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ACCURACY ASSESSMENT OF DIGITAL ELEVATION MODELS GENERATED USING THE ERDAS IMAGINE ORTHOMAX DIGITAL PHOTOGRAMMETRIC SYSTEM

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Abstract

The users of many digital photogrammetric systems are allowed a degree of control over the automated digital elevation model (DEM) generation software with a set of strategy parameters. These parameters control the search and quality control characteristics of the algorithm; hence the wrong choice of parameters can have a significant detrimental effect on the accuracy of the DEM. This paper describes the strategy parameters used in the Erdas Imagine OrthoMAX digital photogrammetric system and a set of tests used to define the optimum set of parameters for a project. The algorithm employs an area correlator and a hierarchical approach in the matching process. The results show that a 35 per cent increase in accuracy can be achieved through the process of parameter optimization. They also demonstrate that changes to the strategy parameters have a similar effect on the results for all areas of a set of imagery used in the test, which is of particular note because the imagery contains a diverse range of landcover types. The paper additionally provides a description of a system currently being developed which will automatically prescribe the correct set of parameters for a project.

Key words: DEM accuracy, strategy parameters, Erdas Imagine OrthoMAX system

Introduction

As digital photogrammetric systems become more sophisticated and the level of automation increases, the technical gap between the user and the system grows. Users must understand the operation being carried out in order to make full use of the tools at their disposal. Without this comprehension, the product is likely to be a compromise, not fully utilizing the opportunities, benefits and capabilities of the system.

With digital photogrammetric systems, one of these technological gaps concerns the user definable strategy parameters which control the production of digital elevation models (DEMs). The Erdas Imagine OrthoMAX digital photogrammetric system has 12 DEM strategy parameters, whilst the MATCH-T package has 28

(Smith *et al.*, 1996). The high number of variables emphasizes the need for an easy and reliable method for determining the correct set.

This paper describes the parameters used in the Erdas Imagine OrthoMAX digital photogrammetric system, together with the effect that they have on the algorithm and the data generated. A series of tests is described which can be used to find the "optimum" set of parameters, thereby maximizing the accuracy of the system.

THE NEED FOR AN UNDERSTANDING OF STRATEGY PARAMETERS

The names of the strategy parameters are defined in a technical language that few people seem to understand and the wrong specification for any given parameter can have a significant effect on the overall accuracy of the derived elevation model. Fig. 1 shows a histogram of difference between two DEMs of the same area (derived from 1:6000 scale photography) with only one parameter changed. The graph shows that this single parameter change has altered the elevation of over 20 per cent of the points by at least 0·25m. If digital photogrammetry is to be used successfully in the GIS, engineering and planning (and other low tolerance) sectors, then these parameters need to be understood by the user. Only through understanding the significance of these parameters can the accuracy be optimized. In OrthoMAX, the parameters are specified by the user when defining the creation of a DEM. Each parameter is given a default value with the option for user specification.

DEM parameterization may vary for each photogrammetric application with the correct set of parameters potentially changing from point to point on the DEM, so that any universal set of parameters will inevitably involve a compromise. Zhang and Miller (1997) state that the parameters are functions of terrain type, signal power, flying height, *x* and *y* parallax, and image noise level. In theory, a correct set of parameters will provide an accurate DEM, with successfully correlated points included and unsuccessful points rejected from DEM processing. An incorrect set may result in filtering successful points and the inclusion of badly correlated points (known as false fixes) or simply in failing to find correlated points.

If the correct set of parameters is a function of image content, it follows that the correct set of parameters for one area of an image will not necessarily be the correct set for another (Liang and Heipke, 1996). Zhang and Miller (1997) describe a system

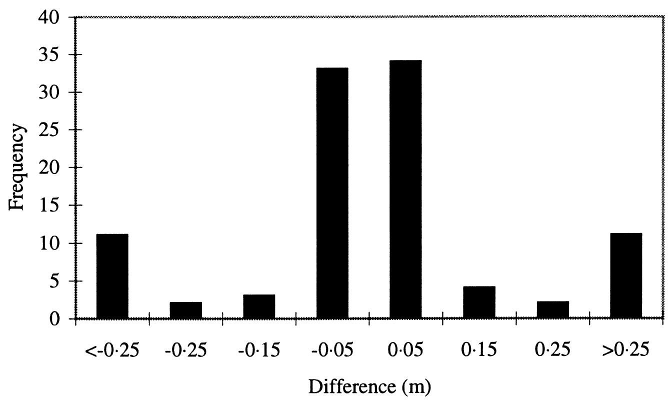

FIG. 1. Histogram of difference illustrating the effects of changing one parameter (Maximum Parallax from 0·5 pixel to 0·3 pixel).

TABLE I. Default strategy parameters for the Erdas Imagine OrthoMAX system (adapted from Erdas, 1994).

Parameter	*Value*
Minimum Threshold	0·6
Noise Threshold	0·4
Maximum Parallax (x)	5
Minimum Template Size	7
Maximum Template Size	9
Minimum Precision	0·5
Rejection Factor	1·5
Skip Factor	2
Edge Factor	2·5
Start RRDS	4
End RRDS	0
Y Parallax Allowance	0
Resampling	Bilinear
Post Processing	On

Units of parameters
Maximum Parallax: pixel.
Template Size: value of x represents window size of $x \times x$ pixel.
Minimum Precision: pixel.
Y Parallax Allowance: pixel.
All other values are without dimensions.

which utilizes an inference engine to generate the correct set of parameters based on a set of facts. However, many digital system users will not have access to such a system. There is, therefore, a need for a set of tests which users of digital systems can carry out to maximize the efficiency and accuracy of their systems.

THE 14 PARAMETERS OF THE ERDAS IMAGINE ORTHOMAX SYSTEM

A full list of the Erdas Imagine OrthoMAX system parameters and their default values is given in Table I. The parameters define the internal operation of the area based image matching algorithm. This process includes defining the search characteristics and sizes of the template windows, together with acceptance criteria and quality control of points. Each of the strategy parameters is briefly described below; further details can be found in Erdas (1994).

Minimum and Noise Thresholds

The threshold values (Minimum and Noise) define the minimum acceptable correlation coefficients (0 to 1·0) between a window of pixels in the left and right hand images. A correlation coefficient below the threshold values forces the algorithm to reject the point and use an estimated value based on the elevations of the surrounding points instead. Setting a high threshold value means that the algorithm becomes more "selective" and only accepts points with a high correlation coefficient. Hence, the probability of obtaining a larger percentage of interpolated points increases, because more points are rejected. A smoothing effect may occur in such an event. If a relatively low value is specified, the algorithm will accept points with a lower correlation coefficient, which may result in a higher number of potentially false fixes. The correct value should accept the correlations derived from corresponding points and reject the false fixes.

Maximum Parallax and Y Parallax Allowance

The Maximum Parallax and *Y* Parallax Allowance parameters facilitate movement of the search window in the right hand image, in the *x* and *y* directions respectively (the units are in pixels). A Maximum Parallax specification of 5 pixels infers a maximum shift of 10 pixels (along the epipolar line) since the movement is not restricted to the positive direction (Stojic, 1997). The *Y* Parallax Allowance is designed to enable successful DEM generation when the bundle adjustment (triangulation) suggests that perfect collinearity has not been achieved. A *Y* Parallax setting is ideal for photogrammetric projects containing small residual *y* parallax. Both parallax allowances enable a greater area to be searched during DEM correlation. Consequences of the relaxation on search area restrictions are increases in the processing time and, more significantly, increased chances of finding false fixes (since more pixels are being included in the search).

Minimum and Maximum Template

The Minimum and Maximum Template Size parameters establish the dimensions (in pixels) of the square correlation template (a value of 5 indicates a 5×5 pixel template window). The image matching approach begins with the minimum template size and increments to a larger size if a successful correlation is not found. A larger window size is usually needed if the image content is low but it has the effect of generalizing the terrain and potentially lowers the accuracy (peaks lowered and troughs raised). Furthermore, raising the template size value increases the chances of finding success but increases both the processing time and the possibility of finding false fixes. The choice of window size should reflect the landcover type, the image content and relief displacement. Low image content and high relief displacement may require a larger template size.

Minimum Precision

Once a pair of correlated points has passed the threshold tests, the corresponding precision in pixel space of the match is estimated. The precision is defined as the geometric mean of the error ellipse axes. The minimum allowable precision is defined by the user with the Minimum Precision parameter. Points failing the test are assigned a null status and the elevation of the point is subsequently interpolated using the surrounding known elevation values. Reducing the Minimum Precision value makes the process more selective with respect to minimum allowable precision.

Rejection Factor

The Rejection Factor is considered as a smoothing filter which removes local maxima and minima. The elevation of each point is predicted using the successfully correlated points within a local neighbourhood of pixels. If the difference between the estimated and predicted values is greater than the Rejection Factor multiplied by the standard deviation of the surrounding elevations, then the point is rejected and the predicted elevation is used. A lower specification will force the algorithm to reject more points, thereby creating a smoothing effect. A larger value will accommodate greater terrain variation, but may allow spurious results to be included in the final model.

Skip Factor

In common with other systems, the DEM extraction algorithm employed by Ortho*MAX* uses a hierarchical Reduced Resolution Data Set (RRDS) approach which reduces the effects of false fixes associated with inaccurate estimations of the point elevations (Erdas, 1994). Results from each RRDS are used as a "seed" for the next RRDS. The reduced resolution data sets are resampled from the original imagery. The Skip Factor allows the collection rate to be increased by collecting grid points no closer than the specified value in all but the last RRDS. The last RRDS normally uses the original image unless otherwise specified.

Edge Factor

The Edge Factor is used to minimize the number of false fixes in the final DEM caused by false correlations along linear features. The error ellipsoid of each correlation is computed using the estimated precision of each correlated pair of image points. An elongated ellipsoid arising from what may be a linear feature suggests that the correlation may not be reliable. The Edge Factor describes the ratio between the major and minor axis of the error ellipsoid. If the ratio is higher than the factor, the point is rejected and an interpolated elevation used. Lowering the value will make the software more selective.

Start and End RRDS

The Start and End RRDS values dictate the resolutions used in the hierarchical process. In order to optimize accuracy, an end RRDS value of 0 (the original image) is recommended since detail and image content can be distinguished at the original resolution. A larger Start RRDS value may be required for rugged terrain and can be a more appropriate way of coping with rugged terrain than raising the Maximum Parallax parameter. This option raises the issue of the interaction between the parameters, a subject which can be complex to predict and model. For example, increasing the template size and lowering the minimum threshold are both ways of handling a low image content. However, changing both of these parameters at the same time is not necessarily correct and care should be taken in adopting this course of action without prior testing.

METHODOLOGY

Some initial tests were undertaken to identify the DEM strategy parameters which had the most effect on DEM quality. Two sets of imagery were used (one close range with a photoscale of 1 : 70 and one aerial with a photoscale of 1 : 4000) for these tests. The aerial photography contained a large section of a landslide on the Dorset coast (Brunsden and Chandler, 1996), so that there was a wide elevation range (0 m to 170 m above Ordnance Datum) in the imagery. In contrast to this, the close range imagery was of a simulated river bed (Stojic *et al.*, 1998), so that the elevation range was very small and the image content very low.

The first step in the processing of the initial test data was to create a DEM using the default parameters. Each parameter was subsequently changed (keeping all other parameters at their default setting), both positively and negatively, and the DEM recreated. The values used were chosen to highlight changes that were being made to the DEM so that trends could be recognized. Each new DEM was differenced from the default DEM to produce a histogram of difference. A visual inspection was made of the histograms to identify the parameters which had the largest effect on the elevation estimates.

A total of six different areas from the two data sets was used in these initial tests. The results were very similar for all of the areas, suggesting that similar conclusions could be applied to other data sets. This finding was of particular note because the two sets of imagery used were completely different in terms of photoscale and image content. The results showed that the following parameters had the most effect on the DEM elevations for all six areas:

Minimum Threshold;
Template Size;
Minimum Precision; and
Start and End RRDS.

Since check point data were not available at the time of the initial tests, it could not be determined whether the changes were beneficial in terms of accuracy.

Following the initial tests, the main tests were carried out with two objectives: (a) to determine and optimize the accuracy with which OrthoMAX can be used to generate DEMs; and (b) to evaluate the effect of the different parameters on DEMs. For these tests, a set of aerial photographs was chosen which covered a variety of landcover types, including residential, urban, forested, agricultural and floodplain areas. The imagery covered a section of the city of London in Ontario, Canada. The photography was taken using a Zeiss RMK A metric camera equipped with forward motion compensation with an average photoscale of 1:6000 (average flying height 920 m). A grid spacing of 0·8225 m was used for all the DEMs, because this was the default setting computed by OrthoMAX.

An appropriate technique for assessing the accuracy of derived data and the impact of the parameters on the data is to carry out tests using redundant check data in the object space. Quality control or check points (in other words, spot heights with a known elevation value considered to be "true") used for the accuracy assessment were digitized from a set of 1:2000 scale Ontario Ministry of Natural Resources topographic maps. Between five and 22 check points were used in each area; the points were clearly defined points on the imagery, such as road intersections.

Ultimately, accuracy optimization was the primary objective of these tests. The parameter changes listed in Table II were applied to each area of the imagery used

TABLE II. Parameter changes for initial tests.

Test	*Parameter change*
a	Default values
b	Minimum Threshold = 0·8
c	Minimum Threshold = 0·4
d	Noise Threshold = 0·7
e	Noise Threshold = 0·2
f	Maximum Parallax = 8
g	Maximum Parallax = 3
h	Template Size: Minimum = 9, Maximum = 11
i	Template Size: Minimum = 5, Maximum = 7
j	Minimum Precision = 0·8
k	Minimum Precision = 0·3
l	Rejection Factor = 2·5
m	Rejection Factor = 1·0
n	End RRDS = 1
o	*Y* Parallax Allowance = 2

See Table I for units of parameters.

TABLE III. List of areas and landcover types for main tests.

Area number	*Photographs used*	*Land cover type*
1	251–252	Open flat fields
2	251–252	Open fields and forest
3	251–252	Rolling open fields
4	251–252	Residential
5	252–253	Open fields
6	252–253	Urban
7	252–253	Forest and floodplain
8	252–253	Field, forest and floodplain
9	252–253	River and floodplain
10	252–253	Open field and car park
11	253–254	Forest
12	253–254	Urban
14	253–254	Mix
15	253–254	Residential and floodplain

and the check point data were used to assess the accuracy of each DEM. In this way, the parameter changes which had a beneficial affect on the DEM accuracy could be identified. The values selected were designed to highlight any changes which were occurring. For each parameter change, all other parameters were given their default values. Varying landcover types on the imagery were identified in 14 areas (Table III) and used in the tests.

Erdas Imagine OrthoMAX software generates a results log file for each derived DEM. Included in the file are the results for each RRDS level of processing. Of primary interest for this study were the results for the final RRDS, because these relate to the final level of DEM processing. The log file contains a summary of results which include:

percentage of correlated and interpolated points;
average and sigma (standard deviation) Signal to Noise Ratio (SNR);
average and sigma parallax changes;
failure analysis (reasons why points were interpolated);
internal precision estimates; and
time and speed of the processing.

It was decided to record the majority of the log file for the final RRDS with the intention of determining accuracy trends within the output data. The accuracy of each DEM was assessed by subtracting the DEM from an image file containing the check points. From these results, the average and sigma elevation differences (Li, 1988) were obtained. Consistent trends in improved accuracy suggested that the following parameters provided the highest accuracies:

low average and sigma (standard deviation) Δz values for the check points;
low interpolation percentages;
low threshold and curvature failure percentages (signifies a good degree of correlation); and
high average SNR values (signifies a good degree of correlation).

The primary goal of the study was to optimize the operation of the DEM extraction algorithm, thereby allowing for the generation of accurate topographic representations of terrain and ground features. Parameter changes which had a beneficial affect on the above results were combined to determine the optimized parameter settings. A trial and error approach had to be adopted to find the optimum

TABLE IV. Accuracy, interpolation and SNR results for main tests.

Area	Landcover type	Value type	Δz Values (m) Average	Δz Values (m) Sigma	Interpolation %	Average SNR
1	Open flat fields	Default	0·157	0·298	33·6	1·953
		Optimized	0·009	0·114	22·5	2·265
2	Open fields and forest	Default	− 0·154	0·123	29·5	2·054
		Optimized	− 0·159	0·116	16·4	2·360
3	Rolling open fields	Default	− 0·132	0·189	50·3	1·702
		Optimized	− 0·052	0·163	7·3	1·683
4	Residential	Default	0·175	0·250	45·5	1·963
		Optimized	− 0·056	0·092	19·3	1·776
5	Open fields	Default	− 0·126	0·265	51·7	1·749
		Optimized	− 0·143	0·140	14·1	1·655
6	Urban	Default	0·227	0·456	51·8	2·151
		Optimized	0·117	0·324	36·2	1·905
7	Forest and floodplain	Default	0·308	0·796	58·4	1·772
		Optimized	0·069	0·148	12·0	2·086
8	Field, forest and floodplain	Default	− 0·056	0·358	51·4	1·757
		Optimized	0·119	0·139	19·6	2·103
9	River and floodplain	Default	0·047	0·341	61·6	1·717
		Optimized	0·006	0·333	64·5	1·724
10	Open field and car park	Default	− 0·099	0·084	57·1	1·724
		Optimized	0·010	0·175	14·2	1·877
11	Forest	Default	0·860	0·619	41·7	2·020
		Optimized	0·096	0·509	44·4	2·038
12	Urban	Default	0·097	0·528	50·0	2·173
		Optimized	− 0·013	0·555	35·7	2·068
14	Mix	Default	0·556	0·408	45·9	2·149
		Optimized	0·549	0·483	34·4	1·807
15	Residential and floodplain	Default	0·001	0·342	47·4	1·992
		Optimized				

set since it was found that the parameters did not always interact positively with respect to accuracy.

RESULTS

Table IV shows the accuracy (Δz values), interpolation percentages and average SNR results for each area, generated using the default and optimized parameter settings. It indicates that 10 areas (out of the possible 13 areas where the settings were changed) showed considerable improvement in DEM accuracy (measured by average Δz). Three areas which showed no improvement (the "optimized" DEM had a lower accuracy than the default DEM) were areas 2 (open fields and forest), 5 (open fields) and 8 (field, forest and floodplain). In these areas, the other results which signify a good degree of correlation showed improvement, but no improvement in the average Δz value could be achieved. In area 15, the results show that the default parameters worked extremely well, negating the need to change them. In cases where an improvement in accuracy did occur, the results indicate that the magnitude of change is large. Overall, the improvement in accuracy was 35 per cent. Considering the successful areas in isolation, the improvement in accuracy increases to 68 per cent. Table IV also shows that in 10 of the 14 areas, the sigma Δz values were reduced.

The need for optimized strategy parameters is indicated by the number of points which have different elevation values when compared to the default DEMs. Between

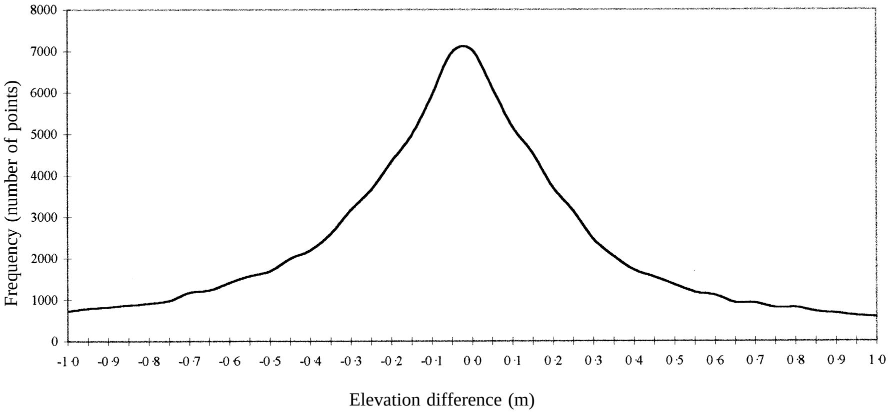

FIG. 2. Histogram of variation between default DEM and optimized DEM (area 7).

56 per cent and 85 per cent of the points in each area had elevation values which changed as a result of parameter variation. Whilst this figure gives no indication as to whether the change is beneficial to the accuracy of the DEM, it does show that the changes that occur are significant in terms of the effect on the DEM. Fig. 2 shows a histogram of difference between the default DEM and the optimized DEM for study area 7. The characteristics of the graph (that is normal distribution) are typical of all of the results.

Table V shows a list of the optimized parameters used for each area in the study. It shows that there is a requirement in 11 of the 14 areas for at least one of the threshold parameters to be reduced and nine of the areas required an increase in either

TABLE V. Optimized parameters for main tests.

Area	*Landcover type*	*Optimized parameters*
1	Open flat fields	Minimum Threshold = 0·5, Noise Threshold = 0·3, End RRDS = 1, *Y* Parallax = 1
2	Open fields and forest	Minimum Threshold = 0·5, Noise Threshold = 0·3, end RRDS = 1, *Y* Parallax = 2, Rejection Factor = 2, Minimum Precision = 0·6
3	Rolling open fields	Minimum Threshold = 0·5, Noise Threshold = 0·3, *Y* Parallax = 2
4	Residential	Minimum Threshold = 0·5, Noise Threshold = 0·3, Maximum Template size = 11
5	Open fields	Minimum Threshold = 0·5, Noise Threshold = 0·3, *Y* Parallax = 2
6	Urban	Minimum Threshold = 0·5, Noise Threshold = 0·3, Maximum Template size = 11, Maximum Parallax = 6
7	Forest and floodplain	Minimum Threshold = 0·5, *Y* Parallax = 2, Minimum Template size = 5, Maximum Template size = 11
8	Field, forest and floodplain	Minimum Threshold = 0·5, *Y* Parallax = 1, Minimum Template size = 5, Maximum Template size = 7
9	River and floodplain	Noise Threshold = 0·7
10	Open field and car park	Minimum Threshold = 0·5, *Y* Parallax = 1, Minimum Template size = 5
11	Forest	Maximum Parallax = 3
12	Urban	Minimum Threshold = 0·5, *Y* Parallax = 2, Maximum Parallax = 3
14	Mix	Minimum Threshold = 0·4
15	Residential and floodplain	Default parameters

See Table I for units of parameters.

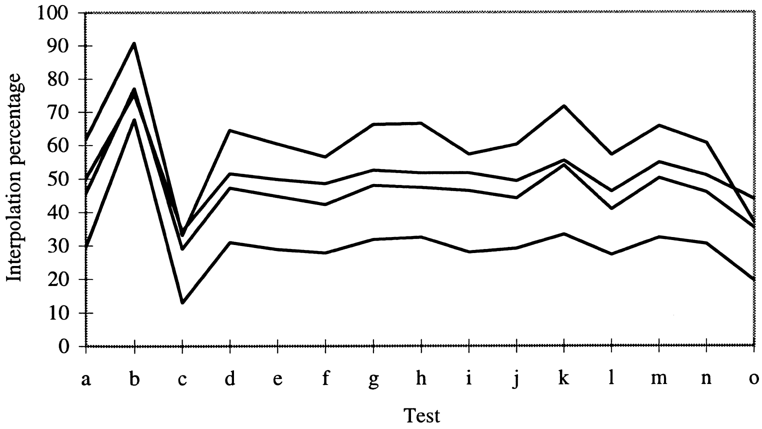

FIG. 3. Interpolation percentages for four areas used in initial tests (defined in Table II).

the *x* and/or the *y* parallax allowance. These broad similarities support the conclusions of the initial tests, which found that the parameters had a similar affect on all of the areas examined and suggest that landcover type is not quite as important as was first thought. However, the slight differences between the optimum parameter sets reinforce the need to find the correct set of parameters for the area of interest if the accuracy of the system is to be optimized.

Additional trends indicate that the level of interpolation (Table IV) for all but two of the areas has been reduced. Overall, the average reduction in the level of interpolation was 42 per cent. However, this does not necessarily indicate an improvement in accuracy. The reduction can be attributed to the specification of a lower Minimum Threshold setting. A reduced value increases the percentage of points considered as image matching pairs. Verification can be found from the initial tests (b and c) in all of the areas, as illustrated in Fig. 3, which displays the interpolation percentages for four of the six areas used in the tests. Each area is represented by a different line on the graph, whilst the tests listed on the horizontal axis refer to the parameter changes given in Table II. The areas used in these examples are arbitrary choices as similar results were obtained for all areas. The graph illustrates that when the Minimum Threshold setting was increased to 0·8 (test b), the percentage of interpolation correspondingly increased for all of the areas. The magnitude of the change is significant when comparing the differences for the other parameter changes. The opposite scenario occurs when the minimum threshold is decreased to a value of 0·4.

The results also indicate that there is no definite link between the average SNR and the accuracy of the results used in the study. The average SNR (Table IV) was higher for seven of the 14 areas. The results from the initial tests indicated that a reduction in the minimum threshold correspondingly lowers the average SNR (Fig. 4). As with the interpolation percentages, increasing the minimum threshold specification raises the average SNR result for all of the areas. The reduction of the minimum threshold parameter is therefore the most likely explanation for the reduction in the percentage of interpolated points and the average SNR.

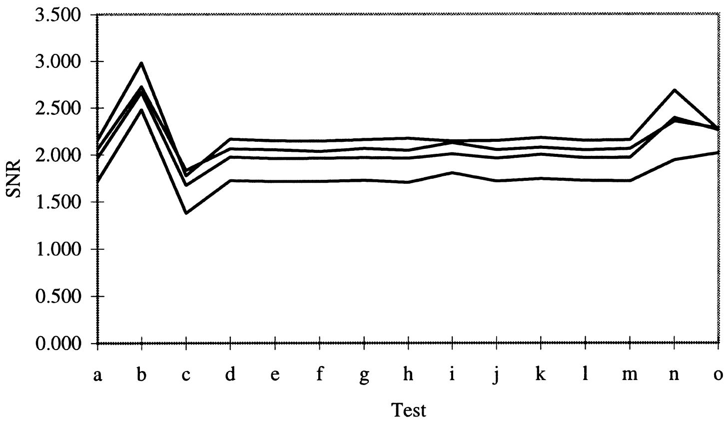

FIG. 4. SNR results for four areas used in initial tests (defined in Table II).

DISCUSSION

The research carried out for the study suggests that a significant improvement in the accuracy of a DEM produced using automated extraction techniques can be achieved by varying the strategy parameters. A good success rate was achieved with a 35 per cent improvement in the overall accuracy for the 14 areas. These results compare well with those in Zhang and Miller (1997), who reported 15 per cent to 35 per cent improvement on average. Changing the DEM strategy parameters has (for these areas) made the algorithm more successful, as illustrated by the reduction in the percentage of interpolated points. It is vital for the level of interpolation to be reduced if the accuracy of the DEM is to be increased. This is especially important in urban areas where the interpolation of points may result in points at street level between buildings being raised or roof tops being lowered.

Additional findings can be made from the study. The variation of signal power (that is, grey level intensities) within the search window must be large enough in order to differentiate between noise and signal levels. In areas with a low signal variation, this problem can be overcome by lowering the threshold values and raising the end RRDS value (resampling the original image reduces the likelihood of noise in the area of interest).

In areas of extreme elevation variation (such as urban areas), an increase in the window size and search range is recommended to facilitate the increase in *x* parallax (the shift in the image position of a point from one photograph to the next caused by the data capture device (Wolf, 1983)).

In areas close to the edge of a stereopair, an increase in the *y* parallax specification may be needed. This facility is used to accommodate weak network geometry, atmospheric refraction and uncompensated lens distortion and film deformation (Stojic, 1997).

Concerns with regard to the limited number of check points used in the study raised issues of sampling size and distribution. Due to time and cost restraints, obtaining additional check points was not a practicable option. A topographic survey would have been preferred to the digitized map points for reasons of accuracy. However, the number and type of points used do allow a relative comparison to be made between the DEMs.

The research highlights the need for a correct and optimized set of strategy parameters. Fig. 3 illustrates the magnitude and critical nature of varying one of the parameters (the Minimum Threshold) from 0·6 to 0·8. If the combination of all 12 parameters is incorrect, the quality of a DEM could be influenced in a way which could affect the success of a project.

An additional aspect of this study, as shown in Figs. 3 and 4, was the similarity of the graphs generated by the data, the only difference being a vertical shift between the lines. This clearly distinguished phenomenon was noted for most of the results recorded in the study (the Canadian, land slide and simulated river bed imagery). A system is currently being developed and tested by the authors which uses these graphs to predict an "optimized" set of parameters based on the set of results obtained from some initial tests. These preliminary results are compared to the results derived using the 1:6000 scale Canadian photography for which the optimum parameter settings are known. An interpolation process is then used to prescribe a set of parameters for the new area of interest. The interpolation process is carried out automatically using a spreadsheet.

CONCLUSIONS

This work has demonstrated the capability of OrthoMAX to derive accurate DEMs, an essential requirement of any digital photogrammetric system. It also shows that the strategy parameters are highly sensitive and significant gains in accuracy can be made by altering their values.

The paper outlines one approach for optimizing the DEM strategy parameters which, subsequently, results in significant improvements with respect to accuracy and decreased levels of interpolation.

The results from this study have also highlighted a potential method for prescribing parameters for an area based on some initial test results and work is being carried out to develop and assess the effectiveness of this approach.

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Résumé

De nombreux systèmes de photogrammétrie numérique offrent aux utilisateurs un certain degré de contrôle sur les logiciels de production automatique des modèles numériques des altitudes par le biais d'un jeu de paramètres. Ces paramètres agissent sur les chactéristiques de recherche et de contrôle de qualité des algorithmes et par conséquent, un mauvais choix *sur ces paramètres peut avoir un effet réellement néfaste sur la précision des modèles numériques d'altitudes.*

On décrit dans cet article la nature des paramètres utilisés dans le système de photogrammétrie numérique OrthoMAX *de* Erdas Imagine *et le jeu d'essai permettant de réaliser le choix optimal ces paramètres dans un projet donné. L'algorithme recourt à un corrélateur surfacique et à une approche hiérarchique dans la recherche d'appariement. Les résultats montrent que l'on peut obtenir un accroissement de 35% sur la précision lorsque les paramètres sont optimisés. Ils montrent également que toute modification de ces paramètres a des répercussions identiques dans les résultats, quelle que soit la zone ou l'image utilisées du jeu d'essai, ce qui est particulièrement intéressant car toute image contient une gamme variée de genres d'occupation du sol. On présente en plus dans cet article un système actuellement en cours de mise au point destiné à fournir automatiquement des valeurs correctes pour ces paramètres dans un projet donné.*

Zusammenfassung

Den Nutzern vieler digitaler photogrammetrischer Systeme ist es möglich, in bestimmtem Maße die automatische digitale Software zur Erzeugung von DEM durch einen Satz Strategieparameter zu steuern. Diese Parameter steuern die Suche und die Qualitätscharakteristika des Algorithmus, weil die unrichtige Auswahl von Parametern einen sehr schädlichen Einfluß auf die Genauigkeit des DEM haben kann. Im Artikel werden die beim digitalen photogrammetrischen System Erdas Imagine OrthoMAX *verwendeten strategischen Parameter beschrieben, und es wird ein Satz von Tests zur Definition des Optimums von Parametern für ein Projekt dargestellt. Der Algorithmus verwendet einen Flächenkorrelator und eine hierarchische Annäherung bei der Korrelation. Die Ergebnisse zeigen, dass eine 35%ige Genauigkeitssteigerung durch den Prozeß der Parameteroptimierung erreicht werden kann. Sie zeigen auch, dass Veränderungen der Strategieparameter einen ähnlichen Einfluß auf die Ergebnisse für alle Gebiete eines bei diesem Test benutzten Bildsatzes haben, was deshalb bedeutsam ist, weil die Abbildungen einen unterschiedlichen Bereich von Landnutzungstypen erfassen. Es wird zusätzlich ein gegenwärtig in Entwicklung befindliches System beschrieben, das den korrekten Parametersatz für ein Projekt automatisch vorschreiben wird.*