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Gravity Map Production Using General Regression Neural Network

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Abstract - *Gravity map production has been improved by using very complicated and expensive versions of geophysics methods [1].*

The main objective of this study is to evaluate the ability of the Artificial Intelligent Techniques product gravity map.

To achieve the objective of this study Artificial Neural Network architecture has been tested. This is the GRNN. The GRNN model was trained with 301 patterns derived from gravity map and satellite image. The maps were converting to ASCII to generate the input part of the learning patterns. The same rows were used to generate the output part. A performance test session was carried out by applying the trained models to the same training patterns and to 75 new test patterns. The output results have been subjected to statistical analysis.

Key Words: AI: Artificial Intelligent, ANN: Artificial Neural Networks, ASCII: American Standard Code for Information Interchange, GRNN: General Regression Neural Networks, GRACE: Gravity Recovery and Climate Experiment.
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1. INTRODUCTION

Gravity is a potential field, i.e., it is a force that acts at a distance. The gravity method is a non-destructive geophysical technique that measures differences in the earth's gravitational field at specific locations. It has found numerous applications in engineering, environmental and geothermal studies including locating voids, faults, buried stream valleys, water table levels and geothermal heat sources. The success of the gravity method depends on the different earth materials having different bulk densities (mass) that produce variations in the measured gravitational field. These variations can then be interpreted by a variety of analytical and computers methods to determine the depth, geometry and density that causes the gravity field variations.

The conventional gravity map is sufficient very costly and not satisfactory enough satisfy the criteria of the research. While the gravity map presents a very rich indicator in oil exploration, to overcome and solve this problem. The research presents a satellite image for the same area, and by using artificial intelligent techniques [1, 2, 3].

The main objective of this study is to investigate the ability of artificial neural networks to product gravity map. This will be achieved by training and testing an appropriate ANN architecture with learning patterns generated from satellite image and corresponding accurate values derived from a satellite image.

To improve the opportunity to find oil, geologists apply earth science to the search for oil. Many techniques have been developed, based on indirect methods to view the subsurface. Among the most important are:

- **(i)** Seismology, which is the study of the sound waves that bounce off buried rock layers. It involves seismic surveys that are analyzed by knowledgeable personnel [4].
- **(ii)** Geological Mapping, which is used by geologist to define possible reservoir shapes or traps, due to the deformation in the rock layer that contains hydrocarbons [5].
- **(iii)** Educated guesses, which use physical geology and seismic information as the base material to guess where to drill [6].

To solve this problem:

a) High spectral space images will be enhanced to highlight gravity issues.
b) An existing gravity map will be georeference to bring the whole test data into a common georeference.
c) Training and test patterns will be generated from the satellite image and the existing gravity map.

d) An ANN's system will be built, specified and trained for predicting gravity indicators (map) based on previous experience.
e) The performance of the trained model will be checked by applying it to a new set of test data (patterns), whose actual outputs are already known.
f) The results will be analyzed, discussed and assessed.

2. STUDY AREA:

The experimental test carried out in this study was based on test data collected and observed from satellite image of Khartoum City (Figure 1).

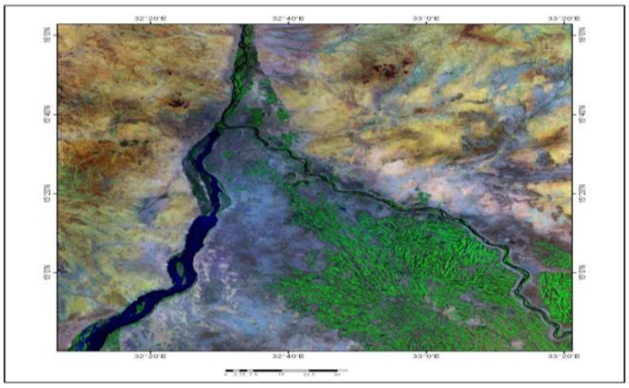

Figure 1: Satellite Image for Khartoum City

The satellite image of Khartoum City (Figure 1) was acquired by the American IKONOS imagining system in 2005. The spatial resolution of this image is one meter, while the spectral resolution covers the visible (two bands) and the infrared (one band) spectrum regions. Table 1 lists the specifications of this image.

One of the most important set of the test data used also in this study is a gravity map of Khartoum City (Figure 2). Earth's gravity measured by NASA's GRACE mission, showing deviations from the theoretical gravity of an idealized smooth Earth, the so-called earth ellipsoid. Red shows the areas where gravity is stronger than the smooth, standard value, and blue reveals areas where gravity is weaker.

Some data has been derived from gravity map as shown in figure 2.

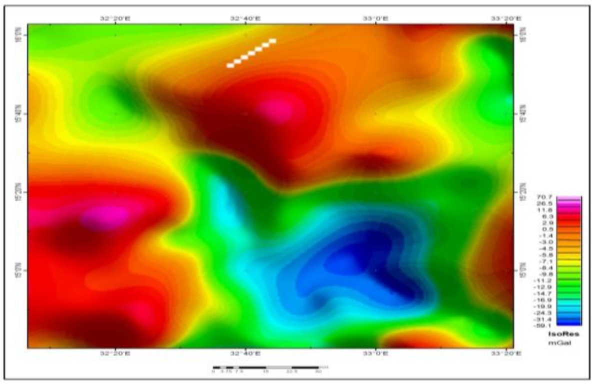

Figure 2: Gravity map of Khartoum City

3. PROCEDURES:

A wide range of procedures were applied to meet the objectives of this study. The test was carried out in three phases. Phase one is concerned with image georeferencing, image slicing and production of ASCII images. In phase two a set of training and test patterns were generate to build an artificial neural network model to predict the gravity map of the test patterns based on the knowledge that was gained during the training session. In phase three the performance of the trained model was assessed.

4. RESULTS AND ANALYSIS:

The GRNN architecture was designed and trained with 5000 patterns. GRNN achieved in less than 4 minutes. The small error value is a quick indication that the shell was able to converge with a minimum average error, and hence reasonable activation state has been achieved by the network. This indicates that the GRNN looks more suitable in resolving the research problem.

In order to assess the training results, the trained model was applied to the same training patterns. The predicted values were compared to the actual values (derived from gravity map). Since the implicit relationships between the input and output variables of the training patterns are supposed to be well defined to GRNN model, small residual values are expected to be obtained. Therefore one can assess the model was well trained.

To assess the performance of the GRNN model for predicting improved values based on input data obtained by gravity map, the shell was applied to 116 new patterns (test patterns) not included in the training session.

The predicted values were compared with original gravity map. The absolute average of averages and the standard deviation of averages for these residuals were also computed. For the purpose of comparison and assessment, the original gravity map was compared with predicted values. The figures below explain pattern 6 (randomly) in training session (gravity and predicted) and the difference between two images. The black area means there are difference between two images in the third figure. And the white color means there is no difference between two images.

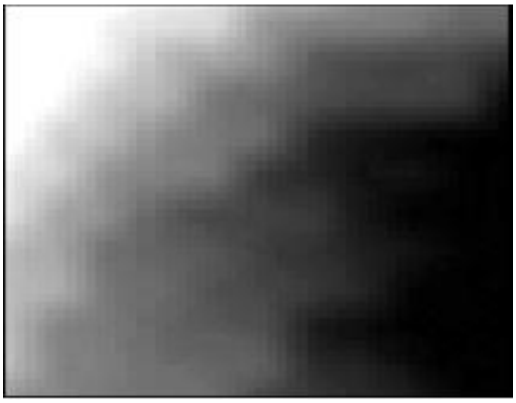

Figure 3: The Gravity Pattern.

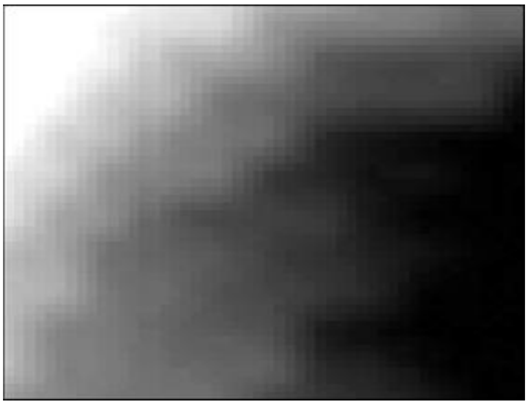

Figure 4: The Predicted Pattern.

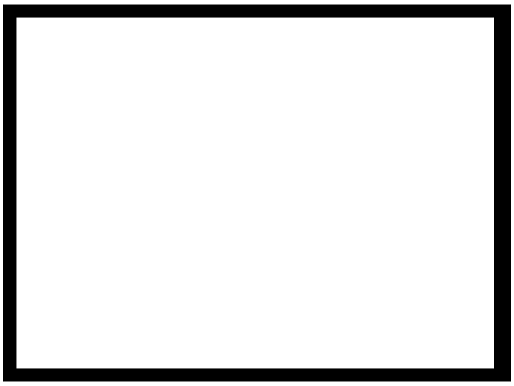

Figure 5: The Difference between Two Patterns.

The histogram illustrate that there is no difference between gravity image and predicted image for the same area.

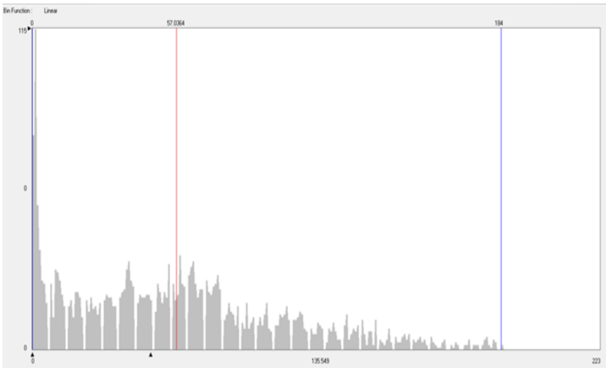

Figure 6: Histogram for Gravity Pattern.

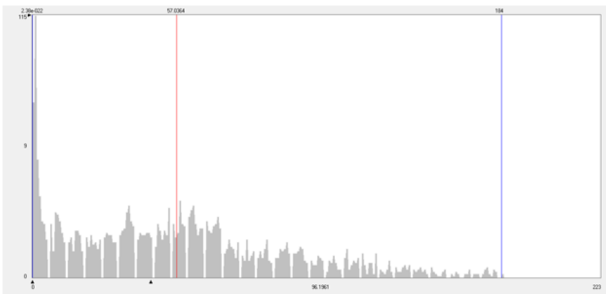

Figure 7: Histogram for Predicted Pattern.

5. CONCLUSION:

In the present research work the research is aiming to product gravity map using artificial intelligence technique.

According to the test carried out in this study it can be concluded that:

1. The GRNN model was able to process the whole set of the training patterns (410 patterns), as well as the test patterns (109 patterns).
2. The Artificial Neural Network is able to produce Gravity Map.

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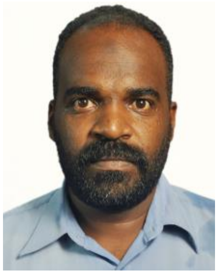
BIOGRAPHIES



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