems is discussed.

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Key words: unmanned aerial vehicles, coordinate measuring, optical imaging, orientation determination

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MODELLING SPATIAL RELATIONSHIPS BETWEEN THE NUMBER OF GEODETIC CONTROL POINTS AND LAND USE

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The aim of this study is to present modelling of spatial relationship between the number of geodetic control points and land use as well as the analysis of spatial distribution of geodetic control points in respect of regulations of the Ministry of Administration and Digitization. An optimal geodetic control network should be characterized by a high precision, reliability and a low cost [1 - 3]. A design of a geodetic network involves selection of locations and the number of network points, with an optimal configuration for the network, and an optimal selection of the type, number, and weight of the observations [1]. In Poland the density of geodetic control points as well as their positional accuracy are defined by the Regulation of the Ministry of Administration and Digitization. This regulation provides that the density of geodetic control is uneven, and it should be at least 1 point per 20 ha for urban areas and 1 point per 120 ha for agricultural and forest areas. The goal of our study is: (1) to measure the actual density of geodetic control points in geodetic sections, the lowest unit of local administration usually comprised of a single village; (2) defining the correlation between the density of geodetic control points and land use, as well as (3) modelling spatial autocorrelation of geodetic sections characterized by similar (high or low) density of geodetic controls. The results are presented in the form of thematic maps. Cartographic presentation of the results in the form of choropleth maps will facilitate decisions concerning modernizing and densification of geodetic controls, and it will enable surveyor to assess the time needed for measurement tasks faster and more precisely [4].

To determine the influence of the land use on the number of control points in geodetic sections, the multiple correlation coefficient R was determined by means of the Pawlowski method [5]. Its value is R = 0.59, which means that the determination coefficient R^2 is 0.35, and the number of geodetic control points in the area depends as much as 35 % on the land use. To model spatial autocorrelation LISA statistics, namely - Getis-Ord, was used. It identifies the local association between a geodetic control density in the geodetic section and its neighbours, up to a specified distance from the observation. We noticed that 40 % of geodetic sections form statistically significant spatial clusters.

The research proved that geodetic control points are scattered with significant visible groupings along roads, railways and built-up areas. It also indicates that information on the land use could not be

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ignored in the phase of designing the location of geodetic control points because it has a vital influence on the number of geodetic control points.

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Key words: geodetic control points, spatial autocorrelation, thematic map

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MODERN SYSTEMS USED IN SURVEYING AND DIAGNOSTICS OF THE TRACKS GEOMETRY

Michał Strach¹, Karolina Makowska²

Ensuring the safety and comfort of rail transport requires conducting systematic observations of the technical condition of the track. This works related to this should be divided into two stages diagnostics and surveying. During survey of the railways geometry and technical infrastructure various measurement techniques are used. It usually associates with the selection of both most appropriate measuring devices and software, which is used to process and analyse the results. Foregoing requirements have to guarantee obtaining the sufficiently accurate results in the shortest possible period of time. The paper presents modern surveying techniques used in the processes of diagnostics and surveys of the railways. Presented systems can be used during surveys of the railway lines, tram lines and underground lines.

The measuring devices were divided into three groups. This division is associated with the survey efficiency, resulting in a length of track section measured in one hour. In first group are the least efficient devices, for example digital track gauge. The second group contains the biggest number of devices, most often track surveying trolleys with measuring sensors. In the last group there are the high-efficient, self-driving track survey cars. These cars can be specially constructed for the purposes of tracks measurements or be adapted to them. The speed of this devices can exceed 100 km/h. The multisensor measurement systems usually are also equipped with: laser scanners, GPS, digital cameras, odometers, inertial measurement units (IMU), ground-penetrating radars and so on.

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Key words: diagnostics, geodetic measurement (surveying), geometry of the track

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MULTI-GNSS IONOSPHERE MODELLING WITH TPS INTERPOLATION

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Popular GNSS-TEC maps provided by scientific organizations such as CODE, ESA, UPC and JPL are often used for ionosphere studies. However, their accuracy of 4-8 TECU and low spatial and temporal resolution is not sufficient for studying the ionosphere on a regional scale. This motivates research community to develop new modelling and interpolation methods. In this paper, we demonstrate new approach to GNSS-TEC estimation. In the new approach we use solely carrier phase multi-GNSS observables and thin plate splines (TPS) for accurate ionospheric TEC modelling. TPS is a closed solution of a variational problem minimizing both the sum of squared second derivatives of a smoothing function and the deviation between data points and this function. This approach allows for generation accurate TEC maps for Europe with high temporal and spatial resolution. In addition, we present the performance of our approach during the most intense ionospheric storm of 24. Solar cycle that took place on March 17th, 2015. Our solution was compared to IGS global and CODE regional maps. The result showed that the accuracy of our maps in better by one order of magnitude comparing to IGS maps.

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Key words: Ionosphere, TEC, GNSS, TPS

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PERFORMANCE OF THE AUTOMATIC BUNDLE BLOCK ADJUSTMENT IN THE VIRTUALIZED ENVIRONMENT

Mariusz Twardowski¹, Elżbieta Pastucha², Jakub Kolecki³

This article explores the level of influence of hardware virtualization on image processing efficiency, due to added software layer of a hypervisor. Paper takes the form of case study in which the capabilities of Agisoft PhotoScan's automatic bundle adjustment, are going to be evaluated in the aspect of processing time under various environment settings. All measurements will be performed using consumer grade hardware running GNU/Linux operating system together with most popular hypervisors for creating virtual machines. Also ownCloud instance will be used to simulate processing with cloud data access, along with its WebDAV interface. Data test field used to estimate processing efficiency will contain block of 171 photographs arranged in 11 strips, acquired using DMC II 230 full-format aerial camera, yielding around 105GB of raw uncompressed image data.

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Keywords: virtualization; photoscan; linux; cloud processing; automatic tie point measurement; bundle block adjustment;. aerial triangulation

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POTENTIAL OF POLISH R&D INDUSTRY IN THE CONTEXT OF PROTOTYPING, DESIGN, DEVELOPMENT AND CONTROL OF DEDICATED NATIONAL SATELLITE SAR SYSTEM

Andrzej Chybicki¹, Zbigniew Łubniewski²

Space technology is currently one of the most important elements in the advance of information societies and knowledge-based economies all over the world. The European Space Agency (ESA) is in the focal point of the European space activities while the European Union provides strong financial support for the development of space technologies and applications in its flagship programs. In domestic scope, Polish Space Agency (POLSA) is a national aeronautics entity responsible for activities related to development of technologies of national space sector. Recently, one of the activities of POLSA aims to establish, is the programme of building the system of satellite SAR observations dedicated for Polish users such as administration, civilian services and Polish scientific and research entities that would expand potential use of satellite technologies among numerous Polish beneficiaries. In the context mentioned above, the paper describes architecture and functional components of exemplary satellite SAR system along with the potential of Polish entities to develop

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Key words: satellite technologies, system architecture

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PRECISION POSITIONING MULTI-GNSS, SIGNIFICANCE FOR IMPROVING THE ACCURACY AND RELIABILITY OF MEASUREMENT IN REAL-TIME

Zbigniew Siejka¹

The rapid development of Global Navigation Satellite Systems (GNSS) such as GPS, GLONASS, BeiDou (BDS) or Galileo led to the development of existing services, eg. International Service GNSS (IGS), creation of new ones such as Experiment Multi-GNSS (MGEX), and also contributed to the creation of many national systems of navigation overlay service, implemented by the governments of various countries, who noticed huge benefits from their implementation. In addition, many commercial systems on a local, regional, national or supranational scale were created, which provide services in the field of satellite positioning.

The rapid development of navigation systems created inter alia new possibilities for improved position determination in real time. This article presents the concept of the development of multi-GNSS, starting from using in the measurements the single real-time navigation system (GPS) for the full model using all the potential of currently available observations in all four systems available in the GNSS.

Designed research was carried out on the basis of precise positioning technology (real-time RT -Real Time) using four different active geodetic network (one national and three commercial), currently available in Poland. These networks are available for a wide group of users using the measurements of satellite techniques. In total, more than 470 permanent reference stations are working there. They differ, however, in terms of technological advancement, because some of them use the observations of only one satellite navigation system (GPS), part of them to two systems (GPS/GLONASS) others to three (GPS/GLONASS/BeiDou) and some even to four systems (GPS/GLONASS/BeiDou/Galileo). For this reason, they also offer a diverse range of services providing: correction network RTN data, correction data for a single RTK reference station, the observations relating to the physical reference stations, the observations relating to the virtual reference stations created on the basis of the parameters given by the user.

The obtained results indicate the substantial benefits resulting from the multi-GNSS solution with respect to a single positioning system based on real-time. This is particularly important for geodetic applications with respect to the reliability and accuracy of obtained solutions. Numerical results show in each case, that adding an additional system, to a single GPS can improve the accuracy of even a few millimetres.

Key words: BDS; Galileo, GLONASS, GPS, ASG-EUPOS, real time, dual/triple-frequency observations

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PROCESSING OF LIDAR AND MULTIBEAM SONAR POINT CLOUD DATA FOR 3D SURFACE AND OBJECT SHAPE RECONSTRUCTION

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Unorganised point cloud dataset, as a transitional data model in several applications, usually contains a considerable amount of undesirable irregularities, such as strong variability of local point density, missing data, overlapping points and noise caused by scattering characteristics of the environment. For these reasons, further processing of such data, e.g. for construction of higher order geometric models of the topography or other sensed objects, may be quite problematic, especially in the field of object detection and three-dimensional surface reconstruction. This paper is focused on applying the proposed methods for reducing the mentioned irregularities from several datasets containing 3D point clouds acquired by LiDAR scanners and multibeam sonars. The good performance of the proposed methods has been shown along with illustration of the importance of the 3D shape reconstruction procedure.

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Key words: LiDAR; multibeam sonars; 3D; point clouds; shape reconstruction; noise reduction

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RESEARCH INTO THE MOVEMENTS OF SURFACE WATER MASSES IN THE BASINS ADJACENT TO THE PORT

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This paper presents the results of the practical and theoretical research in determining the routes of movement of small objects moving together with the water surface masses in basins adjacent to the port. The results of this research were referenced against the modelling of small objects routes in port channel basins. The results of practical research concerning the movement of small objects in basins adjacent to the port were referenced against the modelling of trajectories of these objects in the port channel basins. The purpose of the testing was to determine the efficiency of numerical modelling in dealing with the specific nature of the analysed area. This area is characterised by the multi-aspect hydrodynamic processes, as well as the low spatial resolution of the sea currents data obtained from hydrodynamic numerical models. The research involved two tools used for modelling interactions between the surface currents and the moving objects. One of the tools was the graph model developed for the purposes of this research, whereas the second one was the M3D hydrodynamic model. Results obtained through the experiments carried out in a virtual environment were referenced against the real-world measurements. Practical research was carried out using dedicated drifters in the basins adjacent to the port.

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Key words: harbor hydrodynamic; graph theory; hydrodynamic models; drifter's trajectories

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Fig. 1. Basins used for drifter experiments.



Fig. 2. a) The vertex *i* and its neighbors, b) To the outgoing edges of the vertex *i*, we assigned the angles $\beta \in B$.

SCHREIBER'S DIFFERENCING SCHEME APPLIED TO CARRIER PHASE OBSERVATIONS IN THE MAFA METHOD

Dawid Kwaśniak¹, Sławomir Cellmer², Krzysztof Nowel³

The subject of the article is Schreiber's scheme of carrier phase differencing in precise GNSS positioning. First time this idea was proposed by prof. Roman Kadaj in the Beta method. There is no need to assume the reference satellite in this approach. In this contribution the idea of Schreiber's scheme of differencing was modified and implemented into MAFA method. The modification of the original idea is based on preparing only double differences (instead of triple differences as in the Beta method) and applying them to MAFA functional model. In this approach the integer nature of ambiguities is taken into account. The functional model of this approach is described in details. The numerical tests were carried out. The comparison of the results from the proposed method and a classic approach (with one reference satellite) was performed. The results of the tests are presented and analysed.

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Key words: the MAFA method, the Beta method, GNSS data processing

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SATELLITE REMOTE OBSERVATION DATA DISSEMINATION FOR MOBILE DEVICES USING ESA HMA STANDARDS

Andrzej Chybicki¹, Marek Kulawiak², Daniel Zinkiewicz³

Global Earth Observation (EO) satellite systems provide valuable measurements related to our globe. Providing high quality information related to the Earth's environment requires several satellite missions to be placed in orbit space [1, 2]. For instance, new Sentinel-1 mission provides high-resolution land and ocean radar images, on the other hand, Sentinel-2 provides information on weather conditions, while other missions allow for global monitoring of global sea and land processes [3]. Thus, initiatives aiming to harmonize available datasets and extending their usability is of high interest among many groups of researchers [4, 5]. Therefore, the overall aim of Copernicus (former name: Global Monitoring for Environment and Security - GMES) programme is to provide easy to use, applicable and high quality data from spaceborn observing sensors for various applications.

In this context, the main objective of the Heterogeneous Missions Accessibility (HMA) ESA initiative is to establish harmonised access to the ESA mission data, Ground Segment services from the GMES Contributing Missions (GCM) and related interfaces. SmartHMA project, as a part of implementation of HMA standards, is focused on developing and validating an open source operational platform that allows for an access to a set of Heterogeneous Missions data and services in native thin clients. The article presents a mobile platform for deployment of HMA standarised data and services into different types of system environments, which allows for discovery and distribution of data and services in the form acceptable by mobile devices and based on OGC and HMA specifications.

The main purpose of the SmartHMA is to develop and validate an open source operational platform architecture which implements a set of HMA standards in native client for access to GS data and services from the Copernicus/GMES Contributing Missions (GCM) and the ESA missions distributed by different existing and planned services. SmartHMA as an application designed for the tablet devices that will operate in an environment typical for tablet based application (indoor and outdoor). For this purposes, design process of UI focuses on handy and user friendly EO data discovering and searching mechanisms dedicated for use with a tablet touch screen. The application is designated for all types of tablet devices with all screen size and resolution (mainly 7 and 10 inches). The target operational system for SmartHMA will be Android in version 3.0 and higher.

The aim of SmartHMA is to provide a new platform for distribution of existing EO data and those that will be available in the near future, in the form that will be acceptable by mobile devices (mainly

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tablets). Application is adopted to existing environment and changing user needs associated with mobile user behaviours and growing market of mobile devices. SmartHMA in form of an open source software allows complementing the RSS system environment and EO data discovering platform.

Key words: Android; HMA; ESA; GMES; remote observation

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SELECTION OF AN OPTIMAL DENSITY OF MEASUREMENT POINTS IN TRAVEL TIME MAPPING

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In the research, selection of an optimal density of measurement points in travel time mapping has been undertaken. Study was related to the territory of Warsaw and travelling from anywhere in the city to the Warsaw Frederic Chopin Airport with the use of public transportation.

The measurement points, from which travel times were calculated, were selected using selfacting method. They were automatically arranged in a three different grids with a mesh of 0,5 km, 1 km and 2 km. Travel times were calculated for each measurement point and then these values were interpolated for the whole territory of Warsaw.

In the study, interpolation method named IDW - Inverse Distance Weighted, which is based on weighted sample point distance, has been used. In the IDW interpolation method, the sample points are weighted during interpolation in such way that the influence of one point relative to another decreases with distance from the unknown point. The IDW method is particularly useful for modelling of events where there is a strong correlation between the given value and distance. The best results can be obtained for measurement points densely and evenly located. It is a deterministic, local and true interpolation method. In addition, what is very important in the research, the IDW method allows for the limiting of the interpolation area. The exclusion of some objects, locations or regions from the interpolation has significant effect on its result. In such a similar studies of Authors and others, the IDW method brought the best accuracy results.

The rules for selection of types and size of excluded areas (the areas removed from the interpolation process) were developed in earlier Authors research, because the literature does not take issue with the criteria determination of these areas. There are eight groups of excluded areas - each of them meets the relevant criteria. It was assumed that the excluded areas are regions that are closed or impossible to traverse by foot or public transit due to their topographical features.

In the research undertaken, public transport timetables, available in jakdojade.pl online service, were considered when calculating travel times. Jakdojade.pl is the most popular Polish service dedicated for public transport's passengers and it's also available as a mobile application. The travel time for a particular journey is a function of the origin and destination points, the time of travel, the modes used, and of decisions made by the traveller (for instance whether to prefer faster or cheaper journeys).

The estimated travel time was evaluated by computing absolute error of 25 control points, which were not used in the interpolation. The optimal results gave interpolated data with a mesh 1 km. The

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accuracy was as good as in results from final data with a mesh 0,5 km, but time of data procured was much shorter.

This research is one of the first analysis of the travel time calculation with the use of self-acting method of measurement points distribution and data obtaining. It shows that this method gives very good accuracy outcome, as well as reduces the time of measurement data gathering. The measurement data is current on February 2016.

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Key words: self-acting method, travel time mapping, IDW method, excluded areas

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SELECTION OF PARAMETERS OF SPATIAL DATA GEOMETRICAL SIMPLIFICATION IN MOBILE NAVIGATION SYSTEM FOR INLAND WATERS

Marta Wlodarczyk-Sielicka¹, Witold Kazimierski²

Mobile navigation for inland shipping is an example of GIS (Geographic Information System) designed for mobile devices. Development of the new system called MOBINAV is an fundamental objective of the project "Mobile Navigation for Inland Waters" under the research program LIDER IV, which is funded by the National Centre for Research and Development. The main assumption of the system is its destiny – system dedicated to recreational users using the inland waterways with so called pleasure crafts.

During the work on building the system it was decided to elaborate an own model of spatial data MODEF (MObinav Data Exchange Format), which is described in details in [4]. In mobile navigation system for inland shipping authors focus on ensuring efficiency of cartographic communication, which has relationship with the effectiveness of contents, utility of chart and its usefulness to the user. The model of mobile cartographic presentation described in [2] was used as a base and modified for the purpose of model implementation in MOBINAV. Large dynamic of mobile presentation enforces frequent change of scale of observed presentation. This leads to a need of generalization of input data, including spatial simplification.

The first step of generalization was determination of the values of attributes SCAMIN and SCAMAX. These attributes are responsible for the appearance of the object or its disappearance from the geovisualization window of mobile device. Analysing these, authors drawn a number of important conclusions. One of them is the fact that determination of partial geocompositions, which are responsible for displaying a specific set of the features is inadequate and does not ensure the perspicuity of map content. Defining attributes SCAMIN and SCAMAX proved to be satisfactory in the case of point features. For the purposes of the correct interpretation of the map and to avoid the effect of "littering" the small screen with too many details in case of the line features and polygons geometric simplification has to be performed. The research presented in the paper focus on this aspect of generalization. Classical algorithms of simplification were used in the research and they were carried out in ArcGIS software, using ArcCatalog and ArcMap applications.

Given the requirements of the future user of the system MOBINAV, a separate model simplification for each of the layers of the system was created. These models are combinations of the methods listed below. During the simplification of line features Douglas-Peucker algorithm was mainly implemented. During the generalization of polygon features simplification method was applied, maintaining the basic shape and size of the features. The parameter of simplification tolerance and parameter determining the minimum area of the feature was used. Additionally, features within an

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established distance were merged. Smoothing tool for shape and size of buildings and PEAK method (Polynomial Approximation with Exponential Kernel) were used as well. In addition, selection tool was employed and features with secondary importance to the user of the system during navigation mode, were eliminated.

The overriding factor, that has been taken into account during simplification methods research, was the limitation of sharpness of human eyes. It has been shown that it is about 0.2 mm at a distance of 30 cm from the human eye [1]. In the article authors presented the results of analyses of selected parameters of simplification in the process of creating mobile navigation system for inland waters. In the study authors focused on selected layers of system. Models of simplification for layer with line features and with polygons were tested. The parameters of the tested models were modified for the purposes of study. The article contains the tabular results with statistics and spatial visualization of selected layers for individual scales.

Key words: simplification, inland shipping, mobile systems

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SELF-ACTING DATA GATHERING FOR TRAVEL TIME ANALYSIS – WARSAW AIRPORT AND CENTRAL RAILWAY STATION CASE STUDY

Krzysztof Pokonieczny¹, Albina Mościcka², Joanna Tomala³

The research presents an analysis of travel time mapping with – developed by the Authors - selfacting measurement data gathering method with an identic grid with a mesh equals 0.5 x 0.5 km. Time availability was examined on two cases: Warsaw Frederic Chopin Airport and Central Railway Station in Warsaw – places, which are very popular travel destination for both the residents of Warsaw and the visitors.

Both cases are based on travel by public transport on a weekday. For the travel time made up: getting to the stop, transfer time and of course the travel time by public transport vehicle from any place in Warsaw. All the data were obtained from the Internet service – jakdojade.pl, which determines the travel time.

The measurement data were collected automatically with a mesh 0.5 x 0.5 km for both of cases. Then they were subjected to interpolate by IDW method, which is the weighted average method inverse of the distance, is based on the assigned point in the value of the measuring points with the previously designated neighbourhood. Based on previous research of the Authors and others, this is the best interpolation method for this type of data. What is more, this interpolation method allows to determine the limits of this action. This is particularly important, because in the research there were the excluded areas included – closed areas or impossible to traverse by foot or public transit due to their topographical features. Including the excluded area is a new concept introduced by the Authors in their earlier works, because there are no references in the literatures on this topic. They have defined the criteria for the selection of excluded areas and they divided these areas into eight groups.

For 25 check points absolute errors have been calculated, which are about the credibility of developed travel time maps. In addition, Authors analyzed fragments of maps indicating areas with unsatisfactory accessibility to Warsaw Frederic Chopin Airport and Central Railway Station in Warsaw.

Self-acting measurement data gathering method in time availability mapping greatly accelerates the process of working on the issue. Furthermore, the accuracy of the results is a good as when using manual measurement data gathering method.

Time accessibility maps are of important because can be the basis for the modernization of public transport connections in areas which are characterized by a worse time accessibility of those places. Actuality of studies presented in the article is the end of February 2016.

Key words: self-acting method, travel time mapping, IDW method, excluded areas

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SPATIAL MODELLING OF CRIME BY USING OF GWR METHOD

Somayeh Nezami¹, Ehsan Khoramshahi²

Since the location, human and time are three major factors in incidence of delinquency which includes drug smuggling, therefore, geographic analysis of type and amount of crimes, analysis of social and economic features of perpetrators and their residence place provide suitable opportunity for confronting and controlling abusing and drug smuggling or preventing from its perpetration. Therefore, in this article, at first, crime data relevant to drug smuggling in Southern Khorasan Province of Iran from the randomness point of view were studied. Then, distribution of crimes and its relation with each of the spatial and descriptive variables were examined. Then, crime distribution was modelled according to variables such as population, distance from city, distance to the nearest police station and illiteracy by using Geographically Weighted Regression (GWR)¹. Finally, first grade polynomial and four variables were acquired by using the least squares method which is compared by GWR.

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Key words: Geographic information systems, Geospatial analysis, Regression analysis

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STRUCTURAL HEALTH MONITORING OF COMPOSITE SHELL FOOTBRIDGE FOR ITS DESIGN VALIDATION

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The composite bridge for pedestrians and cyclists, designed within the FOBRIDGE project (Fig. 1a), is the first bridge in the world, which is classified as a consistent single element structural girder, made of sandwich shells, entirely produced in a single production cycle [1]. The outer loadbearing skin of the structure is made of glass fibers reinforced polymer (GFRP) laminate and the core is made of a PET foam.

The composite footbridge has been developed by Gdańsk University of Technology (leader), Military University of Technology and ROMA Co. Ltd. [2]. According to the project assumptions of the FOBRDIGE grant, co-financed by The National Centre for Research and Development the bridge is designed for use over national roads of GP class. However, it can also cross other obstacles, as railroads, channels or small rivers. Due to short production time, easy transportation and installation without heavy equipment (the span is 14.5 m long and has a mass of 3.2 t) the bridge may be used in the areas affected by natural disasters. Especially when there is an urgent need for the recreation of pedestrian paths in difficult technical conditions.

One of the parts of FOBRIDGE project was to develop structural health monitoring (SHM) system, which supports design process, gives a possibility to confirm assumed capacity and to observe long-term rheological changes in structural material. The obtained results were used, among others, in validation of the finite element method model created for a purpose of design process. The proposed SHM system contains three subsystems: monitoring of strains, vibrations and deformations. (Fig. 1b).

The SHM system for the considered footbridge was created to confirm, whether the designed from scratch and subsequently produced structure behaves in accordance with the assumptions made in the project, meets the operational requirements imposed on bridges, and thus confirms the designed capacity. The SHM project so as [3] includes: specification of the measurement points location, adoption of the types of measurement points and definition of methodology for research during the monitoring. The aim of the project was also to define the range for observed parameters during realization of structural monitoring.

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The assumptions for SHM system are: system allows the identification of permanent deformation; system allows to track changes in global stiffness of the bridge by measuring changes in its natural frequencies; system is equipped with a minimal number of sensors with high durability; data acquisition is periodically or continuous depending on the technical possibilities of used sensors; downloading of measurement data with a series of short-term diagnostic tests is performed during the object review; measurement data are stored in the database with via the Internet access; identification of selected design parameters, such as index effort of the state and dynamic parameters; keeping prices as low as possible, both components of the system, and the cost of its installation. The proposed SHM system consist of three independent subsystems: monitoring of strains, vibrations and deformations. It is composed of the following components: Fiber Bragg Gratings (FBG) optic fiber sensors to measure strain and temperature, sockets for connecting the recorder and portable data registration system located on the selected edge of the footbridge; vibrating wire strain gages (VWSG) to measure strain and temperature with wiring and the recorder; accelerometers and gyroscopes with wiring, connecting sockets, box pledged as security and workstation; visual monitoring (video surveillance); benchmarks to conduct geodetic monitoring.

The paper contains introduction to the topic, detailed description of the monitoring system and example results with reference to theoretical values.

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Key words: structural health monitoring, footbridge, composite materials, validation

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Fig. 1. Composite footbridge designed within the FOBRIDGE project (a) and geodetic measurement during load tests of the footbridge (b).

SYNCHRO-PHOTOGRAMMETRY IN THE MEASUREMENT OF OBJECTS IN MOTION THE CASE STUDY

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This paper presents the results of measurements of Foucault pendulum displacement by use of synchronous photogrammetry [1]. The premise of the project was to show the possibility of use nonmetric cameras in close range photogrammetric measurements. The object which has been selected for the study is Foucault pendulum, located in the courtyard of Johannes Hevelius at Gdansk University of Technology. The pendulum is suspended, in such a way that it can freely change the plane of vibration due to the Coriolis force. Due to solenoid point of suspension of the pendulum, the object is in motion [2]. The pendulum has been selected as the object of measurement, because of three properties, availability, continuity and repeatability of movement, with these features it is possible to mathematically describe the pendulum motion. Another argument in favour of Foucault pendulum choice as an object of measurement is that the ability to audit the designated photogrammetrically coordination by calculating the latitude on which the object is located. This is made possible by indirect determination of the angle by which the pendulum has been turned during the measurement series, designated during the work chamber planes after which the pendulum was moving at the time. In the course of the research, a number of calculations carried out during the preparation of the measurement has been performed and analyzed, which was required in order to understand the nature of the pendulum, and to select appropriate parameters of the shooting. An analysis of the object in motion has been conducted due to determine its speed of movement. It has been examined whether the speed of a moving object may allow obtaining the images that will be characterized by sufficient sharpness to make measurement and whether the inaccuracy of shutter synchronization of both cameras will not significantly blur the object.

Calculations were made using the basic principles and physics equations, such as the principle of mechanical energy conservation and harmonic motion. The speed of the pendulum in the various stages of its movement has been calculated.

The premise of the project was to prepare and conduct non-metric measurement of the camera, respectively adapted to capture the measurement, with a fixed shutter speed, and then post-processed the measurement results. Due to the movement of an object, two identical digital cameras,

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which carried pictures of synchronous has been used, then the measurement of the pendulum position has been made. Series of pictures of a moving object has been taken. In post-processing stage computer software Image Master Topcon was used, as a result coordinates of the pendulum at the contact point of the weight and the fastening rope has been obtained. On the base of created points, the plane of the pendulum motion was visualized in the AutoCAD. Then for verifying purposes the latitude, on which the pendulum exist, was calculated.

The paper also focuses on the errors that may interfere with determining the exact position of the pendulum. This subject is widely considered due to determine the expected accuracy [3]. The correct calibration of camera used to take pictures synchronous was also considered. The results of the study do not seem to be obvious and tend to further work on this topic.

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Key words: photogrammetry, synchronous photogrammetry, short-range photogrammetry, non-metric camera, the Foucault pendulum

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SYNTHETIC LANDSCAPE DIFFERENTIATION INDEX A TOOL FOR SPATIAL PLANNING

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Structural diversity of landscape is merely analysed by means of a set of metrics, which are based on number, size, configuration and composition of land use/land cover patches [1]. Landscape matrices could be used for determining stability and diversity of landscape, trends in area developments, as well as for synthetic and explicit landscape modelling [2]. In practice, determining landscape indices requires various analysis-related problems. The most basic are selection of: proper index or set of metrics, land cover data (including level of detail and data format), minimal mapping unit, and a size of moving window [3, 4]. One of the fundamental problem is also data quality and its fitness for use [5].

Literature provides researchers with hundreds of various metrics referring to landscape configuration and composition, many of the metrics are auto-correlated, which makes their interpretation more complex [4]. Following [2-4] observation there is no single index describing all landscape characteristics, while selecting landscape metrics it is necessary to be aware what they are to be used for.

The presented study aims to define a synthetic quantitative index, a Synthetic Landscape Differentiation Index (SLDI), which is calculated on the basis of three landscape metrics: Simpson's Diversity Index (SIDI), Interspersion Juxtaposition Index (IJI), and Shape Index (SHAPE_CV). The elaborated index presents landscape differentiation objectively with regards to local differentiation. It also characterises land cover spatial structure, reflecting area management. To provide functional interpretation of the index values, thresholds with the use of quartile division are determined. Values lower than the first quartile values indicate insignificant land use differentiation, whereas values higher than the third quartile values mean significant differentiation.

The SLDI index was computed for two municipalities neighbouring Warsaw, i.e. Błonie and Leszno. Information on land use was obtained from Polish Topographic Database, at the scale corresponding to the map of 1:10 000. The results, presented in a form of choropleth map, could be used by local authorities as a tool for planning management at the level of municipality or commune.

Key words: landscape metrics, spatial planning, choropleth map, land use

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THE APPLICATION OF GEOINFORMATION THEORY IN HOUSING MASS APPRAISAL

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The aim of this research is an application of Tobler's first law of geography in estimating the value of residential properties. What makes it innovative is a different approach to dividing the property market into submarkets and the way it treats location as a factor affecting property value. The most frequently used model to describe a given property market is the hedonic one. The main disadvantage of hedonic models is that they take into account location by parametrising the distance from a city centre using van Thunen's theory for the neighbourhood and they look at the zoning of the site in the land-use plan [1]. The development of computer techniques and geographical information systems means that statistical analysis is increasingly supplemented with geostatistical analyses and that models take into account the spatial autocorrelation between a property's transaction price and its geographical location. An analysis of the literature [2 - 4] clearly shows that one of the main problems in estimating housing value is taking into account geographical location. The existing solutions based on auto-correlation are dissatisfying, mainly due to the considerable variation within the property market. One solution is to divide the market into local submarkets, based on similarities in the use of land. Yet this solution is not always satisfying either.

This article presents a new approach to isolating submarkets (the first stage of the model), using properties' physical attributes and cluster analysis. Submarkets formed this way are characterised by relative homogeneity but are not continuous in the spatial sense. In the next, second, step, the model performs geo-statistical interpolation and designates a continuous area of property value, which is then used to draw an isoline map. The number of maps created this way corresponds to the number of clusters the properties were divided into. With this set of property value maps it is possible to estimate the value of any given property described by a set of concrete structural attributes. It is also possible to estimate the potential price of a property in a particular location depending on its standard, the type of market, the number of rooms and the storey it is on; in other words, depending on its structural attributes.

The approach was tested for Siedlce, a city located in the eastern part of Poland. The data on transaction prices and property attributes of 911 properties from primary markets (properties acquired directly from the developer), from 2007-2015, were obtained from the Register of Prices and Values belonging to the local administration of the city. As a result of explanatory analysis (*k*-means clustering) of structural attributes of the properties two clusters were formed: one grouping the properties of relatively low standard, and the other - expensive properties of high standard. The second stage of the elaborated approach based on the assumption that the value of a property in each

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cluster depends exclusively on the distance between properties with known prices and the property being evaluated. Each property is spatially unique, in a horizontal and vertical sense, and location is always an intrinsic attribute that directly determines the quality of the mass appraisal model. This is consistent with Tobler's first law of geography [5] which states that "everything is related to everything else, but near things are more related than distant things" and Pearson's well-known statement "location, location, location". To estimate the value of a property in any given place, ordinary kriging, one of the geostatistical methods, is used. The independent variable in this model is the geographical location (x, y coordinates); the dependent one is the property's value. The model results in isoline maps of property values, drawn up separately for each of the clusters. The accuracy of the property value estimates was checked using a test sample of 10 % of the properties not taken into account in the interpolation. The values of the mean absolute percentage error (MAPE) do not exceed 10 %. The research carried out shows that it is possible to model the spatial variation in housing property values using geoinformation theory, namely geostatistics and data mining, after first eliminating the influence of non-spatial attributes on a property's price. Of the many types of kriging, ordinary kriging was chosen to estimate the value of a property at any given point. This method limits the stationary nature of the average price to the local neighbourhood with its centre at the point of estimation, which is particularly significant in the case of individual residential properties.

Key words: data mining, geostatistics, kriging, mass appraisal

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THE CHALLENGE FOR POLAND'S SYSTEM OF ROAD SAFETY DATA COLLECTION AND USE

Joanna Żukowska¹, Wojciech Kustra², Kazimierz Jamroz³, Marcin Budzyński⁴

Road incident data are key to understanding the level of road safety and finding effective ways to improve it. As a consequence, all institutions involved in road and road safety management whether at the central, regional or local level, must have access to reliable and complete safety data. Sadly, Poland does not have a coordinated system for collecting road safety data with levels below the national level finding it difficult to access complete data. In the case of some administrative bodies, the data available are not detailed enough for monitoring road risks and solving safety problems. This also includes poor access to exact accident location data [1].

In its recent report the Supreme Audit Office suggests that more efforts should be made to set up a consistent system of road safety data collection and use in Poland [2]. In particular, the Office proposes a system for data collection and use where the national level of road safety management will use consistent analyses (for the particular road categories) conducted by road authorities. They should be ensured access to reliable and integrated national road accident data. Translating this recommendation into practice will require a specific methodology for collecting and verifying road accident data. In this article the authors will present an analysis of the current situation and an outline of the system as proposed by the Supreme Audit Office. The framework for the system will be identified in reference to the deficiencies of today's solutions. The main ones include: a lack of a systemic approach to road accident data collection, no data verification, no access to additional data and no systematic monitoring of the levels of road safety.

Lack of a systemic approach to road accident data collection. The consequence is that each management level and each road safety management body has its own "island-databases" that are inconsistent and unrelated to one another. The only thing they have in common is the source of data, i.e. the SEWIK, a police database. The databases are built for the purposes of the organisations (institutions, agencies) and are mostly not exchanged between the organisations.

Lack of data verification. Accident data are not verified systematically which makes any analysis and use of the information difficult. As an example in 2013 in the region of Warmińsko-Mazurskie 33% of accidents were not assigned to a specific road category. An exact verification of the accident locations using the road register, GPS coordinates and other road network information brought the figure down to 3% [3]. Having no systemic data verification is a very dangerous thing especially because the SEWIK central database is not verified either. Many regional, county and local

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road authorities do not have their own databases and use SEWIK resources only, putting their analyses at considerable risk of error.

Lack of access to additional data, such as data on road user behaviour: speed, use of seatbelts, drink driving and driving under the influence of substances. They are indirect safety indicators which, if collected systematically, are a critical analytical resource and should form an essential element of road safety monitoring. Unfortunately, data collection at the regional level is hardly systematic or made available to other users.

Lack of systematic monitoring. Key to an efficient system for collecting and analysing road safety data is research designed to identify the causes and factors affecting safety. It is only through such analyses that we are able to recognise the true causes and mechanisms of how specific types of road accidents occur helping us to eliminate them. Unfortunately, there is a lack of systematic work on that in Poland, in particular at the regional level. Monitoring and regular "before and after" evaluations are rare which means that we do not really understand the quantitative effects of road safety interventions. Another area that is lacking is a cost and benefit analysis, a standard procedure for any project in other countries. It helps to evaluate the effectiveness of road safety programmes, set the hierarchy of priority actions and modify them, if needed.

These drawbacks should be considered when developing new organisational, legal and financial frameworks to guarantee the stability of an integrated system of safety information at the national, regional and local level.

Key words: accident information system, road safety

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THE DIGITAL IMAGE CORRELATION SYSTEM IN EXPERIMENTAL TESTS OF BEAM DEFLECTION

Edyta Kowalska¹, Andrzej Rutkiewicz², Małgorzata Szumiło³

The paper presents information on the digital image correlation system, a contactless measurement technique which provides data on displacements of the recorded surface of the tested object. The system enables to test materials, elements and moderately large parts of structures for static and dynamic loadings, recording changes with a speed of even up to 1000Hz. In the paper authors presents analyses on system accuracy, in comparison to the beam theory, for different software adjustments on an example of a quasi-statically bended steel beam. The paper starts with introduction, presenting brief information on measurement techniques applied in civil engineering and accuracy issues concerning the system itself. Afterwards, a description of theoretical beam deflection axe and mathematical basics of the device with short description of the measurement preparations and testing procedure, are given. Finally results and conclusions are enclosing the paper.

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Key words: data mining, geostatistics, kriging, mass appraisal

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THE IMPACT OF EMOTIONS ON CHANGES IN THE CORRELATION COEFFICIENT BETWEEN DIGITAL IMAGES OF THE HUMAN FACE

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Emotions are an integral part of human life. Different situations in our lives affect changing emotional state. It is believed that human facial expressions is distinctive enough to be a part of analysis that allows for assessment of emotional state. The article describes an innovative research conducted by scientists team. As input data used in movies recorded speed camera Phantom Miro M310 at speed of 1 000 frames per second in high definition. Registration of a human face took place during the application of the stimulus causing anger or joy. For an innovative approach to research it consists of several aspects: the use of analysis derived from fluid dynamics (tracking characteristic molecules on the face) and the use of the correlation of the image to detect changes in specific areas of the face. The document in particular focused on the analysis of changes correlation coefficients between frames of the film to search for a differences and relationships between the obtained indicators.

Key words: emotion recognition, image processing, correlation coefficient

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THE INSTITUTION OF CADASTRE – AN EFFECTIVE CHANGE IN ADMINISTRATION

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What does economy need? What should the country guarantee and what should it not deal with? The aim of the paper is to show the necessity to implement institutional changes in public administration in the field of geodesy and cartography as well as offer suggestions for the changes within the context of the questions posed above.

We fully agree with Cooter and Ulen (2009) that property is a factor highly influencing a country's economic development. The issue of property rights is included in the Washington Consensus directives concerning the economic policy, which further confirms this belief. Our assessment presented in the paper entitled "The Effectiveness of Administration and Property Rights Protection as Factors increasing the GDP", was acclaimed by economists and included in the monograph entitled "Modele ustroju społecznego-gospodarczego. Kontrowersje i dylematy" [*The Models of socioeconomic system. Controversies and dilemmas*] (ed. E. Mączyńska). Acknowledging that the state should guarantee the maintenance of the legal order of land (the protection of property rights is contained in the Constitution as the state's task), we show that the land cadastre, focusing on the description of the property's boundaries, is of key importance to the state's functioning. We present the definition of the legal order of lands and the role this order performs in the state and economy, in particular its impact on the efficiency of investment processes and administration service of these processes, and as a result, on the size of the GDP.

We are pointing to the cadastre as the state instrument aiming to maintain this order. We have taken into consideration the following definition of cadastre formulated by the Working Group FIG supervised by Jürg Kaufmann and Daniel Steudle: "a methodically arranged public inventory of data concerning properties within a certain country or district, based on a survey of their boundaries."[2]. We have also considered Van der Molen's statement [5, p.16] that a lot should be perceived as a parcel of land possessing specified boundaries (his position is well illustrated in pic.1, indicating the direction of evolution of the concept of cadastre).

We have put forward a conception of institutional solutions while addressing the question about the scope within which administration should function in terms of the state's tasks concerning geodesy and cartography and how it should be organized. We are offering system solutions which make it possible to have data registered by competent entities responsible for their collection. We emphasize the need to use computer techniques which, on the basis of the cadastre, allow for harmonizing spatial data and interoperability of services related to spatial data. The suggestions for the changes have been formulated with reference to the authors' 20-year observations of the way in which administration functions in the field of geodesy and cartography as well as the research conducted within the author's

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doctoral dissertation about the concept of the cadastre institution as an entity responsible for maintaining the legal order of lands. The formulated research problem, methods, tools and researched entities are presented in [4, p. 15-19]. The proposal to create an institution can be found in [3].

Taking the necessity of protecting property rights for granted, we have focused on the investment process and making it effective, placing an investor among institutions supporting its activities on the one hand, and protecting interests of the remaining members of the society on the other hand. Apart from the existing institutions – public offices, economic entities and others, as well as courts and notaries, also cadastral administration is included, which closely cooperates with the land and mortgage register courts, land surveyor, the institute of meteorology and standardization, and spatial information agency. Cadastral administration possesses a status of a national legal entity acting in a field specified by regulations on spatial information infrastructure, as an entity executing economic tasks of the state – pic. 2. The conception of the structure of cadastral administration is shown here as hierarchized governmental administration with a central body as part of the Council of Ministers (pic. 3).

The results of works, presented (to a different extent) in specialist press and during a series of academic conferences were examined by scholars responsible for an effective functioning of the state. Their assessment was reflected in the monograph "Sprawniejsze Państwo" (*More Efficient State*) (ed. W. Kieżun), in which we address the question "How to effectively change public administration", pointing to the institution of cadastre as a vital and effective instrument of an efficient state.

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Key words: administration, legal order of lands, property, investment, cadastre, interoperability

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Fig. 1. Transformations in the field of land administration. Source: based on Van der Molen (2003, p.16-17)



Fig. 2. Conception of a support system for an investor. Source: based on Nogalski and Klimek (2014, p.150)



Fig. 3. Conception of an organizational structure. Source: Nogalski and Klimek (2014, p.153)

THE METHOD OF MORPHOLOGY OF PARCEL MOSAIC – A NEW TOOL IN GISCIENCE

Agnieszka Bitner¹

Nowadays we are flooded with information. Geo datasets are growing rapidly with the development of data acquisition techniques. It is a challenge to analyze these large files and extract the relevant information. These datasets require new way of looking at it and new forms of processing to facilitate decision making, management planning process. Here, is presented a new way of using cadastral data as a source of information about large-scale spatial processes - not only about particular parcels, as it was used earlier. In the analysis the digital cadastral maps in GIS format were used. The data were from North America, Australia and Europe, the land area totalling about three million km², which is tenfold larger than the surface of Poland. In the investigations the twodimensional structure formed by boundaries of cadastral parcels was treated as a unique morphological fingerprint being a result of the process of the ownership land division. The structure is referred to the parcel mosaic. The new method of cartographic analysis presented here enabled the author to create a new universal classification of land according to the morphological structure of the parcel mosaic. In this method the morphological class of a piece of land is unambiguously determined by the distribution function of the parcel areas. The investigations revealed that there are only three land classes, which are referred to as: city core, suburbs, and rural area. Distinguishing these three classes, that are enough to fully describe the earth's surface, allowed the author for creating: (i) the universal method for determining the urbanisation level of a piece of land, (ii) the universal structural criterion of delimitation of land of a given urbanisation level, and (iii) the universal definition of urban and rural area.

The new method of cartographic analysis was named "morphology of parcel mosaic" and for the first time was described in the paper "Universal rules for fragmentation of land by humans" [1].What makes the described method of cartographic analysis unique is that it can be applied to any area in the world because it is based solely on the areas of cadastral parcels. Thanks to this method it was discovered that, throughout the world, humans carry out the ownership division of land independently of any local geodesy law, any geographical location, or any local historical or cultural factors. Morphology-wise, people all over the world divide the land in the same way, creating the three above mentioned types of land. *It means that it was found the universal mechanism of division of land into cadastral parcels. The structure of cadastral parcels might be an indicator of the level of land urbanisation.* The arguments that a change of the morphological structure of ownership land division is the first sign of the process of spatial urbanisation were provided. This is because the ownership land division starts further transformation, functional changes and settlement of the land.

At the beginning of 90's Michael Goodchild introduced the term GIScience by listing topics that

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might be included in the research agenda of this proposed discipline of science[2]. Since then GIScience has become an important area for multi-disciplinary research. The author believe that the morphology of parcel mosaic method, that utilizes tools from different disciplines, become one of the GIScience methods. The method uses ArcMap program, mathematical model – spatial modelling, spatial statistical analysis, computationally intensive tools and visualisation that enable extract information from large data sets. The information enriches the knowledge about complex spatial phenomena, which is, for example, the urban sprawl. It can be employed in GIS-based multi-criteria analysis of urbanised land. The investigations are in the field of interest of Cartography in particular Thematic Cartography or Analytical Cartography, Spatial Management, and Economic Geodesy, in particular Cadastral Survey.

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Key words: GIScience, Thematic Cartography, morphological analysis, spatial analysis, scientific process, digital cadastral maps

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THE OPTIMIZATION OF REFUGEE LOCATION DETERMINATION FOR FLOOD VICTIMS IN BANDUNG DISTRICT USING ANALYTIC HIERARCHY PROCESS

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Bandung District is one of the area in West Java province that regulary is disrupted by flood during the rainy season [1]. This causes the residents in the flooded area must be evacuated, consequently the determination of refugee location needs to be done as efforts in disaster mitigation. In order to optimize the determination of refugee location, criteria that are considered essential in accordance with the characteristics of the disaster site are used. the following criteria are used: the distance to the water source, slope, accessibility, land cover, distance from the disaster site, and the potential threat of landslides. The assessment of each criterion is done by some respondents who have a background in the science of disaster.

Optimization of the determination of refugee location is done using Analytic Hierarchy Process (AHP) method, which is useful to solve the problems of multi-criteria decisions. This method will produce a value for each of the criteria that is used in subsequent data processing. The final result of this study is a suitability map of the refugee location in Bandung District with total area of 1403.56 ha, considering the dominant value of the distance to the water source criteria by 32.32 %.

Key words: Bandung District, Flood, Refugee Location, Multi Criteria, Analytic Hierarchy Process (AHP), Disaster

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THE POTENTIAL OF WEB-GIS AND GEOVISUAL ANALYTICS IN THE CONTEXT OF MARINE CADASTRE

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The importance of the marine environment to human existence makes it imperative that information models represent the multidimensional nature of reality as closely as possible in order to facilitate good governance. Information for a jurisdiction, on the effects of its formal law and community interests on the marine environment (e.g. nature and spatial extents and the rights, responsibilities, and restrictions etc.) would be stored in a marine cadastre.

The aim of the presented research is to show the potential of the application of open standards and Geovisual Analytics for the purpose of marine cadastre integration, dissemination and analysis with the use of a Geographic Information System (GIS). The presented reasoning aims to show that a marine cadastre designed upon international standards and integrated with dedicated GIS technology will constitute a uniform tool for secure integration of spatial data, effective dissemination and comprehensive analysis of land use data of marine environment in Poland.

Key words: marine cadastre, Geovisual Analytics, Web-GIS, SDI, integrated land information systems

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Fig. 1. Marine Cadastre Concept Diagram (a) and EU Strategy for the Baltic Sea Region website (b).



Fig. 2. Place of the marine cadastre in the ZSIN architecture (a) and Proposed system for marine cadastre management and analysis (b).

THE USE OF FREE ADJUSTMENT AND M_{SPLIT}-ESTIMATION FOR DETERMINATION OF THE VERTICAL DISPLACEMENTS IN UNSTABLE REFERENCE SYSTEM

Daria Filipiak-Kowszyk¹, Waldemar Kamiński²

The problem of the determining of the displacements of engineering objects and their surroundings is the current and important issue in the field of engineering geodesy. The vertical displacements play the special role in this case. The control measurements allow not only to determine the displacements of controlled points but also to assess the safe functioning of the entire facility, which is a very important and significant factor in relation to its use. Most measurements are made in relation to reference points (stable points). On the other hand, sometimes it happens that it is not possible to perform the measurements with reference to the stable points or the identification of stable points is difficult. Therefore, one of the solutions may be the determination of displacements in unstable reference system. One way to solve this problem with using M_{split} estimation [1-3] is presented in [4]. The author of the paper [4] conducted among others, an analysis of the acceptance of erroneous assumptions about the stability of the reference point. In this paper the authors proposed the calculation algorithm that takes into account the use of free adjustment and M_{solit} estimation to determine the vertical displacements of controlled points. The results of empirical calculations suggest the legitimacy of the use M_{solit} estimation for classification of free adjustment results. The presented algorithm allows to determine whether the analyzed controlled points are displaced or if their position has not changed over time.

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Key words: free adjustment, M_{split} estimation, vertical displacement, unstable reference system

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THE USE OF OPEN SOURCE GIS SOFTWARE IN LAND SURVEYING

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Software users, regardless of fields of application, often look for solutions that meet their expectations and which are also inexpensive. Modern computer markets offer many products, with various functionalities. Among these products are open source systems and applications, which are available without fees. Among offers of open source applications, which can be used in geodesy, GIS systems are the most common. It is difficult to find useful open source tools for geodetic measurements. However functionality of some open source GIS systems is large enough to look for other uses for them.

Purpose of this paper is to take a closer look at a popular Quantum GIS (QGIS) system and try to use it as a tool for geodetic computations and development of measurement results. Functionality of QGIS, which leads to take such a task, is a possibility of creating plug-ins using Python or C programming languages. It can be an effective way to create own applications to improve work. Thanks to that, QGIS can be used for tasks other than processing GIS data only. Therefore, to achieve the goal of this paper, special plug-ins for QGIS were developed. These plug-ins can support mapping and geodetic calculations.

Key words: Open source software, GIS software, land surveying, geodetic computations

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THE USE OF TERRESTRIAL SCANNING FOR VISUALIZATION OF HISTORIC BUILDINGS

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Extremely rapid development of technology since the beginning of this century, have resulted in many innovations, also in the field of geodesy and cartography particularly in the field of photogrammetry and remote sensing. In addition to the evolution of the already known forms of measurement, such as the transition from analog to digital imaging, also new methods of obtaining spatial data occurred, like satellite techniques and laser scanning which is the subject of this study. Laser scanning that is spreading in various forms (terrestrial, airborne, satellite scanning) has become a new tool, which extended the existing measurement capabilities, and it is used outside the surveying branch, for example, in archaeology, conservation of monuments or medicine.

Architectural survey is one of the tasks of surveying, which has gained a new dimension thanks to laser scanning. Scanning can get coordinates of almost every point of the scanned surface, allowing the determination of the size of the room at any point, even after the end of surveying and after leaving the object. Thus full and detailed information on the dimensions of the object and on the located inside infrastructure sometimes inaccessible or complex is obtained. Furthermore we gain versatility compared to traditional survey, because the cloud points, which is the result of the measurement gives us the possibility not only to make a drawing of horizontal projections and vertical sections, but also the 3D model and visualization of the facade.

Working with a point cloud provides many possibilities of its processing. It allows creation of cross-sections, subdivision of the cloud into several elements, taking measurements, isolating interesting area, etc. All this helps and gives the opportunity to create an interesting visualization.

The aim of this study was to demonstrate the possibility of using data from the terrestrial laser scanning and presentation of the course of works when creating visualization from the cloud of points. The second aim was to show the benefits of using laser scanning technology in the presentation of a historic building with the specification of its most interesting elements. The terrestrial scans used in this work were acquired thanks to courtesy of two companies: WROGEO from Wroclaw and TERRA MAP Ltd. from Krakow.

The objects of the study were: the Warmia Bishops castle located in Lidzbark and the crypt located in the Archcathedral Basilica in Przemyśl.

The appearance of the rooms and sometimes their functions in Lidzbark castle were changing over the centuries. The fashion and tastes of users had an impact on it. The palace built by one of the

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bishops, standing once by the southern wall of the castle, influenced the changes in the use of the rooms of the castle (this palace was demolished in years 1839 - 1840, only the outline of foundations is left). Visualization covers:

- The castle chapel (it owes the rococo decor to the Bishop Grabowski),
- The Great Refectory (there are wonderful vaults with original Gothic frescoes there, also in other halls original paintings or floors retained),
- The Chapter House located in the southern wing, covered with a five-bay stellar vault,
- The underground of the castle (the castle has basements, which after a thorough renovation has managed to skillfully combine history and modernity).
- Surrounding of the castle (the castle from the outside).

Measurement works were made using a FARO Focus 3D scanner, made available by the WROGEO Company from Wroclaw. Measurement duration was three days for 63 stations. FARO SCENE Application, Bentley Pointools V8i, Format Factory, Google Earth, SketchUp 2013, MAGIX Video deluxe 2013 Plus, Action! was used to analyse cloud of points

Metropolitan Basilica Cathedral crypt in Przemyśl has been open to visitors since 2014. Within the works of survey and restoration that were started there laser scanning proved to be a reliable method. In this study it was used to create a 3D model of the selected crypt.

In order to obtain high accuracy of measurement in the project a Z + F Imager 5010 laser scanner and 3D Reshaper 2014 software were used. This software is a tool to process the cloud of points, and at the same time it served to draw the irregularities of the walls of the crypt built from stone.

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Key words: laser scanning, inventory, 3D modelling, point cloud

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TRANSFORMATION OF THE PERPETUAL USUFRUCT RIGHT INTO THE OWNERSHIP OF A REAL PROPERTY ESTATE

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In addition to the ownership, there is in Poland the so-called perpetual usufruct right, which is an intermediate form between ownership and limited property rights. It allows for long-term use of the land which is not our ownership. Makes it possible to mortgage a property, is transferable and inheritable. The article describes the legal regulations governing the establishment and functioning of the perpetual usufruct, and the conditions under which it is possible to transform it into full ownership.

The publication presents contentious issues which causes the Act of 29 July 2005 on Transformation of Perpetual Usufruct into the Ownership of the Real Property. It also includes caselaw of the administrative courts and the Constitutional Court on this matter. Finally, the author presents proposals for changes in the law, which he believes would organize the process of transformation of the perpetual usufruct right into ownership.

Key words: land use planning, law enforcement, environmental management, perpetual usufruct, ownership, real property

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TRAVEL TIME MAP OF SZCZECIN MAIN TRAIN STATION

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The development of travel time map is the subject of the research. The study area is related to the territory of Szczecin and travelling from anywhere in the city to the Main Train Station – the central point of the city. During Author's earlier study, self-gathering measurement data method has been developed. The quality of results achieved was analysed in research related only to the territory of Warsaw. In this article, the research on developing travel time map for Szczecin and its quality, with the use of this method of data gathering is presented.

The measurement points, from which travel times were calculated, were arranged in net with a mesh of 1 km, which was defined in previous research as the best grid size for such analysis. Travel times to the Main Train Station were calculated for each measurement point and then these values were interpolated for the whole territory of Szczecin. In the study, the interpolation method named IDW - Inverse Distance Weighted, has been used. This method is treated as the best one for travel time analysis.

The travel time for a particular journey is a function of the origin and destination points, the time of travel, the modes used, and of decisions made by the traveller (for instance whether to prefer faster or cheaper journeys). In the research undertaken, public transport timetables, available in jakdojade.pl online service, were considered when calculating travel times. Jakdojade.pl is the most popular Polish service dedicated for public transport's passengers and it's also available as a mobile application. Analysis for Warsaw show that calculation of travel times on the basis of this service are of the high level of accuracy. The measurement data for Szczecin used in present research is current on May 2016.

The estimated travel time was evaluated by computing absolute error on the basis of control points, which were not used in the interpolation. Research shows that this method gives very good accuracy outcome, similar to the results achieved for Warsaw.

This research is one of the first analysis of the travel time calculation for Szczecin Central Train Station. It is the first research for this city, which is based on self-acting method of measurement points distribution and data obtaining.

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Key words: self-acting method, travel time mapping, IDW method, Szczecin

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URBAN STREET NETWORK ANALYSIS USING SPACE SYNTAX IN GIS – CRACOW CASE STUDY

Agnieszka Telega¹

The most common approach of representing physical street network on local, regional or national level is based on graph theory. The analysis usually involves two types of components, where streets or street segments are considered as edges and street intersections are considered as nodes. The network can be characterized by centrality of degree, closeness, betweenness, efficiency, straightness and information [1]. The development of theories, models and techniques of transport network analysis resulted in formation of land-use transport interaction models that combine transportation networks analysis with the distribution of land uses or activities in space [2].

More abstract approach to network analysis, with inverted representation of street network, was proposed in Hillier's space syntax theory [3]. According to this concept, street networks are illustrated as dual representation of spatial graphs, where nodes are identified as street segments and edges represents street intersections. Space syntax street configuration can be analysed using indexes as integration, connectivity, control, local integration and intelligibility [4]. Main measure applied to street network in space syntax methodology is the degree of integration. The integration of node is "the shortest journey routes between each link and all of the others in the network", where 'shortest' means the least number of direction changes. There has been a range of GIS software developed to perform and improve space syntax analysis. GIS became a platform for few of them: Axwoman (Bin Jiang 1999), Una Toolbox (Sevtsuk 2012), sDNA (Chiaradia, Cooper, Webster 2014), Confeego (Chiaradia, Gil, Stutz 2006), iVALUL (Space Syntax Ltd.) and Space Syntax Toolkit (Gil et al. 2015). Every developed tool is an extension or plug-in for different GIS platforms and sometimes requires additional packages and modules.

The main aim of the study is to present the principles of space syntax theory, in particular application in street network studies using GIS. This paper also provides a brief overview of evolution and development of GIS toolboxes for spatial network analysis. Finally, the author attempts to evaluate urban street network system of Cracow neighborhoods using Space Syntax Toolkit [5]. The analysis is performed in QuantumGIS, road network used in analysis is acquired from OpenStreetMap and digitalized raster data. This research was funded with "Grant for Young Researchers (BMN)" 137/WE-KEN/02/2015/M/5137.

Key words: space syntax, spatial analysis, street networks, spatial accessibility

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USING CARTOGRAPHIC SOURCES IN STUDYING THE DEVELOPMENT OF CITIES

Bogdan Wolak¹

Maps are among the main sources of information on land and the environment used in cartographic studies. Proper choice of a source study depends on such factors as the type of phenomenon under analysis, the size of the area under analysis and the availability of source materials. Spatial changes in an area under study, originating in different temporal cross-sections, can be observed by analysing different thematic maps. Collection of data which concern the same area and which originate in different temporal cross-sections helps to obtain information about the pace of changes of geographic phenomena, their spatial location and condition, as well as their connections and relationships.

The article presents the possibility of using topographic maps in studies associated with the development with the town of Ostrołęka used as an example. Data for analyses were obtained from the following cartographic studies:

- map of the Congress Poland (ed. 1843, scale 1:126000),
- karte des westlichen Rußlands (ed. 1915, scale 1:100000),
- topographic map (ed. 1977, scale 1:50000),
- topographic map (ed. 2006, scale 1:50000).

Graphic and numerical processing yielded thematic studies illustrating changes of the geographic environment in the area covering the town of Ostrołęka. The article presents maps of the land development and cover, a map of the dynamics of the town's spatial changes with urbanised land and greenery used as an example. The main urbanisation trends together with consecutive levels of concentric development of the town of Ostrołęka were identified and the functional relationship was determined.

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Key words: topographic maps, town development, multispectral analysis

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VALIDATION OF REAL TIME GNSS NETWORK SERVICES AT GDAŃSK POMERELIA REGION

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This article describes the results of testing campaign established at Gdansk region. The main objective of the test was to investigate reliability and accuracy parameters of real time services provided by permanent GNSS (Global Navigation Satellite System) stations at this area. The main aim of the measurements was to compare results obtained from national WAAS (Wide Area Augmentation System) - ASG-EUPOS (Aktywna Sieć Geodezyjna EUPOS) and SmartNet GNSS Network developed by private industry. This network was launched at 2012 with cooperation between Military University of Technology and Gdańsk University of Technology. SmartNet become an alternative AGNSS solution for polish national WAAS network users. Both networks should develop high quality augmentation data to obtain assumed accuracy and usability at different fields like survey or precise navigation. This paper characterize VRS (Virtual Reference Station) and MAC (Max Auxiliary) [3, 5] concepts used to build augmentation information at GNSS networks and describes results of GNSS RTK/RTN [1] (Real Time Kinematic / Real Time Network) measurements obtain using both networks. Presented conclusions provide the new experience for GNSS network providers and users [2, 4].

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Key words: GNSS, RTK, RTN, GPS, WAAS

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