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DATA MATRICES APPROACH FOR GEOID DETERMINATION

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ملخص البحث :

هناك حاجه لارتفاع النقاط المتعامد في مشتريع الهندسه المدنيه (اي ارتفاع النقاط فوق الجيوئيد).يجب فهم حيود الجيوئيد (الفرق بين سطح الجيوئيد وسطح الالبسويد)لاستخدام نظام الملاحه عبر الاقمار الصناعيه في المسح الهندسي .تم استخدام النهج الهندسي لمحاوله حساب حيود الجيوئيد .في هذه الدراسه لتحديد الجيوئيد المحلي باستخدام طريقه مصفوفات البيانات .تم تحديد نموذج الجيوئيد باستخدام حيود الجيوئيد لنقاط التسويه مع الاخذ في الاعتبار تاثيرات نموذج الجيبوتنتال العالمي ونموذج التضاريس المتبقيه مع بعضها البعض وقيم ارتفاعات جيويديه معروفه من تحديد مستوي نقاط التسويه لنقاط الاختبار لتحديد افضل طريقه .وتظهر النتائج ان دقه مصفوفات البيانات منخفضه للغايه.

ABSTRACT:

The orthometric height of points is needed in civil engineering projects (i.e., the height of points above geoid). Geoid undulation (the difference between an ellipsoid and a geoid surface)[1], [2] must be understood to use the Global Navigation Satellite System (GNSS) in engineering surveying. The geometric approach was used to attempt to calculate the geoid undulation. In this study. For local geoid determination, by using a data matrices method. The geoid model was determined using geoid undulation of GPS/Levelling points considering the Global Geopotential Model (GGM) and Residual Terrain Model (RTM) effects at these stations. this technique has been compared by the value of mean and standard deviation and known geoidal heights values from GPS leveling for testing points to determine the accuracy of this method. The results demonstrate that the data matrices' accuracy is extremely low.

KEYWORDS: GNSS, RTM, GGM, geometric approach, geoid undulation, GPS/Levelling

1. INTRODUCTION

The advent of satellite-based global positioning systems (GLONASS, GALILEO, especially GPS) has had an incredible impact on geodesy and surveying. The heights obtained from the[3], [4] Global Positioning System (GPS) are above an ellipsoid and fundamentally different from the traditionally obtained heights which are given concerning the geoid. the foremost widespread use of GPS in geodesy has, however, been undertaken by obtaining horizontal positions, leaving the vertical positions (the heights from the reference ellipsoid of GPS) out because mostly the physical heights are required in geodetic applications.

The height differences between two points on the topography are obtained traditionally by levelling techniques, and these techniques are employed for vertical control purposes in various countries. However, thanks to the restrictions and difficulties of applying the levelling techniques in rough terrain regions, the vertical control network points are mostly located within the lower parts of the topography, such as in valleys and along roads. This affects the spatial resolution of the vertical control network and restricts the correct representation of the terrain.

On the other hand, the horizontal control networks have been established as a separate network using triangulation and trilateration, and a few overlapping points were created with the vertical control networks in previous times. While in some countries, the horizontal and vertical control networks are still separate, the widespread use of global positioning systems with geodetic aims has changed the understanding of the geodetic control networks and made the countries modernize their geodetic infrastructures so that they are suitable for technological developments.

As a first approximation, the Earth is described as a rotating sphere. The second approximation of the Earth is an equipotential ellipsoid of revolution. The geoid is a surface of a constant gravity potential and coincides with the mean sea level after removing the effect of sea surface topography over the oceans[5]. One particular ellipsoid of revolution referred to as normal Earth, is the one having the same angular velocity and the same mass as the actual Earth, the potential Uo on the ellipsoid surface equal to the potential Wo on the geoid, and its center coincides with the center of the mass[5], [6]. World Geodetic System 1984 (WGS84) is a normal Earth ellipsoid and the GPS delivers the (ellipsoidal) heights above this ellipsoid [7]. From the other side, the orthometric heights from the levelling are relative to the geoid surface. There is a fundamental relation (with a certain approximation) between the ellipsoidal heights from the GPS and heights concerning a vertical geodetic datum derived from the levelling. Equation 1 e.g. [6], [8].

$N_{GPS/Levelling} = h - H$ Equation 1

2. Study areas and available data

Kuwait is a small emirate tucked between Iraq and Saudi Arabia, amid a stretch of one of the world's driest and least-hospitable deserts. Kuwait Bay, a deep harbor on the Persian Gulf, is located on its shore. Bedouin from the interior established a trading post there in the 18th century. Kuwait derives its name from the Arabic diminutive of the Hindustani word kt ("fort"). The country's fortunes have been linked to international business since the emirate's reigning dynasty, the l ab, formally formed a sheikhdom in 1756. Kuwait city, a modern metropolis mixed with skyscrapers, apartment complexes, and mosques, evolved out of the modest fort over time and with acquired wealth. Kuwait City is home to the majority of the country's population, making it one of the world's most urbanized nations. Kuwait is located between 28.5° N and 30.1° N latitudes and 46.5° E and 48.5° E longitudes, Kuwait has a total area of 17818 km2. The GPS/leveling system vision International Co. gathered the data. Kuwait in the 2016/2017 academic year and made available for this research. The benchmarks' GPS coordinates were calculated. by Static and a dual-frequency GPS receiver Refer to the method of rapid-static measurement.ITRF2008 is the current year's date. The orthometric heights have an absolute precision of about 1.0 cm. The GPS/Levelling-based geoid undulation runs from 18.54 to 10.95 meters, with a mean of 15.45 meters and a standard deviation of 1.51 meters. The GPS/Levelling stations, used in this study, are composed of 83 stations distributions checking points and training points as shown in figure1.

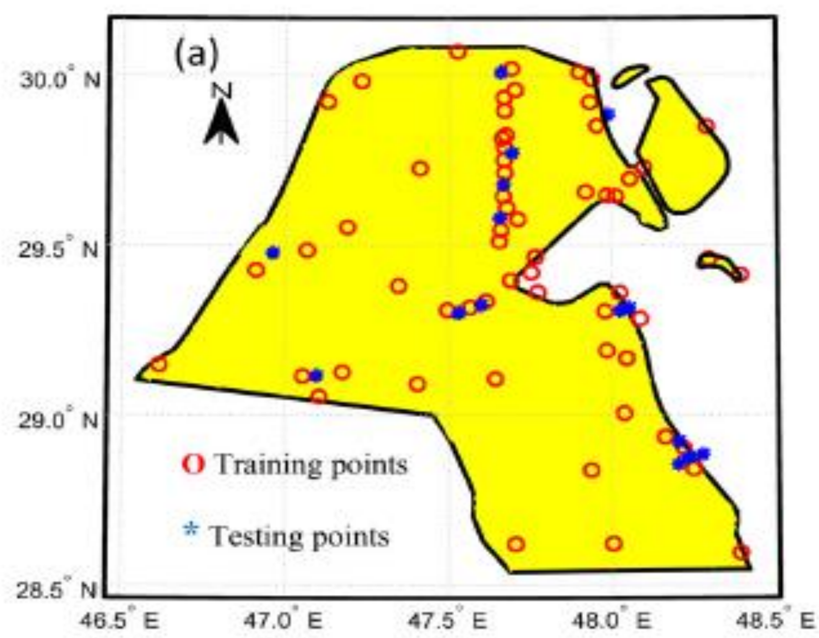

Figure 1: GPS/levelling points' distributions checking points and training points[9]

2.1 Global geopotential models

With global navigation satellite system (GNSS)/leveling data, a new method for locally upgrading the global geopotential model (GGM) (EIGEN-6C)[10][11] is proposed. The GNNS/leveling data are first transformed to disturbing potential data using the inverse Bruns' formula in this method. A three-parameter correction surface is then used to reduce the systematic inaccuracies in the disturbing potential data. After then, using the inverse Poisson's integral equation, the disturbing potential data on the Earth's surface is extended downward to the surface of an inner sphere. With a combination of downward continuing data and GGM-derived data, global disturbing potential data for the entire sphere might be obtained. Finally, using the least-squares method, the final regionally improved geopotential model (RIGM)[12] could be reconstructed from the troubling potential data.

2.2 Residual terrain model

The residual terrain modelling (RTM) methodology is a well-established method for modelling short-scale gravity effects inferred by topographic masses, such as those provided by digital elevation models (SRTM/DTM2006.0)[13][14]. The RTM technique is used in a variety of applications in physical geodesy, including high-resolution combined gravity field modelling, smoothing reduction of gravity observations (remove compute restore approaches), computation of Bouguer anomalies, global height system unification, and more. The generation of high-pass filtered topographic source masses is a vital stage in the technique model of residual terrain By subtracting certain (long-wavelength) reference topography from the digital elevation model, high-pass filtering is achieved. The fact that filtering in the topographical domain is not equal to filtering in the gravity domain is not taken into account during the conversion to gravity. As a result, undesirable low-frequency gravity signals enter the RTM-gravity, while parts of the desired high-frequency signals are missed.

3. METHODOLOGY

3.1 Data Metrics Method

On a node-by-node basis, the collection of data metrics methods provides grids of information on the data. In general, the data metrics approaches are not weighted average interpolators of Z-values. You can, for example, receive information such as:

a) The number of interpolated data points for each grid node. If the quantity of data points used at each grid node is approximately equal, the grid quality at each grid node can be determined.

b) At each grid node, the data's standard deviation, variance, coefficient of variation, and median absolute deviation. These are measurements of the grid's variability in space, which is useful data for statistical research.

c) The distance between the current data point and the nearest data point. If a data set's XY values are sampling locations, for example, the Distance to the Nearest Data Metric can be used to find new sampling locations. Higher sampling density can be quantified using a contour map of the distance to the nearest data point.

On a node-by-node basis, the collection of data metric interpolation methods provides grids of information about the data. In general, data metric interpolation algorithms are not weighted average Z value interpolators[15]. For the specified data metric, data metrics use the local data set, including brake lines, for a specific grid node. The search parameters determine the local data collection. Each grid node has these search parameters applied to it. Identify the data set that is local to you. When computing the value of a grid node (r, c) in the following descriptions, the local data set $S(r, c)$ consists of data within the specified search parameters centered at the specific grid node only. The set of selected data at the current grid node (r, c) can be represented by $S(r, c)$, where

$$S(r, c) = \{(x1, y1, z1), (x2, y2, z2), . . . , (xn, yn, zn)\}$$ Equation2

n is the number of data points in the local data set.
The $Z(r, c)$ location refers to a specific node within the grid.

4. RESULTS

It was found that the GPS leveling points which had been interpolated have a significant error. To reduce the error resulting from interpolation of GPS leveling points of $N_{GPS/leveling}$. is based on Remove- Compute-Restore technique (RCR) e.g.[16], [17]. With RTM reduction method [18] and GGM. The first step in the geoid determination according to RCR technique is to reduce accomplished by removing the topographic effects, i.e. the TC and RTM. The effects of topographic masses according to the RTM model [18] have been computed using the TC-program [19]for all masses within a radius of 176 km around the computational point.

5. DISCUSSION

the grid value must be calculated for both GGM and RTM, and after that add them to the value of Nr (N_{GPS}-N_{GGM}-N_{RTM}) after interpolation($Nr_{intrpolated}$+$grid_{GGM}$+$grid_{RTM}$), For the surface model shown in figure2, the surfacing is made by different numbers of training points.

In addition, the checkpoints have been selected in the application region, and the geoidal heights of checkpoints are calculated from GPS/ levelling data. the checkpoints geoidal heights have been calculated from the data matrices method by using training points and these have been compared with geoidal heights which have been calculated from GPS/ levelling data showing the results of this method is not accurate, the variations in M and STD values that have been evaluated as76, N/A.

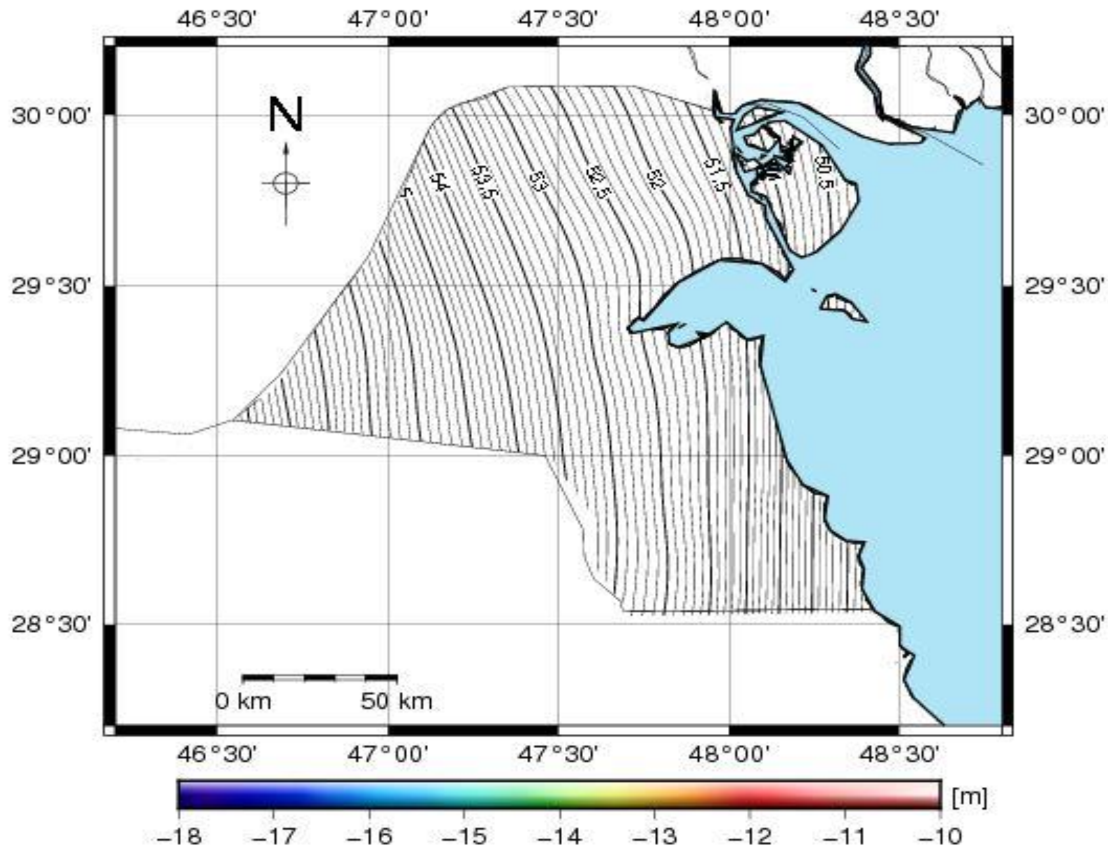

figure2:The grid from the data matrices method

6. CONCLUSION

In determining the geoid of areas with a slight slope, the data matrices method is considered the worst. Its applicability, algorithm, efficiency, and advantage are all examined. Before selecting a spatial interpolation method that is relatively best in particular cases, one should first analyze the characteristics and theory of each approach, as well as the property and geographic analysis of data. However, conscientious experiences should be used to assess the outcome.

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