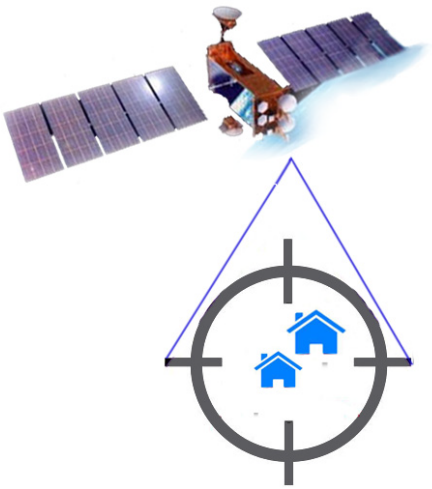
State of Israel
Ministry of Housing and Construction
Survey of Israel

Survey of Israel
Research Program for 2014
Abstracts of Scientific Studies



April 2014

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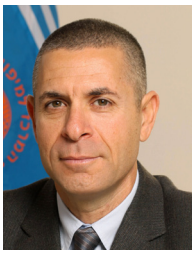


Forward

Ronen REGEV, Director General

During the last decade, there has been an increased demand for high-quality and reliable geodetic, cadastral and topographic data.

To meet these demands, the Survey of Israel had to focus its activities on three key themes:

1. Focusing on customers' needs
2. Enhancing and expanding the Survey of Israel products and services
3. Becoming more efficient and cost effective using advanced technologies

Moreover, it was recognized that strong research program is the basic foundation for a successful future for the Survey of Israel. This research program is application oriented and has a high degree of technology readiness level (TRL) thus enables quick transition from the research domain to the production lines domain.

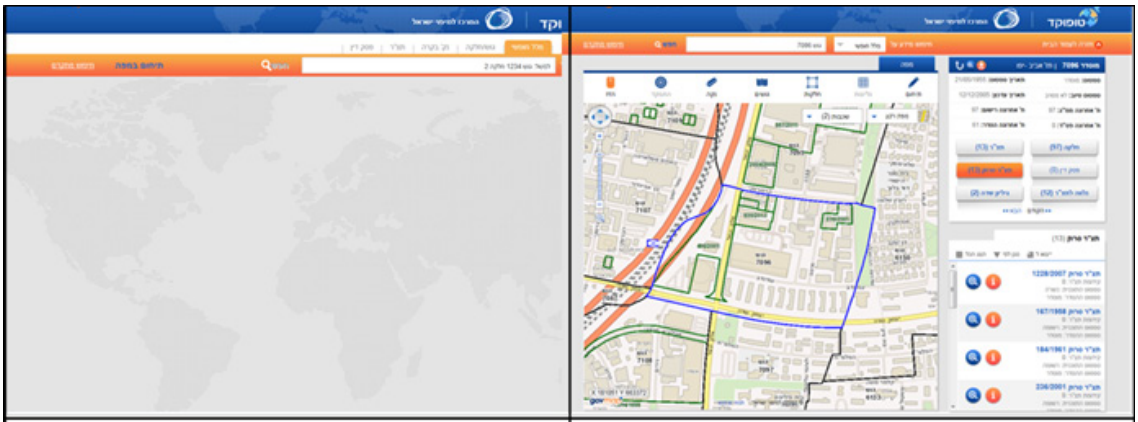
The following annual review provides a summary of the key research and development projects in the Survey of Israel. I hope that you will find it interesting, informative and useful to your organization.

Research and Development in Geo-informatics, the Next Five Years

Yaron FELUS, Chief Scientist

While it is impossible to predict the future of geo-information and related fields, we can identify some directions that are likely to dominate in the next five years. For simplicity, this report will be divided according to the three generations of internet technologies:

A. Web 1 - Data dissemination and presentation technologies will provide much more information to a greater number of users in light of the trend that mobile devices using natural and intuitive user interface are becoming ubiquitous. This is already reflected in the Israeli geo-portal and the TopoCad Systems that employ natural language user interface to display more than 140 heterogeneous dataset and systems (topographic and cadastral geographic data from GISs, financial, alpha-numeric data from DBMSs, scanned documents from ECMs, aerial photographs and more) – See also Figure 1.



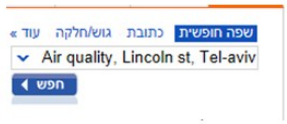
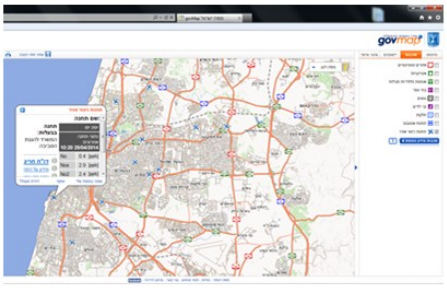
A. Main Screen (one line)

B. Results screen that combines a map and results from eight national databases

Moreover, still in the realm of data visualisation, the Survey of Israel is advancing technologies for 5-dimensional data management where X,Y, and Z are the standard 3D geographic parameters, time is the 4th dimension and quality or the level of detail is the 5th dimension.

B. Web 2 - Automatic data integration, compilation, and processing tools will be used to synthesise data from smart phones (volunteered or crowd sourcing methods), satellites, surveyors, engineers, municipalities and many more into the national spatial databases. This will require on-line quality control and data validation as well as mechanisms to manage the flow of data. The Survey of Israel is currently working on establishing a standard file format for topographic and cadastral data and the development of an advanced data integration system.

C. Web 3 - Data understanding and technologies for linking of databases and services. The next generation of Internet technologies will be able to understand enduser requirements (and needs), and make the proper connections with the required databases, services and objects (Internet Of Things). The Survey of Israel is working to develop tools and methodologies to link governmental datasets and services. Figure 2 presents an example of a search for information on air-quality at a given address (using natural language interface), the Israeli geoportal makes the connection with the Ministry of Environmental Protection database to get initial information. The user can get real-time information from the sensor (thing or object) which is highlighted in the map.

		
A. Search for air quality on a given address	**B. Look at the Ministry of Environmental Protection database for information**	**C. Connect to the sensor and obtain real-time information**

These technologies will continue to evolve and change the way we conduct our business. The Survey of Israel has an ambitious research program aiming at preparing the nation for the future that lies ahead in geo-information. It is my pleasure to provide you with a brief outlook on some of the key research projects.

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Validation & Standardization of New Mapping Technologies

Garry ZALMANSON, Ilan COHEN, Elad SHAPIRA

Introduction of digital aerial cameras during the 2000 ISPRS Congress in Amsterdam provided the final missing link for turning the photogrammetric mapping production workflows into fully digital. Three flagships of this revolution (Leica ADS40, Intergraph DMC and Vexcel Ultra-Cam-D) with their high-end and large format systems, designed and manufactured specifically for mapping solutions, have dominated the market in the first couple of years of the current millennium. But the innovation has not stopped there.

In the past few years more and more medium and small-format solutions are reported to be in operation world-wide and also in Israel. These systems are significantly smaller, lighter and cheaper than their high-end counterparts and comprised of commercial (and sometimes general-purpose) optical, electronic and mechanical elements. But at the same time they claim to have an unprecedented geometric accuracy being comparable to that of their legacy counterparts and achieved using their proprietary state-of-the art image-processing and computer-vision algorithms. The key factor for these systems successful performance is their ability to carry out in-flight self-calibration of the system obtained for every acquisition mission.

In the past two years LMY R&D has conducted a research project aimed at validating the performance of three such aerial systems operated in Israel. During the research an autonomous validation process based on proprietary LMY infrastructure has been employed. The research results have been reported during the MAPI conference held in March 2013 and concluded in a detailed research report submitted to MAPI later this year.

In the current research we'll extend the validation procedure to **general purpose systems (optics + cameras) with fixed zoom and terrestrial mobile systems** coupled with state of the art imaging, navigation and laser technology. Similarly to the aerial case, we intend to develop a validation procedure for these systems to be applied by system operators as part of the system certification process for large-scale industrial mapping.

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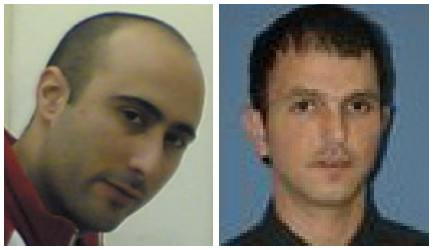


Technology for Automatic Change Detection and Building Layers Updates

Iovav COHEN, Dror OUZANA

This proposal deals with the examination of available methods for automatic change detection and with a research and development process for a defined methodology as a first step for updating the geo-spatial databases.
The purpose of the activity is to perform a survey of technological capabilities and possible processes, and then focus on the development of a novel algorithm in which a comparison is made between the current status of the geo-spatial database and a new orthophoto. The algorithm is then customized for SOI data for the purpose of updating the national topographic database and for the detection of changes.

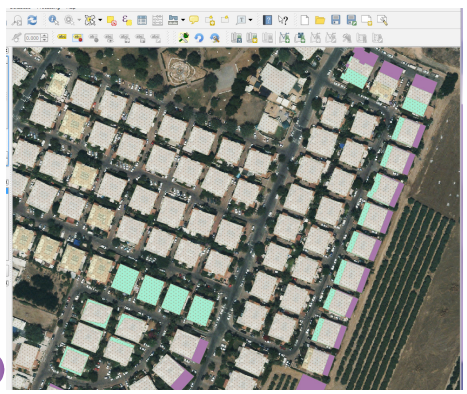
Object identification and extraction in images, is a broad category in the field of computerized image processing.
The purposed method consists of:

- Finding the area in which changes occurred
- Analyzing the change and understanding what have changed
- Outlining the differences
- Updating

In this program 2 major research questions will be tackled with:

- Methods for object detection
- Methods for object extraction

During the program the topic of what is an appropriate input type for building identification in ortho-rectified imagery will be explored, as well as several methods for marking and extracting the outline of a building in a way that is consistent with procedures currently used in the SoI databases. Different image resolutions will be explored, as well as different sources, in order to optimally identify the buildings in ortho-rectified images. Furthermore, different filters and heuristics will be employed to raise correct identification percentage.
Testing will be carried out on 2 typical land tiles: urban and open field, for which the algorithm is to be calibrated.
The research is led by Iovav Cohen, R&D manager at Quartet Technologies Ltd., and the image processing specialist, Mr. Ofer Zilberstein as co-researcher. Also assisting will be Nir Rozman, a computer engineering student at the Tel-Hai Academic College.



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Updated of Geographic Databases by Automatic Change Detection between Recent Image & Geo-database

Ofer ZILBERSTEIN

Updating geo-database is done by identifying and capturing changes between new imagery and current geo-database.

Updating is the biggest challenge in national geographic databases management. Today most of update processes are based on traditional mapping processes, which are labor intensive and costly processes. The answer to this challenge is by automating the change detection process.

Until recently, automated change detection processes, which are usually based on timely difference image comparison, have not yielded satisfactory results. Object detection success rates were low and the results required to be corrected by manual editing which made the process less attractive. Today, the development of new VHR sensors and image processing algorithms allow automatic solutions to be much more successful and cost effective.

This research proposal open with reviewing current automatic detecting changes processes as a mean for updating geo-databases, and continues with implementing an innovative approach developed by leading European mapping centers in the last few years. The main activity of this research is implementing innovative algorithmic process that performs image segmentation follows by image classification and end with change detection between extracted classes and existing vector database.

Because the match is made between the current image classes and geo-database, the results are more accurate and less noisy.

As a first step, this research will use as an input a stereo model from the Pleiades satellite sensor with 0.5 m' pixel covering area of 100 km^2, and focusing on identifying buildings, and roads.

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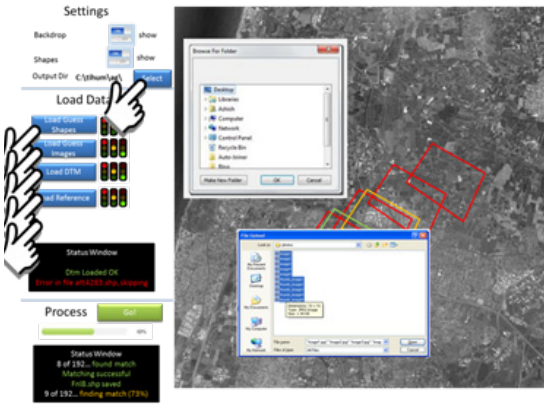
Enabling Reliable Geographic Querying of SOI Imagery Archive by Autonomous Geo-Registration

Garry ZALMANSON, Yossi SCHWARTZMAN

The survey of Israel (SOI) maintains a digital archive of about half a million photos. More than 10,000 are added every year. Since only few of the sorties have been photogrammetrically triangulated following the collection, the accuracy of most existing coverages is still insufficient to have them imported AS-IS into the GOI mapping portal to be later used for focused image querying.

In this project we propose an autonomous solution for improving the accuracy of the archive coverage. We employ autonomous image geo-referencing process aiming at accuracy of up to several meters for image coverage. We employ a fully photogrammetric process in which a down-sampled imagery will be geo-referenced using existing geo-referenced imagery (or ortho-photo). Following geo-registration we use DTM for computing the exact image boundaries to be entered into the coverage's databases. Since a registration of historically imagery is also sought we're planning to carry out the project in a so called "reversely temporal" manner. First, we'll begin with the geo-registration of the most recent imagery. Then we'll take care of more outdated imagery. The idea is to first try to geo-reference it using the most accurate infrastructures but in case of a failure (due to significant changes the area underwent) to move back in time and try to register them to imagery which is closer in time.

Technologically speaking we employ a variety of standard and proprietary photogrammetric, image matching and optimization strategies. Specifically we use standard procedures for feature detection and matching (SIFT, SURF, FAST, Harris, etc) along with robust parameter estimation procedures (namely, Ransac, Robust Least-squares, M-estimators, etc) to cope with obvious matching outliers. The system is developed within ARC-GIS environment and expected to be delivered to the SOI by the end of 2014.



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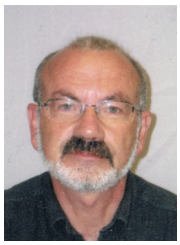


Determination of the Sea Depth Using Multispectral Images of WorldView 2 Satellite

Peter ISRAELEVICH, Kasem SLALHA

Determination of the sea depth by means of remote sensing is a challenging problem important for many fields including: cartography, navigation, geological studies, and oil and gas exploration. We propose to develop and validate a practical method of determination of the sea depth using multispectral images of WorldView 2 satellite. The method is based on the fact that the radiance from the sea surface depends on the optical thickness of the water column between the bottom and the surface. The optical thickness is a function of the sea depth and the wavelength dependence. Multispectral measurements of sea surface reflection allow us to separate these dependences and determine the sea depth via the optical thickness of the water column.

The first step was to use WV2 data was used for bathymetry mapping in regions with known bottom topography for the calibration of the algorithm. Such calibration is a straightforward way to determine the coefficients and their dependence on the wavelength. The calibration also examined the method sensitivity to the water quality and substrate albedo.

The study examined three methods: linear method based on reflectance (gray values) of one channel between the number of channels of multi spectral satellite iamgery, the second method is a method of logarithmic ratio between the two channels and the third method is PCA. The method that was chosen is based on PCA (Principal Components Analysis) algorithm.
This process was tested on a number of areas in the north of Israel and the results obtained to calculate the depth with the process was good with a mean deviation of 0.58 m, a standard deviation of 0.74 m and a relative error of 12% with a standard deviation of 9% (relative error is the ratio of the difference between the depth measured, calculated depth measured).

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The Hydrology Dataset Enhancement Project

Iris ZILBER, Basheer HAJ-YEHIA, Yoav TAL

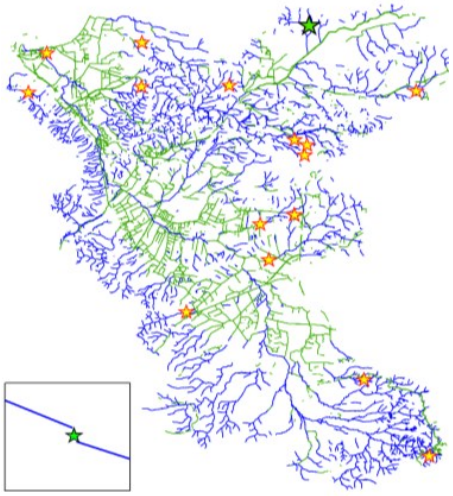
In the past spatial databases were utilized in order to store and organize the data. Nowadays, the modern information systems require the data to be organized in order to enable the support for complicated spatial applications running complex processes. Modern databases are expected to be organized based on the hierarchy concept, logical consistency (topology and linkage) and to be multi-dimensional, in order to support rich and vast content.

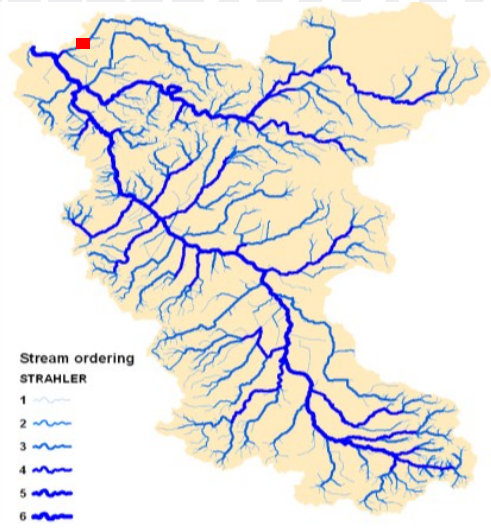
The Israeli national topographic database consists of 7 datasets. Dataset No. 7 contains the hydrographic feature classes: flow lines (streams and tunnels). Water bodies (natural and manmade), shore-lines, hydrographic lines (waterfalls, dams, etc.), water sources (fountains, wells), basins, sinks, and pour points.

Currently the flow lines layer has no network structure because of gaps, loops and incorrect directions. The layer contains a lot of small and tiny lines that are not relevant to the network and the flow rules. There are 1.6 m' lines – 170,000 km length. This phenomenon also onerous the visualization and cartographic processing, names are missing and the update is poor.

Recently many of the potential users such as the Hydrology Authority, the Drainage Authorities, Ministry of Agriculture, and Ministry of Environment, and green organizations – raised their demand for a modern enhanced hydrographic data with a network structure.
The Survey of Israel established a project that aims to enhance the data and build a streams network and hierarchy based on Strhaler Model. The process includes also the calculation of accumulated length.

The project was implemented in two stages: First we took a pilot project in 3 basins. This was implemented with the help of "Stav" company specialized in hydrology GIS projects. The pilot helped us to establish the work methodology, work plan, and to develop automatic software tools for editing the data.
The second stage was to implement the work on the other 180 basins and complete the hydrology dataset of Israel.





The Kishon basin before and after

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Development of Intelligent Integration Processes of Cadastral Information with Statutory Planning Data

Yerach DOYTSHER, Shamai ASSIF, Alexei NOSKOB

The two principal statutory geospatial layers in any country, and especially in Israel, are the Cadastral layer , which describes the division and ownership of land, and the layer of Master Plans (especially Local Plans), that describe the planned use of the land. In Israel, the level of accuracy of both these layers, as well as the mutual accuracy between them, are central factors in the planning, engineering, and fiscal management of the national land-based economy.

Local Plan Maps (LPMs) are legal documents that describe the rights and restrictions regarding the landuse of a particular unit of land. The landuse coverage is not spatially continuous, and the Local Plan boundaries, as well as the divisions of the various landuse zones of the Plans, are usually not aligned with cadastral boundaries. In addition, due to the fact that full or partial overlap exists between various Local Plans, there is no continuous coverage available of up-to-date approved landuse. Lastly, up until recently, LPMs were characterized by a lack of uniformity in the definition of landuse categories and associated styling. On the other hand, the Cadastral layer, which divides the entire country up into land blocks and parcels, is a continuous coverage.

LPMs usually contain the Cadastral layer together with Topographic data layers as base data for the presentation of the proposed landuse zones. Due to several factors, the geospatial accuracy of the LPMs is relatively limited, which results in geospatial discrepancies between overlapping Plan Maps. Furthermore, considerable difficulties arise in the preparation of Real Property Registration Plans, which are intended to update the Cadastral layer according to the changes in land division introduced by the Local Plans.

This research endeavor proposes to develop algorithms and work processes that will enable the improvement of the geospatial accuracy of approved LPMs in order to bring them up to the quality of the current Cadastre layer. This will contribute to three levels of improvement of the Landuse layer: absolute geospatial quality of LPMs; relative geospatial quality between various LPMs; and, reduction of the discrepancies in defining landuse categories between LPMs.

These planned improvements, as described in the proposal, will be based on the development of algorithms from the fields of Computer-based visualization, Computer Science, and Geo-Information Science, and will rely on Feature-based solutions rather than the Coordinate-based solutions commonly used in the past to coordinate between geospatial data layers from a variety of sources.

These achievements will enable the creation of a continuous and precise statutory Landuse layer that will cover the entire country, and accordingly a considerable improvement of land management in Israel, which in turn will have significant positive consequences for the national economy.

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3D Cadastre GIS System

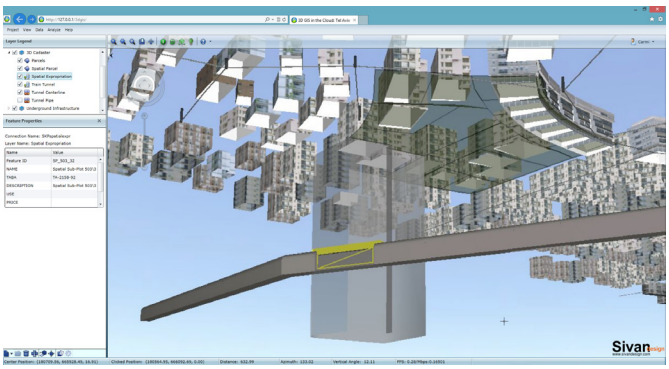
Carmi ZION, Ilya BALKAREY, Roland MISHAEV, Uri KOROGODSKY

The development of land use has promoted the need for land parcels to be subdivided in three dimensional (3D) according to certain property rights, especially in metropolises with dense population. This results in 3D parcels above or below the land surface. The management of 3D space becomes an urgent task for governments. Thus the representation and modelling of these 3D parcels with geometrical representation as "solid" in computer environment should to be handled using 3D Cadastre GIS system. This research defines and develops the basic concepts of 3D Cadastre GIS as a step for achieving full and rich 3D Cadastre for Isarel.

A 3D Cadastre GIS shall store and manage 3D Cadastral data. Data structure, topological relations between features, and optimization of generated 3D geometries should be part of such system, while considering legal concerns especially in cases of expropriation, sub parcelation, spatial allocation, etc. It will enable handling challenges faced by land authorities when dealing with cadastre such as complex multilevel spatial spaces that are populated above and below a land parcel.

The 3D Cadastre GIS system will provide several unique functionalities, through them users can easily understand complex urban planning as 3D visualization, and display property rights and 3D cadastral objects based on 3D volumetric calculations. Since the system is a web based, it will support local governments in achieving regulations and planning consents with relevant communities.

The 3D Cadastre GIS System is based on Sivan Design's "3D-GIS in the Cloud" system, a cloud based application that provides decision makers, stakeholders, professionals, and public users with 3D views and 3D analysis tools of spatial information for cadastre management, city planning, infrastructures and roads.



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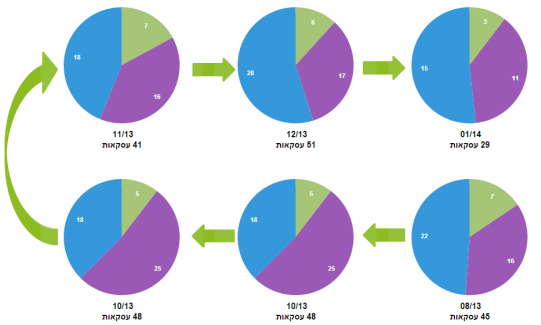
Characterization of Location Based Business Intelligence Systems to Support Governmental Decision-making in Land and Real-estate Development and Management

Amir WINSTOK, Assaf RUBIN, Raveh EYTAN

The purpose of this study is to characterize a location-based business intelligence system, which will support current activity as well as decision-making processes in the field of real-estate, in government ministries as well as public sector organs.

The study will be based on the applying institute's experience in the development of technologies, algorithms and user interfaces for making real-estate and business intelligence data accessible to the public at large as well as the business and professional sectors (via the Madlan-all-about-houses-and-neighborhoods -- madlan.co.il) website.

The study will include: A survey of the required databases and current problems; a survey of available technologies, algorithms and systems; a survey of relevant publications on the subject; A process of questioning the relevant ministries and organizations, in order to characterize the main needs of the Israeli government. The characterization process will include usability testing, during which potential users will obtain hands-on experience of the various options provided by the system's components. In addition to that, and based on the characterization, it will be possible to construct a preliminary prototype to provide a partial demo of the characterization. This will be done utilizing technologies and systems which combine geographic display, advanced analytics, graph charting, cartographic modeling suitable for real-estate analysis and more.



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Optimal Transformation Methods for Achieving Accurate Coordinate Based Cadaster

Gershon STEINBERG, Gilad EVEN-TZUR

Coordinated Based Cadaster (CBC) is one of the important issues for the Survey of Israel (SOI). The ultimate goal is that all the cadastral boundaries will be defined by accurate coordinates for their reconstruction when necessary. The CBC can be divided into two categories of accuracies: The first category is accuracy of 5 cm in 95% statistic confidence level relatively to the nominal coordinates of the Permanent GPS Stations APN of Israel. The second category is Approximate CBC (ACBC), in which the cadastral coordinates are defined with lower accuracy, meaning they are not good enough for reconstructing the boundaries without additional checks and measurements according to its accuracy estimation. Every mutation plan (plan for registration) and cadastral settlement blocks that was measured in the new Israel 2005 grid (IG05) should belong to the first category. On the other hand all the other CBC projects belong to the second category.

The research deal with those CBC projects (actually ACBC projects) in urban area and with improving the SOI Director General ability to classify boundary points of approved mutation plans as CBC.
The boundaries definition in mutation plans and ACBC projects is computed by coordinate transformation from the old Israeli grid to IG05 using some control points, boundary marks or other details that were found and supposed to be authentic. The accuracy of the transformed coordinates depends mainly on the density and spread of the authentic marks, on their real authenticity, on the accuracy of the original measurements and on the kind of the transformation.

The research deals with characterizing optimal methods for achieving CBC followed by accuracy estimation. Focus is taken on examining the kind of transformations which suite best cadaster in general and especially CBC, authenticity checks of the transformation- basis points, quality examinations of the transformations, ways for excluding outliers, and the influence of the density and geometry of the transformation- basis points on the results. The accuracy estimation use the technic of Least Squares Adjustment.

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Improving and Establishing a Vertical Control Net on the Geoid in Israel

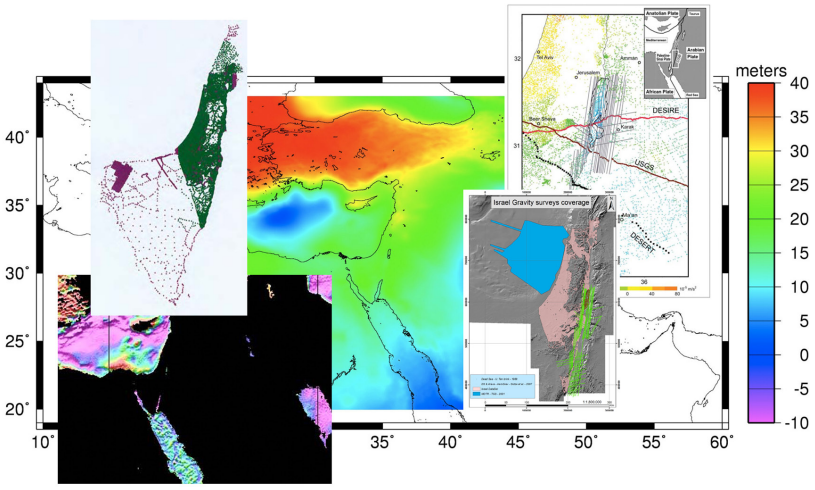
Dan SHARNI

This research will compute the Geoid in Israel.
We also propose the continued research (for 2015), to base the corrected vertical control net on the geoid.

The research will entail: Improving the preliminary geoid (2010), with updated data; balanced incorporation of various field-effects in the Stokes' Kernel; and then Geoid determination with NGS (and UNB) approaches.

The actual computation of the geoid will be executed with the Remove-Compute-Restore method, whereby all known (attraction) effects (Atmosphere, Terrain Correction, Regional Terrain Model, EGM'08 global anomalies) are removed from the surface anomaly field - to form a residual-anomaly field; this will be gridded, and a refined Stokes Integration performed – to obtain the residual undulation field; and finally, the removed effects will be restored (as potential/vertical distances) – to obtain the improved geoid.

The final undulation model for Israel, ILUMx, will be based on the actual Geoid in Israel (not on a statutory decision, nor tied to sea-level); and a procedure/program finalized, for calculating it at any point. And finally, the vertical control network for Israel – gravimetrically corrected and adjusted - will be based on the Geoid.



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Formation of a Hybrid Geoid Undulation Model in Israel

Sagi DALYOT, Yerach DOYTSHER, Yechezkel SARID

Nowadays, there is a widespread use of GNSS for surveying and mapping in Israel and internationally. This system allows obtaining very high measurement accuracies (several centimeters) in the horizontal and vertical position components, measured in respect to the reference mathematical plane of the ellipsoid. While the horizontal coordinates components are converted to the local network (datum) very accurately by using known mathematical formula (that is relatively straight-forward), the conversion of the coordinates' height component, i.e., altitude, requires to acquire knowledge on the undulation model describes the spatial relationship between the ellipsoid height and the local geoid.

The objective of this research is the development of new methods and tools that will make use of new and innovative data sources, to enable the formation of a more accurate and reliable hybrid Israeli geoid model – in respect to the one existing today. Since the determination of the reference geoid entity is affected by various factors, and is obtained from diverse data sources (e.g. ground-based measurements, satellite observations), this study will make use of the variety of available data sources with the aim to create the best possible model. The motivation is that the hybrid geoid model will be based on a mathematical method that will use the most accurate data source available as a function of required spatial location.

The proposed research will use data and measurements in Israel and abroad and compare methods available to calculate an accurate hybrid geoid that combines ground gravity measurements together with global gravity models. According to Israel's unique topography along the Great Rift Valley, the study will examine the implementation of the needed research methods, specifically in respect to gravity measurements performed in areas below sea level. Due to the fact that areas of land that are below sea level are rare, this topic has not yet been adequately studied.

This research will develop an accurate and reliable Hybrid geoid in Israel, including factors as gravity, linkage (correlation) to national heights and sea level measurements via the use of mario-graphs. The formation of a reliable and accurate geoid model will enable the use of height measurements received from GNSS, thus allowing precise and consistent field surveying.

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Generation of a Tsunami Inundation Sensitivity Evaluation Model as a Function of Land Usage and Structural Elements

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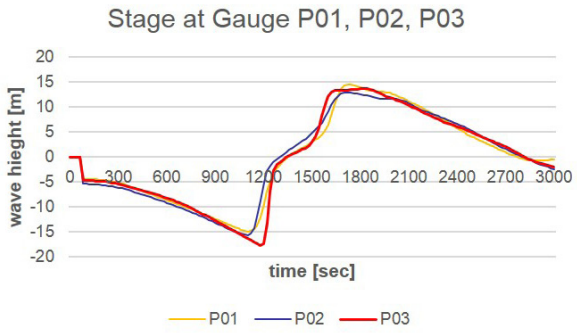
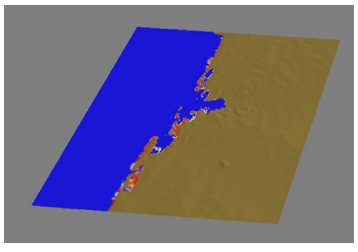
This research project is named after the late Aviel Ron, SOI Director General (1994- 2002) who was tragically murdered with his two children, Anat and Ofer, in a terror attack on March, 2002.

Historical record of tsunami in Israel is limited and often inconclusive. However, the presence of geo-hazards in our region exposes the Israeli coastline to significant and even devastating tsunami events. The magnitude of the tsunami impact in land is also a function of the urban morphology. Our coastline is characterized by a rapid development due to the real estate pressure. Thus, it is of vital importance to understand the influence that these rapid changes of the spatial structural and textural morphology have on the tsunami inundation distribution. A detailed Tsunami inundation simulation will be performed in the proposed research. This will be done in a test case of a tsunami event along the Tel Aviv coastline.

The study methodology will consist of 3 main stages: (i) Determining the roughness coefficient values for Land Use classes at the Tel Aviv coastline; (ii) Analyzing several approaches for data modeling, commonly used in the numerical models; And (iii) Analyzing the influence of structural and Land Use elements on the inundation pattern.





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