HYBRID RESECTION TECHNIQUE PROCEDURES AND ACCURACIES

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ABSTRACT

After the great developing of surveying instruments, the surveying procedures have to be developed. The surveying procedures have to be much with the electronic development of the instruments such as the total stations, electronic level,... etc. In this paper, new procedures for resection using EDM is introduced with their accuracies.

Keywords: Hybrid, Resection, Total Station, Observations, Mathematical Model.

1. INTRODUCTION

Resection problem is depending on only measuring angles from unknown points to known points as accurate distance measurements where not easy. Angular observations from one unknown point to 3 known points are to find the 2 coordinates of the unknown points. If the observations are to 4 known points the fourth is taken for check the results. Also resection could be done by observing at least 2 known points from 2 unknown points. In case of observing 2 known points the observations are 4 and the unknowns are the 4 coordinates of the 2 unknown points. Mathematical formulae for solving the resection were introduced.

2. TRADITIONAL METHODS

The problem of resection has a unique solution from three rays provided that all points do not lie on a circle.

There are several methods used for analytical solution, two methods of these are described as follows :

a- The Tienstra or Barycentric method. [2]

In Figure (1), The coordinates of points (P) are obtained from

$$E_p = (K_1 E_A + K_2 E_B + K_3 E_C) / (K_1 + K_2 + K_3)$$

$$N_p = (K_1 N_A + K_2 N_B + K_3 N_C) / (K_1 + K_2 + K_3)$$

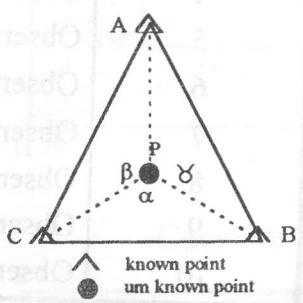

Fig (1)

where

$$1/K_1 = \cot A - \cot \alpha$$
$$1/K_2 = \cot B - \cot \beta b$$
$$1/K_3 = \cot C - \cot \gamma$$

b- The collin's point or Bessel's methods. [2]

In Figure (2), the coordinates of points (1) are obtained from

$$E_1=(-E_B \cot \alpha - E_C \cot \beta - N_B + N_C)/(-\cot \alpha - \cot \beta)$$

$$N_1=(-N_B \cot \alpha - N_C \cot \beta + E_B - E_C)/(-\cot \alpha - \cot b)$$

Nowadays, it is easy to measure distances electronically, the procedure of resection are developed and then can be clled ***Hybrid*** resection.

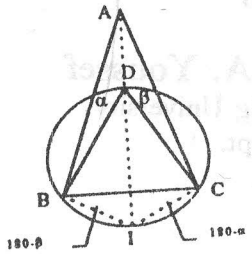

Fig (2)

3- HYBRID RESECTION

Hybrid resection differ from angular resection as :

a. Using electronic distance measurements between the unknown points.
b. Increasing the number of observations than the number of unknowns.Table (1) shows the selected cases used as a test for traditional and *Hybrid* techniques, Figure (3).

Table 1.

Case No.	Case condition
1	Observing 2 known stations from 2 unknown stations
2	Observing 3 known stations from 2 unknown stations
3	Observing 4 known stations from 2 unknown stations
4	Observing 2 known stations from 3 unknown stations
5	Observing 3 known stations from 3 unknown stations
6	Observing 4 known stations from 3 unknown stations
7	Observing 2 known stations from 4 unknown stations
8	Observing 3 known stations from 4 unknown stations
9	Observing 4 known stations from 4 unknown stations
10	Observing 4 known stations from 1 unknown station

Table (2) gives the number of obser vations against the number of unknowns:

Table 2.

Case No.	No. of observations		Total observations		No. Of unkowns	No. of redundancies	
	lengths	angles	Trad.	Hyb.		Trad.	Hyb.
1	1	4	4	5	4	-	1
2	1	6	6	7	4	2	3
3	1	8	8	9	4	4	5
4	3	8	8	11	6	2	5
5	3	10	10	13	6	4	7
6	3	13	13	16	6	7	10
7	6	14	14	20	8	6	12
8	6	17	17	23	8	9	15
9	6	20	20	26	8	12	18
10	-	3	3	-	2	1	-

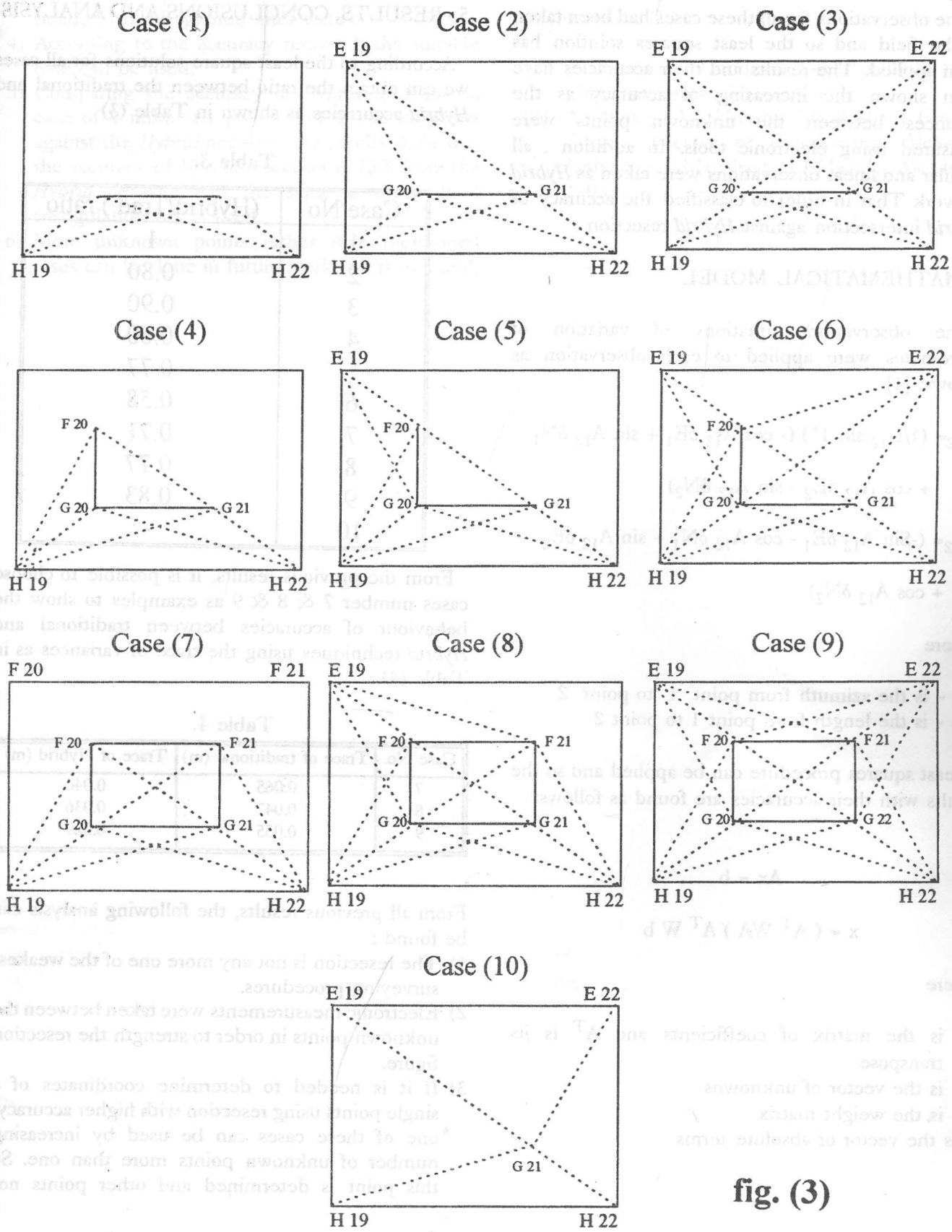
Case (1)
H 19
H 22
Case (2)
E 19
G 20
G 21
H 19
H 22
Case (3)
E 19
E 22
G 20
G 21
H 19
H 22
Case (4)
F 20
G 20
G 21
H 19
H 22
Case (5)
E 19
F 20
G 20
G 21
H 19
H 22
Case (6)
E 19
E 22
F 20
G 20
G 21
H 19
H 22
Case (7)
F 20
F 21
F 20
F 21
G 20
G 21
H 19
H 22
Case (8)
E 19
F 20
F 21
G 20
G 21
H 19
H 22
Case (9)
E 19
E 22
F 20
F 21
G 20
G 22
H 19
H 22
Case (10)
E 19
E 22
G 21
H 19
H 22

fig. (3)

The observations for all these cases had been taken in the field and so the least squares solution has been applied. The results and their accuracies have been shown the increasing of accuracy as the distances between the unknown points were measured using electronic tools. In addition , all angular and linear observations were taken as *Hybrid* network That in order to classified the accuracy of *Hybrid* intersection against *Hybrid* resection

4. MATHEMATICAL MODEL

The observation equations of variation of coordinates were applied to each observation as follows: [1]

$$\delta A_{12} = (1/L_{12} \sin 1'') (- \cos A_{12}\, \delta E_1 + \sin A_{12}\, \delta N_1 + \cos A_{12}\, \delta E_2 - \sin A_{12}\, \delta N_2)$$

$$\delta L_{12} = (-\mathrm{Sin}\, A_{12}\, \delta E_1 - \cos A_{12}\, \delta N_1 + \sin A_{12}\, \delta E_2 + \cos A_{12}\, \delta N_2)$$

Where

A_{12} - is the azimuth from point 1 to point 2
L_{12} - is the length from point 1 to point 2

Least squares procedure can be applied and so the results with their accuracies are found as follows:

$$Ax = b$$

$$x = (A^T WA)\, A^T W b$$

Where

A- is the matrix of coefficients and A^T is its transpose
x- is the vector of unknowns
W- is the weight matrix
b- is the vector of absolute terms

5 - RESULTS, CONCLUSIONS AND ANALYSIS

According to the least square solutions for all cases we can obtain the ratio between the traditional and *Hybrid* accuracies as shown in Table (3)

Table 3.

Case No	(Hybrid/Trad) ratio
1	1
2	0.80
3	0.90
4	0.60
5	0.77
6	0.58
7	0.71
8	0.77
9	0.83
10	-

From the previous results, it is possible to choose cases number 7 & 8 & 9 as examples to show the behaviour of accuracies between traditional and *Hybrid* techniques using the trace of variances as in Table (4).

Table 4.

Case No.	Trace of traditional (m)	Trace of Hybrid (m)
7	0.065	0.046
8	0.047	0.036
9	0.035	0.029

From all previous results, the following analysis can be found :

1) The resection is not any more one of the weakest surveying procedures.
2) Electronic measurements were taken between the unknown points in order to strength the resection figure.
3) If it is needed to determine coordinates of a single points using resection with higher accuracy, one of these cases can be used by increasing number of unknown points more than one. So this point is determined and other points not

needed can be ignored after wards.

4) According to the accuracy required, the suitable case can be used.
5) Comparing the accuracy of *Hybrid* resection in case of 4 unknown points and 4 known points against the *Hybrid* network, the results show that the accuracy of *Hybrid* resection is 75% from the *Hybrid* network and the same accuracy as if triangulation net is used.
6) More unknown points rather than mentioned cases can be done in future work if it is required.

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