Comparative Analysis of the Digital Terrain Models Created from Ground Surveying Measurements with the Use of Different Ordinary Kriging Models

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Abstract:

Digital Terrain Model (DTM) is a continuous surface containing ground elevation values as well as other elements describing the topographic surface such as slope, aspect, curvature, etc. DTM is created from discrete elevation data through an interpolation operation. Ordinary Kriging methods are geostatistical approaches that incorporate spatial autocorrelation and generate estimated surfaces from scattered sets of points through minimizing the errors between the predicted values and the statistical model of the surface (Maune and Nayegandhi, 2018). This research aimed at comparative analysis of the DTMs created from ground surveying digital elevation data through exploitation of the different models of the ordinary kriging. DTMs have been created from ground surveying sample data using t ordinary kriging models. Statistical analysis of the DTMs indicated that Gaussian model DTM depicts the smallest standard deviation of elevations. Additionally, the spherical, linear, circular, and exponential model DTMs achieve standard deviations of elevations of 101.99%, 102.21%, 102.40% and 102.43% of the standard deviation of elevations given by the Gaussian model DTM, respectively. Moreover, statistical analysis of the elevation residuals extracted from the different DTMs using external checkout points shows that the DTM from the Gaussian model achieve the highest standard deviation of elevation residuals which refers to the lowest accuracy DTM. Thus, the DTMs from the linear, spherical, circular, and exponential models achieve smaller and remarkably close standard deviation of elevation residuals that are about 80.83%, 80.88%, 81.11% and 81.3% respectively of the standard deviation of elevation residuals achieved by the Gaussian DTM model.

Keywords: DTM, Geostatistical interpolation, Ordinary Kriging Models, Visual Analysis, Accuracy Analysis.

1 Introduction:

A Digital Terrain Model (DTM) is a continuous surface that determines topography through representation of elevation/height values referenced to a specific vertical datum as the third dimension along with horizontal coordinates; northings and eastings in a rectangular Cartesian coordinate system (Li et al., 2005). The U.S. Geological Survey defines a grid digital terrain model as the digital cartographic representation of the elevations of the land at regularly spaced intervals in the x and y directions, using z-values referenced to a common vertical datum (Guo, et al., 2010). Thus, a DTM represents the surface as bare earth free of vegetation and urban features. However, when the digital elevation data includes surface features such as trees, and buildings the created surface from the dataset is referred to as Digital Surface Model (DSM). Thus, DSM depicts the elevations of the surfaces visible from the sensor, such as building tops, treetops, or unconcluded bare ground. Specialists from a wide range of disciplines make use of the DSM. Also, for all applications of the DSM it is crucial to know the accuracy of the input data for the DSM generation as they influence the usability and reliability of the generated results (Malinverni, 2014). Since the DSM provide the basis for characterization of both natural and artificial or man-made surface features such as vegetation, buildings …etc., there is the DTM which depicts the spatial elevations of the terrain as a bare land in a digital format (Karel et al., 2006). A DTM is considered as a continuous surface which, in addition to the elevations contained in the DTM depicts, the DTM also contains other elements that can describe the topographic surface such as the slope, the aspect, the curvature, the gradient, and others. In this case, it is of immense significance to mention that a filtered DSM would result in a DTM (Li et al., 2005; Isioye and Jobi, 2011).

DTM is usually created through a spatial interpolation process where measured elevations are exploited to predict unknown elevations. There are several spatial interpolation methods to derive a DTM from point data. Each interpolation method has its own advantages and disadvantages depending on the characteristics of the data sets (Henrico, 2021). In this context, spatial interpolation can be classified into two main categories; deterministic and geostatistical methods (Burrough et al., 2015). Deterministic interpolation methods calculate the unknown elevation and create surfaces from measured points, based on either the extent of similarity or the degree of smoothing however, deterministic methods do not use the probability theory (OzTurk and Kilic, 2016). Deterministic interpolation methods may include the Inverse Distance Weighting (IDW) interpolation, Triangulated Irregular Network (TIN) interpolation and Spline interpolation (Munyati and Sinthumule, 2021). On the other hand, Geostatistical interpolation techniques exploit the statistical properties of the known elevations to quantify the spatial autocorrelation among the known elevations and account for the spatial configuration of the sample elevation (Zhu et al., 2005). Kriging is a geostatistical technique for optimal spatial estimation that estimates elevations based on a continuous model of stochastic spatial variation and takes the variogram model (Salekin et al. 2018). Geostatistical interpolation methods, such as Kriging, are probabilistic statistical models that incorporate spatial autocorrelation. The strength of similarity between measured sample points accounts for distance and direction. Kriging is an advanced geostatistical procedure that generates an estimated surface from a scattered set of points with z-values through minimizing the errors between the predicted values and a statistical model of the surface (Maune and Nayegandhi, 2018). Kriging is based on the theory that assumes that the spatial variation in the phenomenon represented by the z-values is statistically homogeneous throughout the surface (Biernacik et al., 2023).

2 Interpolation with Ordinary Kriging Methods

To quantify the spatial variation in the input digital elevation data, the semivariogram of the sample data is estimated. Due to developments in computing technologies, geostatistical techniques have been integrated into modern geographic Information System (GIS) and have become strong alternatives to the deterministic methods in interpolation of spatial data and creation of continuous surface models. In addition, application of the different statistical approaches in the analysis of the interpolated layers provides strength to the interpolation operations with the use of the geostatistical methods (OzTurk and Kilic, 2016). In this context two main types of kriging interpolation may be distinguishable: Ordinary Kriging (OK) and Universal Kriging (UK) (Biernacik et al., 2023). Thus, kriging interpolation methods including Ordinary Kriging interpolation, and Universal Kriging are examples of geostatistical interpolation techniques that takes into consideration the distances and degrees of variations between known data points (Biernacik et al., 2023).

Semivariogram is one of the most essential tools in geostatistical analysis to quantify and model the spatial variability degree of the data. These models can be later used to make estimations using kriging, cokriging .etc. (Malvic´ et al., 2019). Interpolation of DTM elevations with kriging is performed through steps. The first step encompasses fitting a model which means creation of the variograms and covariance functions for estimation of the statistical dependence, referred as spatial autocorrelation values depending on the model of autocorrelation (ESRI, 2002). The second step involves making an estimation of the unknown values (ESRI, 2002, ESRI, 2003). In Ordinary Kriging (OK) the first step is to create a semivariogram from the scatter point set to be interpolated where semivariogram consists of an empirical semivariogram (experimental variogram) in addition to a model semivariogram. A Semivariogram can be defined as a mathematical model of the semivariance expressed as a function of lag while displaying the statistical correlation of nearby points (Jassim, 2013a). In addition, Spatial autocorrelation refers to feature similarity basing on feature locations and feature values simultaneously (Jassim, 2013b).

Ordinary kriging considers that variation in z-values is free of any structural component/drift. In this context, ordinary kriging can be performed through the application of different five models on the data set known as OK models. The five OK models may be distinguishable as: Linear, Circular, Spherical, Exponential and Gaussian OK models where the mathematical expressions of these five models are presented in table 1 (Pasini et al., 2014, Ly et al.2011, Biernacik et al., 2023):

Table 1: The mathematical expressions of the different ordinary kriging models.

Ordinary Kriging Model	Semivariogram equation
Linear Model	$\gamma(h) = \begin{cases} A_0\delta(h) + A_1 h & for\ h < a \\ A_0 + A_1 a & for\ h \geq a \end{cases}$ (1)
Circular Model	$\gamma(h) = \begin{cases} \frac{A_0\delta(h)}{\pi} + (\frac{w}{\pi})[\frac{h}{a}\sqrt{1-\left(\frac{h}{a}\right)^2} - \arcsin(\frac{h}{a})] & for\ h < a \\ A_0 + w & for\ h \geq a \end{cases}$ (2)

Spherical Model	$\gamma(h) = \begin{cases} A_0\delta(h) + (\frac{w}{2})[\frac{3h}{a} - \left(\frac{h}{a}\right)^3] & for\ h < a \\ A_0 + w & for\ h \geq a \end{cases}$	(3)
Exponential Model	$\gamma(h) = A_0\delta(h) + w[1 - \exp\left(-\frac{h}{a}\right)]$	(4)
Gaussian Model	$\gamma(h) = A_0\delta(h) + w[1 - exp(-\frac{h}{a})^2]$	(5)

Where: $\gamma(h)$ = the semivariogram for the elevation variable h.

$\delta(h) = 1$ for $h > 0$; $\delta(h) = 0$ for $h = 0$

A_0 = nugget effect caused by errors of measurement,

A_l = the rate of decrease of the spatial covariance in the field for the linear model,

$Ao+w$ = sill, which is the variance of the field less the discontinuity Ao,

a = range, or the correlation distance, and is in practice the maximum distance for which observations are correlated.

Guo et al. 2010 state that ordinary kriging with a spherical model where parameters are to be determined by weighting least squares methods are commonly used to fit semivariogram models. Thus, the advantage of this method is the statistical formulation of the best linear unbiased estimate. However, the disadvantage of that method could be that the weights must be computed for each node of the grid, that is why this method is usually used for small samples where Ordinary Kriging approaches could produce undesirable “pits” and “circular” contours (Wieskotten, et al., 2023).

3 Aims and Objectives

This research aims at undertaking comparative analysis of the Digital Terrain Models (DTM) created from ground surveying digital elevation data through the employment of the different models of the ordinary kriging geostatistical method namely, the linear model, circular model, spherical model, exponential model, and Gaussian model as interpolation approaches. Also, analysis and estimation of the accuracy of the elevations extracted from the created DTMs in addition to comparison of the different estimated accuracy measures for the DTMs created with the use of different ordinary kriging models constitute main objectives of the study.

4 Materials and Methods

A sample of ground surveying digital elevation data collected from a construction site near Cairo, Egypt using a total station instrument has been employed in this study. The digital elevation data set represents a test site that is of corrugated terrain at the most. The sample data covers a test site which is of dimensions of about 428.5 meters by 340.5 meters and an area of 145904.25 of squared meters (about 36.0537 acres). The size of the test site conforms with the size of medium sized projects required to be surveyed and processed by the Geomatics Engineers very frequently with the use of ground Surveying techniques. The sample data consists of about 2700 spot elevation measurements forming a density of one spot elevation measurement for every about 214 of squared meter and an average spacing between successive spot elevation measurements of about 14.630 meters. The lowest elevation in the sample data records 116.73 meters while the highest elevation depicts 138.57 meters above the mean sea level. Thus, a range of elevations of about 21.84 meters can be calculated in the digital elevation data. , the mean elevation calculates 128.763 meters while the standard deviation of elevations in the sample data is ±4.325 meters, referring to highly varied terrain. Figure 1 shows the distribution of the spot elevation data viewed over a DTM of the area. Apart from a few small gaps it can be said that uniform distribution of the digital elevation dominates the original landform area in the test site.

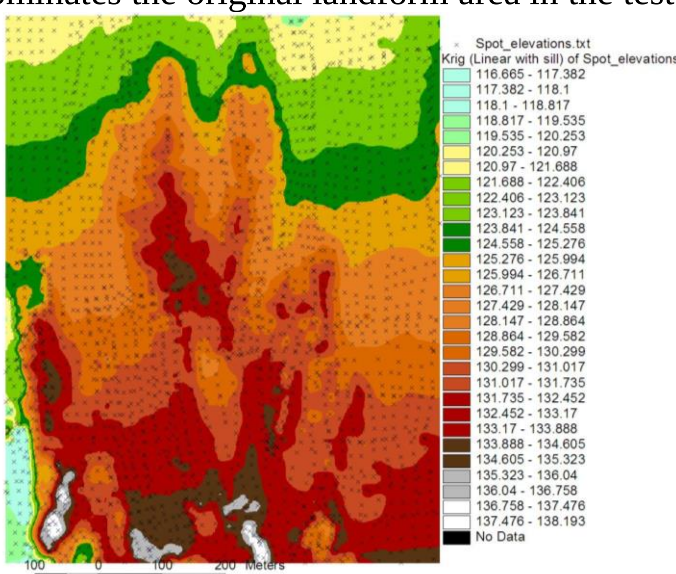


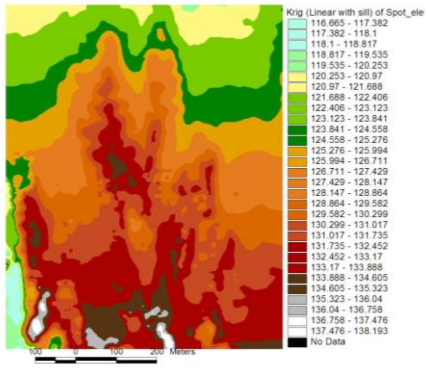
Figure 1: Distribution of the digital elevation data over the original landform area

A group of DTM continuous surfaces have been created from the sample data using ESRI ArcView 3.3 with 3D analyst and Spatial analysis extensions in addition to other extensions where different ordinary kriging models including the linear model, circular model, spherical model, exponential model in addition to Gaussian model have been used in creation of the different DTMs from the sample of ground surveying digital elevation data with a unified grid cell size of 0.5 meters. Comparative Visual analysis of the group of the created DTMs from OK different models at two dimensional and three-dimensional levels has been undertaken. Additionally, comparative statistical analysis of the different ordinary kriging model DTMs has been conducted. Moreover, Accuracy Assessments of the that group of DTMs created with the employment of the different OK Models with the use of external checkout points has been thoroughly performed. Finally, conclusion points have been drawn from the study along with recommendations for future work.

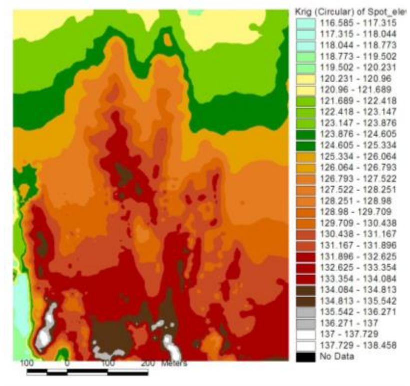
5 Results and Discussions

5.1 Creation and analysis of DTMs with the Use of Different Ordinary Kriging Models

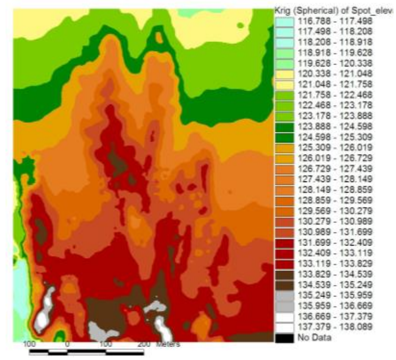
Figure 2 depicts the digital terrain models created from ground surveying digital elevation data set using different ordinary kriging models, the linear OK model,. circular OK model, spherical OK model, exponential OK model in addition to the Gaussian model. Visual analysis of the different DTMs shows differences between the different DTMs in figures 2-a, 2-b. 2-c and 2-d; created from the OK linear, circular, spherical, and exponential models, respectively. This can be noticeable in the sizes and distributions of the correspondence color patches within the corresponding DTMs. This added to variations in of the tones within the DTMs created with the use of different OK models. Also, the textures and patterns within the DTMs, figures 2-a, 2-b, 2-c and 2-d record slight differences. On the other hand, figure 2-e, which depicts a DTM created with the use of Gaussian OK model show wider differences compared to the DTMs in figures 2-a, 2-b, 2-c and 2-d. The tones and textures in the DTM from the Gaussian model are coarse and rough compared to the tones and textures in the DTMs created using the other OK models namely, the linear, the circular, the spherical and the exponential models. This is clear in the bigger sizes of the corresponding color patches with clear differences in the shapes and distribution of the color patches compared to their correspondence in the other four OK model DTMs. Thus, it can be said that OK Gaussian model provides coarse DTM when comparing with the DTMs produced from the other four OK models



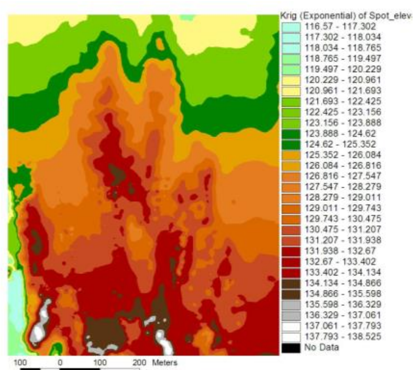
a) Linear OK model



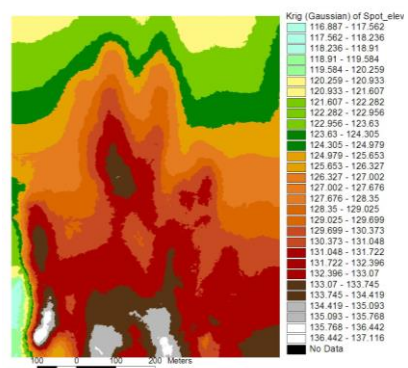
b) Circular OK model



c) Spherical Ok Model



d) Exponential OK model



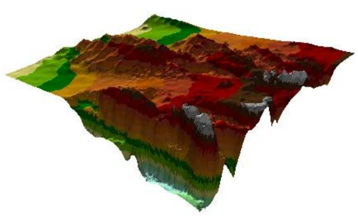
e) Gaussian OK model

Figure 2: DTMs created from ground surveying digital elevation data with the use of different Ordinary Kriging models.

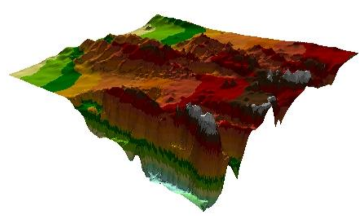
5.2 3D Visualization of DTMs from Ground Surveying Elevation Data Using Different OK Models.

The elements of digital image interpretation namely, shape, size, 3D locations of the color patches in addition to changes in the tone/color are main criteria that can be investigated in visual interpretation of the 3D views generated from the different OK model DTMs. Also, the texture which expresses the arrangements and repetitions of the tones within the DTM where it can be smooth texture, intermediate texture or rough textures constitutes another important criterion that can be evaluated from the different 3D views. Furthermore, the pattern which expresses the arrangements of the spatial objects on the ground can be another important criterion that could be studied in such analysis. Moreover, the height/depth of objects and the shadow of the different objects constitute main elements that can be assessed and evaluated in the analysis of the 3D views extracted from the different OK model DTMs created (Jensen, 2015, Lillsand and keifer, 2015).

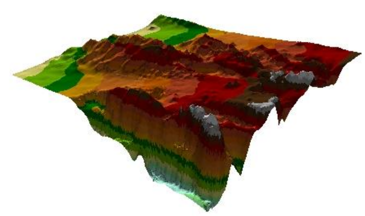
No clear differences can be interpretable between the 3D views of the DTMs generated from different OK models namely, the linear model, circular model, spherical model, and exponential model presented in figures 3-a, 3-b, 3-c and 3-d respectively. In figures, 3-a, 3-b, 3-c and 3-d, similar tones, similar textures, and similar patterns can be interpretable. On the other hand, figure 3-e which depicts a 3D view of the DTM generated from ground elevation data using the OK Gaussian model shows a clear different 3D view of that DTM. In figure 3-e the smoothing effect of the terrain is noticeably clear. Also, the sizes and shapes of the color patches are vastly different compared to their corresponding in figures 3-a, 3-b, 3-c



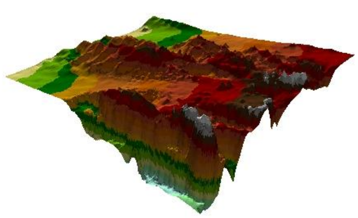
a) 3D view from linear OK model



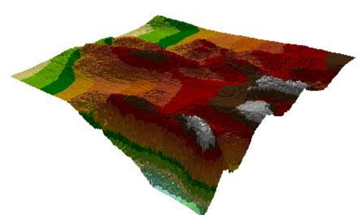
b) 3D view from circular OK model



c) 3D view from spherical Ok Model



d) 3D view from exponential OK model



e) 3D view from Gaussian OK model

Figure 3: 3D visualization of the DTMs created from ground surveying elevation data with the use of different OK models.

and 3-d. Also, the texture in figure 3-e is exceptionally smooth compared to the textures in figures 3-a, 3-b, 3-c and 3-d depicting rough textures and referring to less smoothing of the DTM elevation. On the opposite figure 3-e shows high degree of terrain smoothing and elevation approximation. Moreover, the DTMs in figures 3-a, 3-b, 3-c and 3-d depict rough and corrugated surfaces compared to figure 3-e which represent a smooth surface.

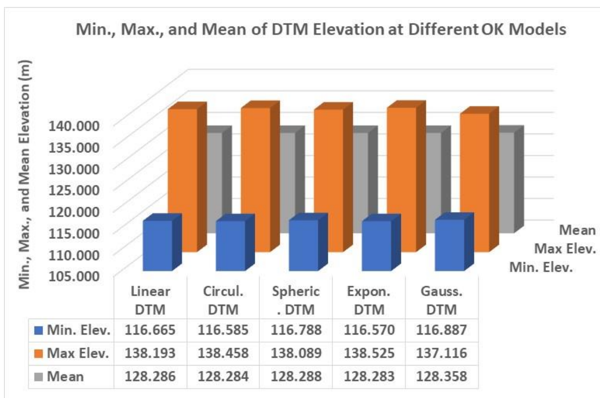
5.3 Statistical Analysis of the Created DTMs from Different OK Models

Table 2 depicts the statistical analysis results of the digital terrain models created from ground surveying digital elevation dataset through employment of different ordinary kriging models including the linear model, circular model, spherical model, exponential model in addition to the Gaussian model. The number of rows and columns in the table are the same for all the created DTMs. This is because the grid cell sizes have been kept the same of 1.0 meters for all the created DTMs that is to marginalize of the effect of changing the grid resolution on the characteristics of that DTMs.

Table 2: Statistical analysis results of DTMs created from ground surveying data with the use of different ordinary kriging models.

OK model used / Statistical Quantity	Linear OK DEM	Circular OK DEM	Spherical Ok DEM	Exponential OK DEM	Gaussian OK DEM
Rows No.	857	857	857	857	857
Col. No.	681	681	681	681	681
Count	583617	583617	583617	583617	583617
Min. Elev.	116.66455	116.58541	116.78803	116.56992	116.88720
Max Elev.	138.19328	138.45811	138.08923	138.52486	137.11632
Range	21.52873	21.87270	21.30120	21.95493	20.22912
Mean	128.285973	128.283924	128.288459	128.283273	128.358131
Std Dev.	4.14478	4.15258	4.13588	4.15397	4.05529
Sum	74869875	74868678	74871325.83	74868299.49	74911987.85

Figure 4 provides graphical representations of different statistical quantities of the DTMs created with the use of the different five OK models investigated in this research. In this context figure 4-a is a graphical chart of three statistical qualities namely, Maximum, Minimum, and mean elevations in the five DTMs created with the use of linear, circular, spherical, exponential and gaussian OK models. Also, figure 4-b depicts a graphical chart of the range elevations in the differently created DTMs. Additionally, figure 4-c provides a representation of the sum of elevations in the created five DTMs under investigations. Finally, figure 4-d depicts a chart for the standard deviation of the elevations contained in the same five DTMs under evaluation.



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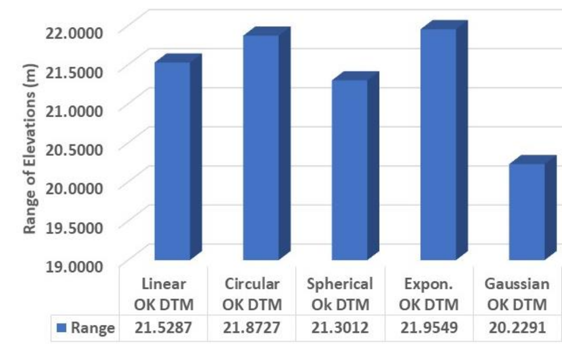

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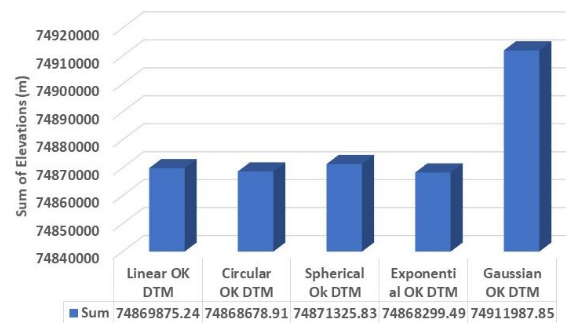

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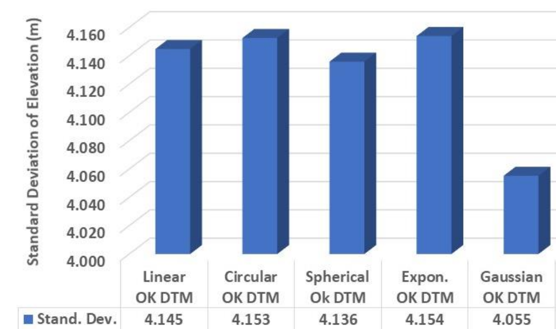


d)

Figure 4: Charts depict representations of the statistical analysis results of the DTMs created from ground surveying elevation measurements through exploitation of the different ordinary kriging models.

From table 2 and figure 4-a the five DTMs from the different five OK models record slightly changeable values in the min., max., and the mean elevations where no strict conclusion can be extracted. This is not the case in figure 4-b which is a chart of the ranges of elevations in the created DTMs where in figure 4-b the DTMs from the exponential and circular OK models depict the highest ranges of elevations in the DTM while lower ranges of elevation can be observed in the DTM from the linear and circular DTMs. However, the DTM from the Gaussian model depicts the lowest range of elevations. In figure 4-c which is a representation of the sum of elevations in the created DTMs the linear, circular, spherical, and exponential model DTMs record close sums of elevations while the Gaussian model DTM depicts vastly different sum of elevations which is of extremely high value compared to the corresponding values in the other four models. Also, in figure 4-d the circular and exponential model DTMs achieve close high values of the standard deviations of the elevations contained in the DTMs while the linear and spherical model DTM depict lower values of the standard deviations of the elevations. In contrast, the Gaussian model DTM gives the lowest value of the standard deviation of the elevations. That is the spherical, linear, circular, and exponential model DTMs achieve standard deviations of the elevations of 101.99%, 102.21%, 102.40% and 102.43% of the standard deviation of the elevations given by the gaussian model DTM. This indicates that the DTM from the Gaussian model depicts the highest degree of elevation smoothing compared to the DTMs created with the use of other four OK models. In other words, it can be concluded that the exponential and the circular models provide highly structured DTMs with lower degrees of elevation smoothing.

5.4 Accuracy Assessments of the DTMs Created from Different OK Models with the Use of External Checkout Points

This analysis aims at evaluation and assessment of the accuracy of the generated DTMs from the ground surveying digital elevation data through exploitation of different ordinary kriging models namely, the linear model, circular model, spherical model, exponential model and finally the Gaussian model. Therefore, a handful of data points have been retained from the original ground surveying data set so that they can be used as external checkout points in the assessment of the residual errors resulting from using different ordinary kriging models in creation of the continuous surfaces namely, the DTMs. Also, this analysis aims at assessment of the accuracy of the elevation measurements extracted from such generated DTMs. Additionally, assessment of the standard deviation of the mean elevation of the DTM complements the analysis for accuracy investigation of the created DTMs. In this test the elevations at the positions of the checkout points, have been measured from the different OK model DTMs where the residual elevations have been calculated using the following equations (Zhu et. at, 2005, Karl et. al, 2006):

$$\delta_{Elevation} = \text{Elevation (checkout)} - \text{Elevation (DTM)} \qquad (6)$$

where: $\delta_{Elevation}$ =residual elevations.

Elevation (checkout) = the elevation of the external checkout point.

Elevation (DTM) = the elevation from the DTM at the same position as the external checkout point.

Then, the standard error $\sigma_{Elevation}$ of the elevation residuals can be computed as:

$$\sigma_{Elevation} = \sqrt{\frac{\sum_{i=1}^{n}(\text{Elevation(checkout)} - \text{Elevation (DTM)})^2}{(n-1)}} \qquad (7)$$

Where: n = no. of observations (checkout points).

Also, the standard error of the mean $\sigma_{Mean\_Elevation}$ can be calculated using the following equation:

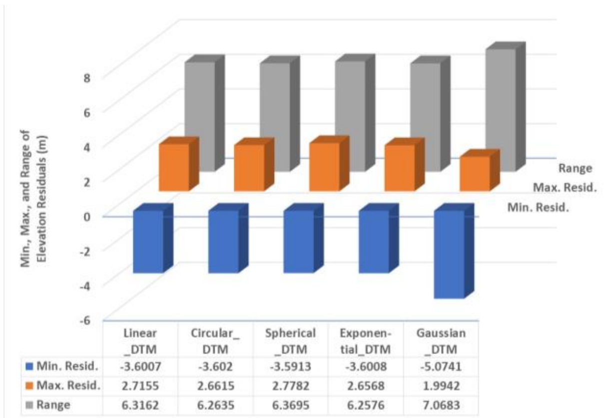
$$\sigma_{Mean\_Elevation} = \sqrt{\frac{\sum_{i=1}^{n}(\text{Elevation(checkout)} - \text{Elevation (DTM)})^2}{n(n-1)}} \qquad (8)$$

From table 3 and Figure 5-a is a chart that depicts the maximum, minimum and range of the elevation residuals calculated as the algebraic difference between the actual elevations of the external checkout points as ground truth data and the elevations extracted from the different DTMs generated from using the different OK models at the positions of checkout point. From figure 5-a, the Gaussian model records the smallest maximum elevation residual compared to the other four models while the spherical model records the highest maximum value of elevation residual. Regarding the minimum elevation residuals, the Gaussian model records the biggest absolute value of minimum residual while the values of the minimum residuals from the other four models are remarkably close. This is reflected on the ranges of the elevation residuals where the range from the Gaussian model is the biggest while the ranges of the elevation residuals from the other OK models are not that far from each other's in values, however the DTM from the exponential model has recorded the smallest value of the range of the elevation residual.

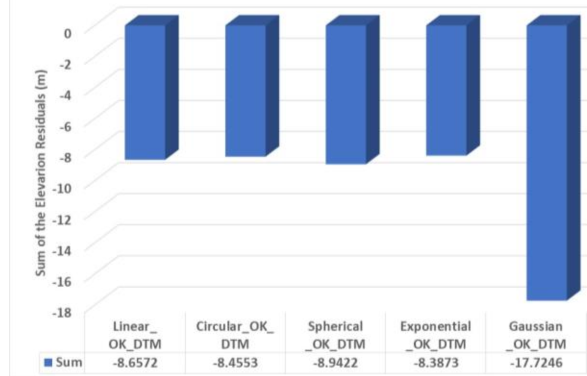
Table 3: Statistical analysis of the elevation residuals extracted from the different DTMs created from ground surveying data with the use of different ordinary kriging models at positions of the external checkout points.

Statistical quantity	Linear OK DTM	Circular OK DTM	Spherical OK DTM	Exponential OK DTM	Gaussian OK DTM
Count	72	72	72	72	72
Min. (m)	-3.6007	-3.602	-3.5913	-3.6008	-5.0741
Max. (m)	2.7155	2.6615	2.7782	2.6568	1.9942
Range (m)	6.3162	6.2635	6.3695	6.2576	7.0683
Mean (m)	-0.120238	-0.117434	-0.124197	-0.116490	-0.246175
Median (m)	-0.02975	-0.01965	-0.04945	-0.01615	-0.0905
Sum (m)	-8.6572	-8.4553	-8.9422	-8.3873	-17.7246
Standard Dev. (m)	0.797294	0.800011	0.798824	0.801864	0.986356
Stand. Dev. of mean (m)	0.093962	0.094282	0.094142	0.094500	0.116243

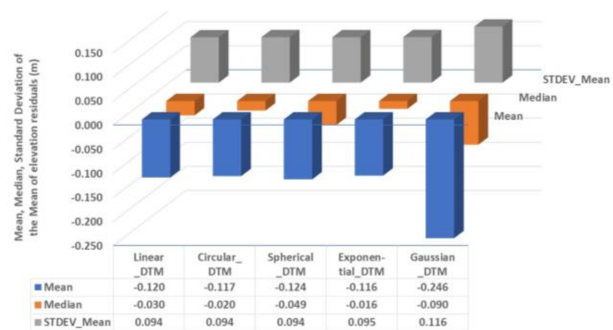
From table 3 and figure 5-c which depicts a chart of the mean, median and the standard deviation of the mean of the elevation residuals extracted from the DTMs created from ground surveying digital elevation data with the use of different ordinary kriging models, it can be noticed that the DTM from the Gaussian model records the highest absolute value of the mean, median and standard deviation of the mean of the extracted elevation residuals that can be more than the doubles of the corresponding values from the other OK model DTMs especially, in the case of the mean and the median of the residual elevations. On the other hand, the exponential model DTM achieves the lowest values of mean and median elevation residuals that are about 47.3% and 17.8% of the corresponding values recorded by the Gaussian DTM, respectively.



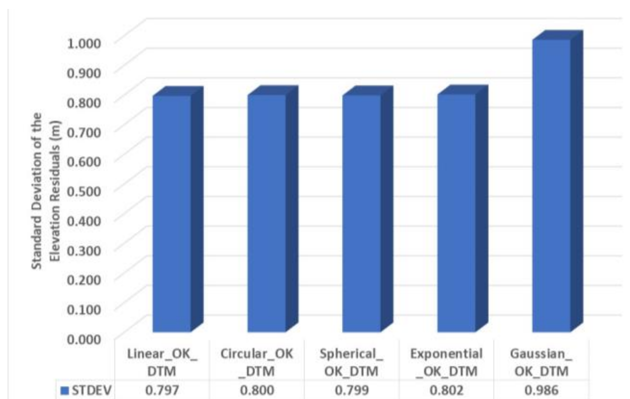
a)



b)



c)



d)

Figure 5: Charts represent the results of the statistical analysis of the residual elevation of DTMs created from ground surveying elevation measurements through exploitation of different ordinary kriging models.

The DTM from the circular model records the second lowest values of the mean and median of elevation residuals that can be about 47.7% and 21.71% of the corresponding values recorded by the Gaussian model DTM. Finally, from table 3 and figure 5-d which depicts a chart of the standard deviation of the elevation residuals extracted from the different OK model DTMs at the positions of the external checkout points it can be observed that the Gaussian model achieve the max value of the standard deviation of the elevation residuals which refers to the lowest accuracy OK model DTM since the standard deviation or in other words is considered as the most trustful measure of accuracy. The DTMs from the linear, spherical, circular, and exponential models achieve lower and remarkably close values of the standard deviation of the residual elevations that are about 80.83%, 80.88%, 81.11% and 81.3% of the standard deviation of the elevation residuals achieved by the Gaussian DTM model, respectively.

6 Conclusions

Digital Terrain Model is as a continuous surface that contains ground elevation values as well as other elements that describe the topographic surface such as the slope, the aspect, the curvature, …etc. DTM is usually created through spatial interpolation operation where measured elevations are exploited to predict unknown elevations. Ordinary Kriging methods are geostatistical and probabilistic statistical approaches that incorporate spatial autocorrelation. Also, Ordinary Kriging models constitute advanced geostatistical procedures that generates estimated surfaces from scattered sets of points with elevation values through minimizing the errors between the predicted values and a statistical model of the surface (Maune and Nayegandhi, 2018. This research aimed at the application of comparative analysis of the Digital Terrain Models created from ground surveying digital elevation data through exploitation of the different models of the ordinary kriging geostatistical method namely, the linear model, the circular model, spherical model, the exponential model, and the Gaussian model as interpolation approaches. A sample of ground surveying digital elevation data collected using a total station instrument has been employed in this study. DTM has been created from the sample data using different ordinary kriging models namely, the linear, the circular, the spherical and the exponential models in addition to the Gaussian model. 2D visual analysis of the DTMs created from the OK different models shows that the tones and textures in the DTM from Gaussian model are much coarser compared to the DTMs created using the other OK models namely, the linear, the circular, the spherical and the exponential models. This is clear as the sizes and different shapes of color patches in the Gaussian model DTMs are hugely different from their correspondence in the other ordinary kriging model DTMs. Also, Ordinary Kriging Gaussian model provides coarse DTM compared to the DTMs produced from the other OK models. Additionally, the statistical analysis of the DTMs from different OK models indicated has the Gaussian model DTM gives the smallest standard deviation of the elevations. That is the spherical, linear, circular, and exponential model DTMs achieve standard deviations of the elevations of 101.99%, 102.21%, 102.40% and 102.43% of value of the standard deviation of the elevations given by the gaussian model DTM respectively. This is an indication that the DTM from the Gaussian model depicts the highest degree of elevation smoothing compared to the DTM from the other models. Finally, statistical analysis the elevation residuals extracted from different ordinary kriging DTMs using external checkout points show that that the DTM from the Gaussian model achieve the biggest value of the standard deviation of the elevation residuals which refers to the lowest accuracy achieved by different OK model DTMs. The DTMs from the linear, spherical, circular, and exponential models achieve smaller and remarkably close values of the standard deviation of the residual elevations that are about 80.83%, 80.88%, 81.11% and 81.3% of the standard deviation of the elevation residuals achieved by the Gaussian DTM model. More investigations including extraction and analysis of the different terrain parameters from the generated DTMs using different OK models could be useful in giving concrete conclusions on the usefulness of the employment of different OK models in generation of DTMs form ground surveying data.

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