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TRANSFORMATION OF CONTOUR MAPS TO DIGITAL TERRAIN MODEL (DTM)

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ABSTRACT

Digital Terrain Model(DTM) is considered to be a new method of relief representation of the Earth surface.There are many methods to obtain data required for creation a DTM. One of the methods is transformation of the existing contour maps to DTM, which consists of laying out a grid net on the contour map and measuring the coordinates of the intersection points of the contour lines with X and Y axes of the grid net. From these data, profiles are drawn along the lines then elevations of grid nodes are obtained. These are the basic data required for creation of DTM in the computers.

A comparison carried out between this method and photogrammertic method of data acquisition, the results were very good and encouraging. The method is simple and gives a comprehensive visualisation of the area, which can not be imagined perfectly from contour maps. DTM's will replace contour maps in the stages of desigen and execution of Civil engineering projects in very near future.

1.INTRODUCTION

The concept of terrain modelling has been in continous growth in the recent years, and it's application has been widened as a result of spectacular advance in computer graphics and imaging technology, at the same time there has been a vast increase in the speed with which the data about the terrain surface can be acquired due to the development of electronic theodolites ,distance measuring equipment and automated photogrammetric instruments .

Digital Terrain Model, [(DTM) is simply a statistical representation of continuous surface of the ground by a large number of selected points with known XYZ coordinates in any coordinate field (1)], is becoming a powerful tool for both the design and the construction phase in many engineering projects .The technique of DTM are in wide spread use and has been applied in many fields such as :Topographic mapping, Civil engineering, Hydrographic mapping, Geology, Minning and Military engineering.(2)

The acquisition of accurate 3-Dimensional coordinates which represent the surfase of the Earth is a vital stage in the process of terrain modelling. It is possible to form such models using a range of different technicques which will depend on the size of the area to be survyed, the accuracy required and the type of information which will be extracted from the model. THREE methods may be followed for data acquisition for terrain modelling: Ground survey or field data collection, Photogrammertic method of data acquisition ,and Data acquisition from exsiting maps or plans, The later method was followed for creation of DTM and compared with the second method from the accuracy point of view in this paper.

2. TERRAIN DATA ACQUISITION FROM EXISTING CONTOUR MAPS.

Since a single map sheet may contain a very larg amount of information in the form of lines representing detials in the planimetric and altimetric plans, the task of converting these information into a digital form, does indeed, becomes a matter of very considerable importance. Terrain elevation data acquisition from existing maps which contain very few spot heights or elevations is a matter of dealing with the measurement of contour lines so that they represented by suitably structured strings can be of digital coordinat data and with the subsequent processing or dreivation of the spot higths or evelation data creation of Digital Terrain Models.(2,4)

These conversions may be carried out by the following methods(1):

a. Manual line following method.

b. Automatic or semi automatic line following method.

c. Automatic raster – scan.

3- METHODOLOGY

In this study the method (a) was followed with some modifications:

TEST AREA :

Location: Gais – Buhler – Teufen area – Switzerland located between 750000 and 751000m along X- axis, and 246000 and 247000m along Y- axis according to their National Coordinate System.

Aerial converage : The area covered by vertical aerial photographs taken by WILD UAg II- 3008 Aerial Camera of focal length 153.03 mm at the scale of 1:14000 (photo nos: 2629, 2630).

Restitution: Planimentric and controur map of 5m vertical interval at the scale of 1:5000 resituted by Schlund – Zurich and printed on plastic sheets.

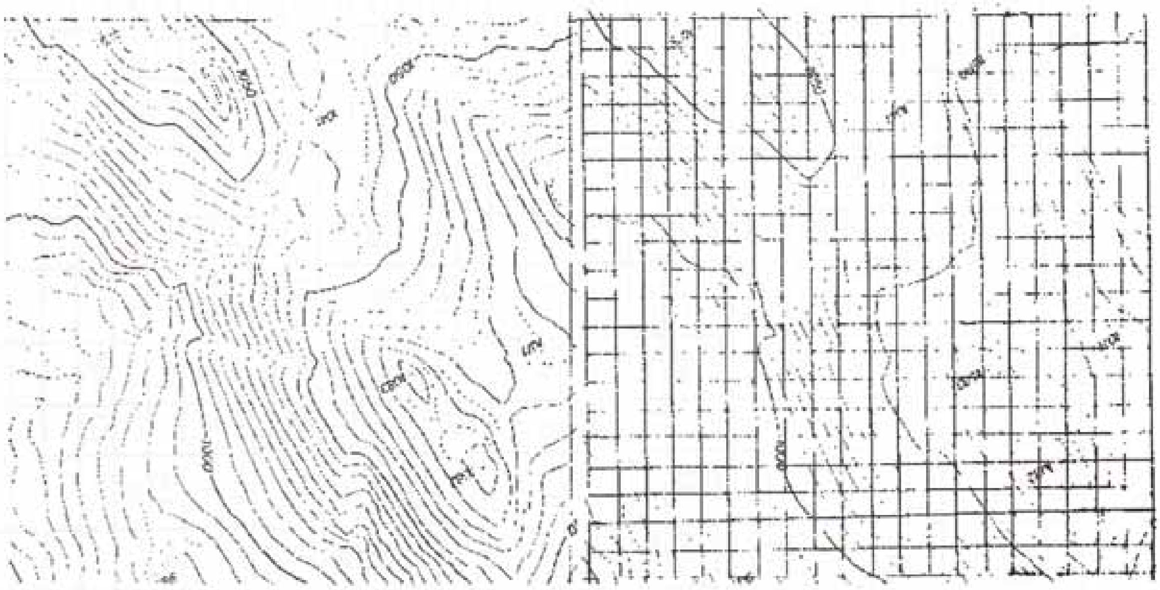
(Note : These data are available within the training program of WILD – Heerbrug of photogrammetry)

The over-all procedure consists of the followings:

3-1 : GRID LAYOUT :

Superimpose (or draw) a square grid on the contour map of a certain side length which depends on the topography of the area and the accuracy required for the final out-put (25m square grid used in this study drawn on the photocopy of the original contour map of the scale 1:5000, covering an area of 500,0m x 500,0m) .

see (Fig-1-a) and (Fig-1-b).



Contour map of test area (a) — Grided contour map. (b)

(Fig – 1)

3-2 : MEASUREMENT OF CONTOUR LINE COORDINATES

The coordinates of the intersection points of the contour line with the X and Y axes of the grid net are measured using (r+a, rost- Coordinatograph) in the following procedure:

a. At the intervals of 25m at the map scale along Y- axis, X- coordinates of the intersection points of the contour lines with X- axis are measured, these yeilded to 21 lines of 503 points (Table-1).

B. At the intervals of 25m at the map scale along X-axis, Y-coordinates of the intersection points of the contour lines with Y-axis are measured, these yeided to 21 lines of 425 points (Table-2).

3-3 PREPERATION OF PROFILES:

From data obtained in step (3-2), profiles are drawen for each line from the measurments carried out along X and Y axes at scales: Horizantal scale = 1:2500 , Vertical scale = 1:1000.

(Total of 42 profiles are drawn on a single page each, 21 profiles for measurements along X-axes of the grid and 21 profiles for measurements along Y-axes of the grid). (Fig-2).

3-4 : ACQUISITION OF GRID NODES ELEVATIONS:

On the basis of graphical interpolation, Two sets of 25m grid node elevations are obtained by direct reading of elevations from the height axis of the profiles of measurments

Measurments of coordinates of countor lines along x-axis

Table(1)

Line No. 1			Line No. 2			Line No. 3			Line No. 4			Line No. 5			Line No. 6			Line No. 7			Line No. 8			Line No. 9			Line No. 10			Line No. 11		
x	y	z	x	y	z	x	y	z	x	y	z	x	y	z	x	y	z	x	y	z	x	y	z	x	y	z	x	y	z	x	y	z
500	0	1045	489.5	25	1050	483.5	50	1055	474.5	75	1060	490.5	100	1060	491	125	1065	453	150	1070	449.5	175	1070	442	200	1070	489	225	1075	458.5	250	1075
481.5	0	1050	476	25	1055	472	50	1060	463.5	75	1065	453	100	1065	448	125	1070	400.5	150	1075	414.5	175	1070	387.7	200	1070	429	225	1070	426.5	250	1070
463.5	0	1055	464	25	1060	457	50	1065	451	75	1070	450	100	1070	430	125	1075	352	150	1075	385	175	1075	359.5	200	1075	382	225	1065	400.5	250	1065
449.5	0	1060	440	25	1060	450	50	1070	445.5	75	1075	442	100	1075	370	125	1075	337	150	1070	370	175	1080	330	200	1075	365	225	1065	369.5	250	1060
445.5	0	1060	410	25	1060	439	50	1075	426.5	75	1080	432.5	100	1080	353	125	1070	324.5	150	1065	355	175	1080	313.5	200	1070	333	225	1065	315	250	1055
426	0	1055	390	25	1055	428	50	1075	400.5	75	1075	407	100	1080	340.5	125	1065	310	150	1060	336	175	1075	300	200	1065	295.5	225	1065	260	250	1050
405	0	1050	378.5	25	1050	408	50	1070	385	75	1070	384	100	1075	328.5	125	1060	291	150	1055	324	175	1070	289	200	1060	281.5	225	1060	247	250	1045
390	0	1045	368.5	25	1045	394	50	1065	374	75	1065	369	100	1070	309	125	1055	272.5	150	1050	311	175	1065	277.5	200	1055	271	225	1055	234	250	1040
379	0	1040	358.5	25	1040	382.5	50	1060	364	75	1060	357.5	100	1065	287.5	125	1050	262.5	150	1045	298	175	1060	268	200	1050	249.5	225	1050	224	250	1035
367.5	0	1035	347	25	1035	365.5	50	1055	351	75	1055	347.5	100	1060	278	125	1045	251	150	1040	285	175	1055	258.5	200	1045	247.5	225	1045	211.5	250	1030
357	0	1030	337.5	25	1030	359	50	1050	342.5	75	1050	336	100	1055	267	125	1040	242.5	150	1035	263	175	1050	249	200	1040	239	225	1040	201	250	1025
346	0	1025	326.5	25	1025	349.5	50	1045	334	75	1045	324.5	100	1050	257	125	1035	232.5	150	1030	254	175	1045	239.5	200	1035	230	225	1035	192.5	250	1020
332	0	1020	317.5	25	1020	341	50	1040	325.5	75	1040	318	100	1045	246.5	125	1030	224	150	1025	240	175	1040	225.5	200	1030	225	225	1030	182.5	250	1015
316	0	1015	306.5	25	1015	331.5	50	1035	320	75	1035	283	100	1040	236	125	1025	214.5	150	1020	231	175	1035	213	200	1025	211	225	1025	173.5	250	1010
300	0	1010	277	25	1010	323	50	1030	299	75	1035	273	100	1035	226.5	125	1020	204.5	150	1015	222	175	1030	201.5	200	1020	201	225	1020	164.5	250	1005
283.5	0	1005	246	25	1005	287.5	50	1025	291.5	75	1035	262	100	1030	216.5	125	1015	193	150	1010	212	175	1025	187	200	1015	192	225	1015	156	250	1000
254	0	1000	222.5	25	1000	275	50	1020	279	75	1030	250.5	100	1025	204	125	1010	181	150	1005	202.5	175	1020	174	200	1010	183	225	1010	145.5	250	995
224	0	995	204.5	25	995	261	50	1015	266.5	75	1025	240	100	1020	189.5	125	1005	167	150	1000	192.5	175	1015	165	200	1005	172.5	225	1005	131.5	250	990
199.5	0	990	184.5	25	990	243	50	1010	255	75	1020	229	100	1015	170	125	1000	147	150	995	183	175	1010	153	200	1000	164	225	1000	124	250	990
167	0	985	106.5	25	985	221.5	50	1005	242.5	75	1015	215	100	1010	142.5	125	995	126	150	990	172.5	175	1005	144	200	995	151.5	225	995	95.5	250	985
135	0	985	92.5	25	980	203	50	1000	226	75	1010	196	100	1005	121	125	990	108.5	150	985	161.5	175	1000	132.5	200	990	139	225	990	74	250	980
108.5	0	985	74	25	975	182.5	50	995	208	75	1005	173.5	100	1000	98.5	125	985	90.5	150	980	148	175	995	120	200	985	121.5	225	985	17	250	980
93	0	980	60	25	970	154	50	990	182.5	75	1000	142	100	995	80	125	980	74.5	150	975	135.5	175	990	105.5	200	980	118.5	225	985			
75.5	0	975	45.5	25	965	102.5	50	985	154.5	75	995	119	100	990	61	125	975	51.5	150	970	115	175	985	86.5	200	975	107	225	985			
62	0	970	30.5	25	960	84	50	980	121	75	990	95.5	100	985	44	125	970	20	150	965	100	175	980	77	200	975	86.5	225	980			
49.5	0	965	6.5	25	955	65	50	975	94	75	985	75.5	100	980	15.5	125	965				80	175	975	66.5	200	975	15	225	975			
36	0	960				48.5	50	970	79	75	980	56.5	100	975							57	175	970									
22.5	0	955				33	50	965	59	75	975	41.5	100	970																		
5.5	0	950				5.5	50	960	43	75	970	25.5	100	965																		
									29.5	75	965	2	100	960																		

Measurments of coordinates of countor lines along x-axis

Table(1) continued

Line No. 12			Line No. 13			Line No. 14			Line No. 15			Line No. 16			Line No. 17			Line No. 18			Line No. 19			Line No. 20			Line No. 21		
x	y	z	x	y	z	x	y	z	x	y	z	x	y	z	x	y	z	x	y	z	x	y	z	x	y	z	x	y	z
487.5	275	1080	500	300	1085	492.5	325	1090	478.5	350	1090	466.5	375	1090	425	400	1080	479.5	425	1070	460.5	450	1060	480	475	1050	458	500	1040
449	275	1075	476	300	1080	476	325	1085	460.5	350	1085	448	375	1085	412.5	400	1075	458	425	1070	409.5	450	1060	466.5	475	1050	379.5	500	1035
427	275	1070	451	300	1075	463.5	325	1080	450	350	1080	436.5	375	1080	399	400	1070	397.5	425	1070	367	450	1055	431	475	1050	360.5	500	1035
405.5	275	1065	424.5	300	1070	444	325	1075	432	350	1075	424	375	1075	381.5	400	1065	379.5	425	1065	341	450	1050	383.5	475	1045	203	500	1040
383	275	1060	410.5	300	1065	419.5	325	1070	411.5	350	1070	403.5	375	1070	368	400	1060	367.5	425	1060	315	450	1045	339	475	1045	180	500	1045
360	275	1055	389	300	1060	405	325	1065	396	350	1065	387	375	1065	359	400	1055	351	425	1055	277	450	1040	269	475	1040	165	500	1050
322	275	1050	368	300	1055	389.5	325	1060	385	350	1060	377	375	1060	342.5	400	1050	337.5	425	1050	249	450	1040	244	475	1040	155	500	1055
244	275	1045	346	300	1050	371.5	325	1055	374.5	350	1055	367.5	375	1055	328	400	1045	323	425	1045	217.5	450	1045	205	475	1045	145	500	1060
231.5	275	1040	313	300	1045	346.5	325	1050	349.5	350	1050	350.5	375	1050	237	400	1045	270.5	425	1040	206	450	1050	189	475	1050	134	500	1065
218.5	275	1035	246.5	300	1040	323.5	325	1045	322.5	350	1045	328	375	1045	223	400	1050	258.5	425	1040	196.5	450	1055	176.5	475	1055	112.5	500	1070
214	275	1030	230	300	1035	294	325	1040	289	350	1040	286.5	375	1040	208.5	400	1055	226.5	425	1045	187.5	450	1060	168	475	1060	83	500	1070
202.5	275	1025	219.5	300	1030	256.5	325	1035	238	350	1040	252.5	375	1040	200.5	400	1060	220	425	1050	182.5	450	1065	160	475	1065	71.5	500	1065
194.5	275	1020	209.5	300	1025	220	325	1035	207.5	350	1045	234.5	375	1045	186	400	1060	205.5	425	1055	174	450	1070	120	475	1070	50	500	1060
185	275	1015	179.5	300	1025	194	325	1035	196.5	350	1045	218.5	375	1050	171	400	1055	198.5	425	1060	169.5	450	1070	98.5	475	1070	20.5	500	1055
176.5	275	1010	137	300	1020	136	325	1030	175	350	1040	179	375	1050	152.5	400	1050	193	425	1065	155.5	450	1065	86.5	475	1065	11	500	1050
139	275	1005	115.5	300	1015	120.5	325	1025	127.5	350	1035	160.5	375	1045	109.5	400	1045	174	425	1065	95	450	1060	75	475	1060	0	500	1045
125.5	275	1000	102.5	300	1010	107	325	1020	110	350	1030	119	375	1040	91.5	400	1040	161	425	1060	83.5	450	1055	60	475	1055			
84	275	995	88.5	300	1005	95.5	325	1015	101	350	1025	102.5	375	1035	80	400	1035	114	425	1055	70.5	450	1050	43	475	1050			
71	275	990	78	300	1000	85	325	1010	88	350	1020	88	375	1030	69	400	1030	96	425	1055	56.5	450	1045	32.5	475	1050			
			64.5	300	995	71.5	325	1005	74.5	350	1015	78.5	375	1025	48.5	400	1025	81.5	425	1045	45	450	1040	17	475	1045			
						54	325	1000	63.5	350	1010	65.5	375	1020	18.5	400	1020	70	425	1040	12.5	450	1035	6.5	475	1040			
						12	325	1000				39.5	375	1015				54	425	1035									
						0	325	1000										32	425	1030									
																		4	425	1025									

Measurements of counter lines along y-axis

Table(2)

Line No.1			Line No.2			Line No.3			Line No.4			Line No.5			Line No.6			Line No.7		
x	y	z	x	y	z	x	y	z	x	y	z	x	y	z	x	y	z	x	y	z
0	500	1045	25	492.5	1055	50	500	1060	75	491.5	1065	100	472	1070	125	451.5	1065	150	494	1060
0	482.5	1040	25	478.5	1050	50	479.5	1055	75	473.5	1060	100	459	1065	125	435	1060	150	485	1065
0	460	1035	25	465.5	1045	50	467.5	1050	75	457.5	1055	100	446.5	1060	125	421	1055	150	454.5	1065
0	441.5	1030	25	453.5	1040	50	455.5	1045	75	445	1050	100	434.5	1055	125	406.5	1050	150	432.5	1060
0	426	1025	25	441.5	1035	50	442	1040	75	430.5	1045	100	421	1050	125	385.5	1045	150	417	1055
0	408.5	1020	25	428	1030	50	426	1035	75	418.5	1040	100	405.5	1045	125	368.5	1040	150	401.5	1050
0	390.5	1015	25	414.5	1025	50	412	1030	75	405.5	1035	100	391.5	1040	125	351.5	1035	150	382.5	1045
0	357.5	1010	25	395.5	1020	50	398.5	1025	75	390	1030	100	376	1035	125	333	1030	150	363.5	1040
0	335	1005	25	379	1015	50	384.5	1020	75	378	1025	100	360.5	1030	125	319	1025	150	344.5	1035
0	324.5	1000	25	361.5	1010	50	359	1015	75	363.5	1020	100	350	1025	125	304	1020	150	320	1030
0	310.5	995	25	344	1005	50	356	1010	75	348.5	1015	100	334	1020	125	294.5	1015	150	306.5	1025
0	277	990	25	322.5	1000	50	340	1005	75	334.5	1010	100	318.5	1015	125	287	1010	150	297	1020
0	262	985	25	305.5	995	50	322	1000	75	320	1005	100	302.5	1010	125	262.5	1005	150	289	1015
0	246	980	25	288	990	50	306.5	995	75	304	1000	100	267	1005	125	275	1000	150	280	1010
0	231	975	25	270.5	985	50	291.5	990	75	285	995	100	278.5	1000	125	255.5	995	150	270.5	1005
0	181.5	970	25	253.5	980	50	271	985	75	270	990	100	272.5	995	125	240	990	150	263	1000
0	154.5	965	25	223	975	50	255	980	75	260	985	100	264.5	990	125	148	990	150	227	995
0	142	960	25	18 0	970	50	222.5	975	75	249	980	100	241.5	985	125	69.5	990	150	220	995
0	114	960	25	160.5	965	50	181.5	970	75	198.5	975	100	219.5	980				150	81.5	990
0	92	960	25	155.5	965	50	145.5	970	75	151	975	100	174	980				150	52.5	985
0	62.5	960	25	101.5	965	50	44.5	970	75	99.5	980	100	130	985						
0	30	955	25	31	960	50	0	965	75	12	975	100	54.5	985						
0	9.5	950																		

Measurements of counter lines along y-axis **Table(2) continued**

Line No.8			Line No.9			Line No.10			Line No.11			Line No.12			Line No.13			Line No.14		
x	y	z	x	y	z	x	y	z	x	y	z	x	y	z	x	y	z	x	y	z
175	488	1050	200	500	1040	225	485.5	1040	250	445.5	1040	275	492.5	1040	300	453	1040	325	4197	1040
175	476	1055	200	480.5	1045	225	427	1045	250	371	1040	275	459	1040	300	285	1045	325	476	1045
175	465.5	1060	200	450	1050	225	362	1045	250	341.5	1035	275	440.5	1040	300	263.5	1050	325	465	1045
175	459.5	1065	200	439.5	1055	225	350.5	1040	250	322	1035	275	387.5	1040	300	247.5	1055	325	365.5	1045
175	447.5	1070	200	416.5	1060	225	329	1035	250	313.5	1040	275	306	1045	300	238.5	1050	325	319.5	1045
175	441.5	1070	200	399.5	1060	225	292.5	1035	250	281	1045	275	257	1050	300	230.5	1055	325	278	1050
175	423	1065	200	379.5	1055	225	260	1035	250	218.5	1045	275	245	1055	300	199.5	1055	325	253	1055
175	409.5	1060	200	356	1050	225	213	1030	250	152	1040	275	208	1055	300	175	1060	325	238.5	1060
175	394.5	1055	200	349	1045	225	199.5	1030	250	136.5	1035	275	145	1050	300	136	1055	325	225.5	1065
175	377.5	1050	200	335.5	1040	225	165	1030	250	119	1030	275	129.5	1045	300	111.5	1050	325	215	1070
175	353	1045	200	319.5	1035	225	148	1025	250	100.5	1025	275	111	1040	300	101	1045	325	172	1070
175	349	1040	200	308	1030	225	128	1020	250	82	1020	275	95.5	1035	300	91	1040	325	149	1065
175	336	1035	200	298.5	1025	225	107	1015	250	53	1015	275	79	1030	300	75	1035	325	129	1060
175	310	1030	200	290	1020	225	77	1010	250	42	1010	275	65	1025	300	61	1030	325	117.5	1055
175	300.5	1025	200	282.5	1020	225	45	1005	250	21	1005	275	49.5	1020	300	40	1025	325	99.5	1050
175	291	1020	200	253.5	1025	225	22.5	1000	250	2	1000	275	37	1015	300	34	1020	325	90	1045
175	285	1015	200	226	1020							275	25.5	1010	300	28.5	1015	325	75.5	1040
175	278	1010	200	198.5	1020							275	6.5	1005	300	0	1010	325	56.5	1035
175	273.5	1010	200	178.5	1020													325	46.5	1030
175	243.5	1010	200	158.5	1015													325	28.5	1025
175	219.5	1005	200	132.5	1010													325	8	1020
175	212	1010	200	90	1005															
175	202	1010	200	52.5	1000															
175	166	1005	200	30.5	995															
175	91.5	1000	200	0	990															
175	56	995																		

Measurements of counter lines along y-axis

Table(2) continued

Line No.15			Line No.16			Line No.17			Line No.18			Line No.19			Line No.20			Line No21		
x	y	z	x	y	z	x	y	z	x	y	z	x	y	z	x	y	z	x	y	z
350	493	1040	375	498	1035	400	495	1040	425	497.5	1040	450	498	1040	475	492	1045	500	499	1045
350	480.5	1045	375	488	1040	400	477.5	1045	425	484.5	1045	450	485	1045	475	474.5	1050	500	486.5	1050
350	453.5	1050	375	476.5	1045	400	467.5	1050	425	471	1050	450	476	1050	475	464.5	1055	500	465	1055
350	423	1055	375	470	1050	400	458	1055	425	455	1055	450	462	1055	475	454.5	1060	500	456.5	1060
350	375	1050	375	456.5	1055	400	448	1060	425	447.5	1060	450	0	1060	475	440	1065	500	446	1065
350	352.5	1050	375	442.5	1060	400	437	1065	425	499	1065	450	433	1065	475	425	1070	500	439	1070
350	264.5	1055	375	380	1060	400	426	1070	425	430	1070	450	425.5	1070	475	417	1075	500	421.5	1075
350	240	1060	375	350.5	1055	400	397	1070	425	415	1075	450	416	1075	475	408	1080	500	406.5	1080
350	224.5	1065	375	254.5	1060	400	337.5	1065	425	400	1075	450	405	1080	475	396.5	1085	500	395	1085
350	212.5	1070	375	223.5	1065	400	247.5	1065	425	370.5	1070	450	390.5	1085	475	379	1090	500	385.5	1090
350	202.5	1075	375	204.5	1070	400	189.5	1070	425	299	1070	450	372.5	1085	475	357	1090	500	320	1090
350	194	1080	375	186	1075	400	151	1075	425	167.5	1070	450	350	1080	475	326.5	1085	500	300	1085
350	181.5	1080	375	116	1075	400	76	1075	425	136	1075	450	311	1075	475	302	1080	500	260.5	1080
350	152.5	1075	375	91.5	1070	400	57.5	1070	425	113.5	1080	450	270.5	1075	475	234.5	1075	500	214	1075
350	130	1070	375	74	1065	400	44.5	1065	425	75.5	1080	450	175	1070	475	156.5	1070	500	162.5	1070
350	110.5	1065	375	59	1060	400	30.5	1060	425	53	1075	450	149	1070	475	116.5	1065	500	130	1065
350	96.5	1060	375	38.5	1055	400	12	1055	425	40.5	1070	450	51.5	1070	475	91.5	1060	500	105.5	1060
350	77.5	1055	375	28.5	1050	400	4.5	1050	425	30.5	1065	450	28.5	1065	475	23	1055	500	72.5	1055
350	63.5	1050	375	20	1045				425	19	1060	450	0	1060					43.5	1050
350	49	1045	375	7	1040				425	2.5	1055								1.5	1045
350	37	1040																		
350	21	1035																		
350	9	1030																		

along X-axis and profiles of measurments along Y-axes of the grid net. (Table-3) and (Table-4).

3-5 : GENERATION OF DIGITAL TERRAIN MODEL (DTM).

Once the grid elevations are obtained, the actual terrain model may be generated. TWO Digital Terrain Model are generated – the(using SURFER package) from both sets of grid elevations obtained in step (3-4), (Fig-3 and Fig-4),(Note the likeness between both of the Digital Terrain Models).

4- THE ACCURACY OF GENERATED DTM.

4-1 The accuracy of the method:

Since Digital Terrain Model Systems either rely on the production of a regular grid of height points directly as from field or photogrammetric methods or such grid can be generated as in this study.So the accuracy may be assessed by comparison of height values derived from Contour maps with that of the photogrammetric or field method. The data obtained from such comparison will consist of height difference (v) residuals at the tested points. This data will provide the basis for the assessment of errors liable to occure (2,3).

To carry out such assessment the photogrammetric method for data accquisition was followed in this study using diaposetive of the verticalaerial photographs of the same area of the original contour map coverage in the WILD- B8S restitution instrument in the usual photogrammetric procedure for the measurements of the heights of the grid nodes layed on the original contour map in the stereomodel created in the restitution instrument.(Total of 21*21=441 node points (5)were measured (Table-5) and a Digital Terrian Model generated from these data (Fig-(5)) (Note the likeness of this DTM with the Fig-3 and Fig-4).

The accuracy of photogrammetrically measured terrian elevations depends on :Base :Height , B:H ratio , the flying heigh H and the accuracy of the stereoplotting machine on which the measurements are carried out. The expected accuracy of height measurements using wide angle photography- as in our case - will lie in the range of 1/5000 of the flying height depending on the type of the restitution instrument used, this will yeild to Root Mean Squar Error (RMSE) of the method (1).

In this study :

H =2142 m., RMSE = +0.43 m.

The accuracy of the derived elevations from the contour map is determined with the reference to the interrelated factors of: scale of the map, terrian slope and vertical interval which they form the basis of the establishment of RMSE values for such derived elevations. The normally accepted standard for elevations obtained from contour maps is about 3 times that which can be attained for measured heights

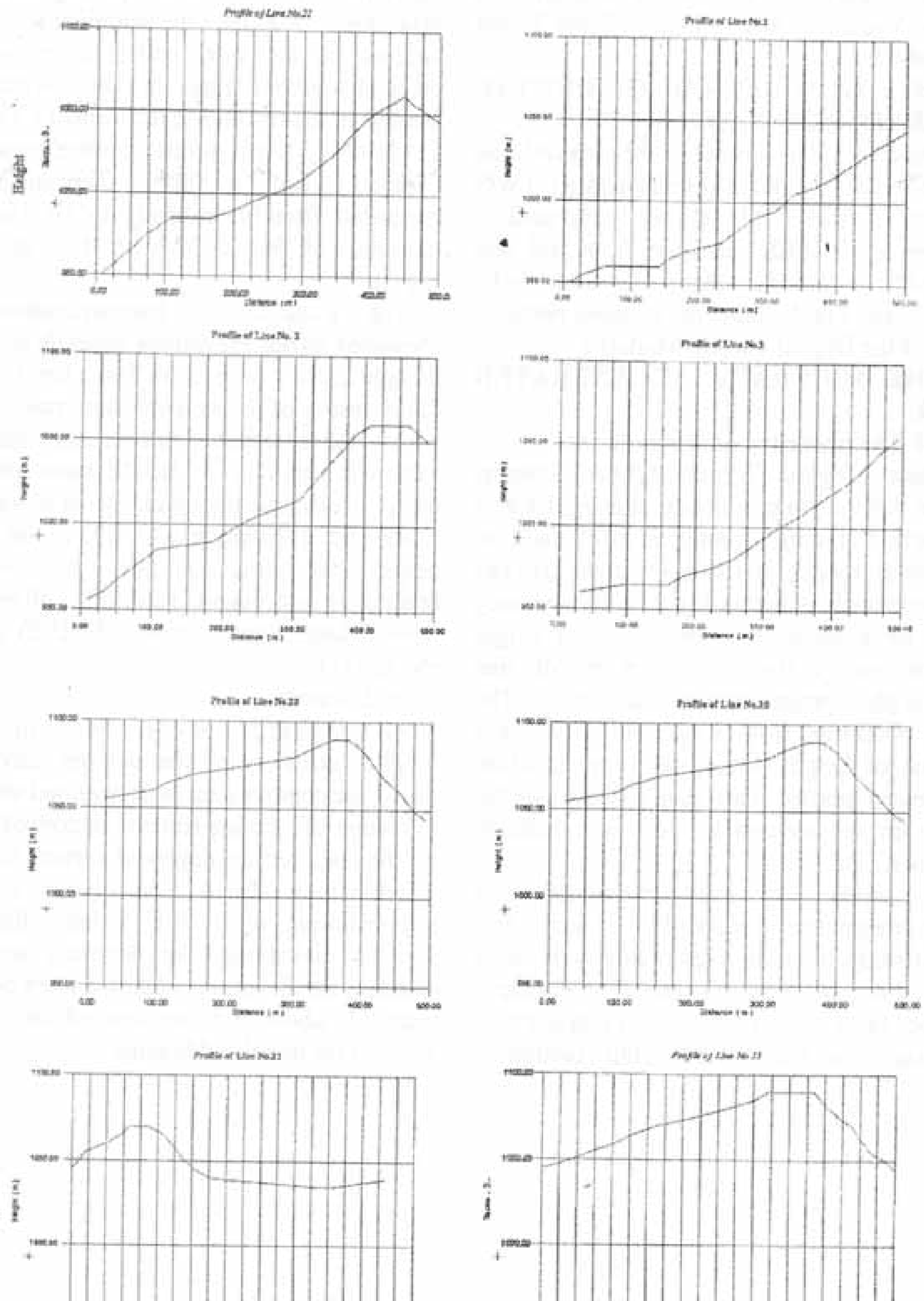


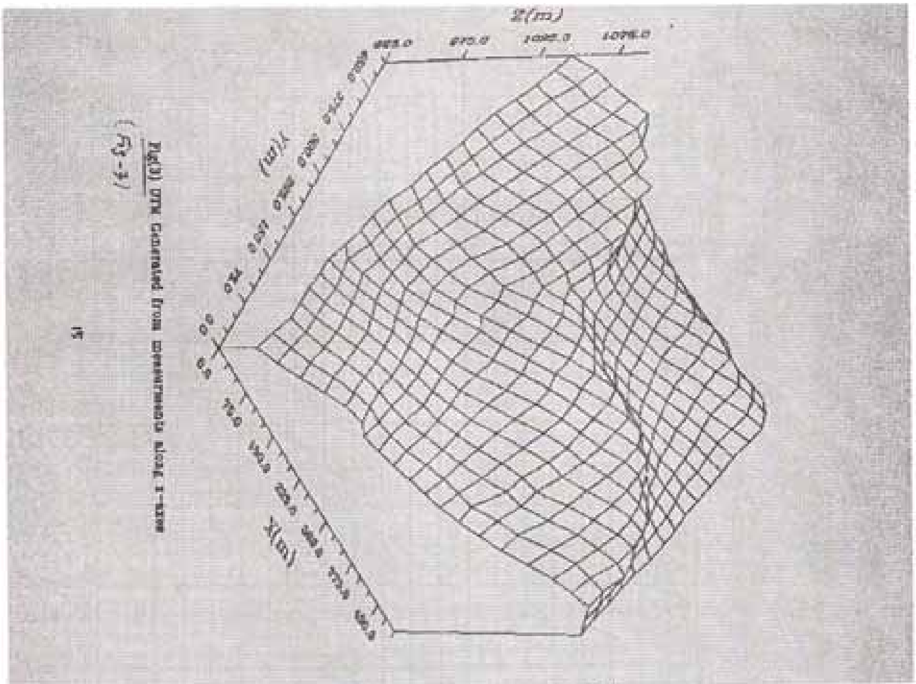
Fig. (2) Samples of profile along X and Y axis

(Table-3) Grid node elevations from profiles along X-axes.

500	1045.5	1056.0	1060.0	1066.5	1073.0	1067.0	1056.5	1046.0	1040.0	1039.0	1038.5	1038.0	1036.5	1038.0	1035.0	1035.0	1036.5	1038.0	1038.5	1041.0	1044.0
	1039.5	1048.5	1052.5	1061.0	1071.0	1069.0	1067.0	1055.0	1046.5	1041.5	1040.0	1040.0	1041.5	1042.5	1045.0	1045.0	1046.0	1049.0	1050.0	1050.0	1051.0
	1033.0	1037.5	1042.5	1051.5	1061.0	1064.5	1064.0	1069.5	1050.0	1043.5	1040.0	1040.0	1042.0	1046.5	1050.5	1055.0	1056.0	1055.0	1055.0	1057.0	1059.0
	1025.0	1029.0	1034.5	1042.0	1051.0	1056.0	1058.5	1064.5	1058.5	1046.0	1041.0	1040.5	1041.5	1045.0	1053.5	1062.0	1070.0	1070.0	1070.0	1070.0	1070.0
400	1017.0	1021.0	1024.5	1033.0	1042.0	1047.0	1050.0	1056.0	1059.5	1049.0	1041.0	1040.0	1041.0	1045.0	1051.0	1061.0	1069.0	1079.0	1079.0	1083.0	1085.0
	1010.0	1013.0	1016.5	1024.0	1034.5	1041.5	1043.0	1049.0	1054.0	1048.0	1041.0	1040.0	1041.0	1044.0	1049.5	1057.0	1068.0	1075.0	1085.0	1088.5	1091.0
	1006.0	1006.5	1007.5	1015.5	1024.5	1035.0	1036.5	1040.0	1044.0	1041.5	1037.8	1038.0	1041.5	1045.0	1050.0	1054.5	1065.0	1072.5	1080.0	1089.0	1093.5
	1000.0	1000.0	1000.0	1005.5	1016.5	1026.0	1031.0	1032.5	1035.0	1032.0	1035.0	1037.0	1040.5	1045.0	1050.0	1055.0	1062.5	1070.5	1075.5	1084.0	1090.0
300	993.0	994.0	993.5	998.5	1008.5	1017.8	1021.5	1024.5	1024.5	1032.5	1039.5	1041.0	1042.5	1046.0	1049.5	1056.0	1062.0	1070.0	1074.5	1079.5	1084.5
	989.0	988.0	986.8	991.5	997.0	1000.0	1006.5	1009.5	1024.0	1036.5	1045.5	1046.5	1047.0	1049.5	1053.0	1057.0	1063.0	1068.0	1074.5	1077.5	1082.0
	979.5	979.5	980.0	979.5	985.5	990.5	997.0	1011.0	1025.0	1035.5	1046.0	1051.5	1053.5	1055.5	1057.0	1059.5	1063.5	1068.0	1073.0	1076.0	1079.0
	974.5	975.0	976.5	978.5	982.5	986.0	994.5	1005.5	1019.0	1032.2	1046.0	1056.0	1065.0	1065.0	1065.0	1065.0	1066.5	1066.5	1071.0	1071.5	1075.5
200	972.5	972.5	973.0	975.0	978.5	986.5	998.0	1010.0	1018.5	1030.0	1041.8	1053.5	1064.5	1072.5	1075.0	1070.0	1069.0	1069.0	1070.0	1071.5	1072.5
	968.0	963.5	967.5	973.5	980.0	986.5	995.5	1005.5	1018.0	1031.0	1043.0	1052.5	1060.0	1069.0	1078.0	1078.5	1072.5	1069.5	1069.0	1071.0	1071.0
	962.0	965.0	969.5	975.0	982.5	989.5	995.5	1002.0	1012.0	1026.0	1039.0	1050.5	1057.0	1064.0	1074.0	1078.0	1075.0	1072.5	1070.0	1068.5	1069.0
	962.0	966.5	971.0	978.0	985.5	990.5	996.2	1001.0	1007.0	1019.0	1031.0	1043.5	1053.2	1058.5	1068.0	1075.0	1078.0	1078.0	1069.5	1066.5	1064.5
100	960.5	964.5	972.0	980.0	985.5	991.0	995.8	1000.0	1005.8	1013.5	1024.5	1036.0	1046.0	1050.0	1060.0	1071.0	1078.0	1080.0	1070.0	1062.6	1059.0
	960.5	963.8	971.6	978.8	985.6	990.0	994.0	998.5	1003.0	1009.5	1017.5	1027.5	1035.0	1038.5	1053.0	1064.0	1074.0	1079.0	1072.8	1060.5	1055.5
	959.5	963.3	969.5	977.5	983.5	987.5	989.5	993.0	999.2	1005.4	1011.5	1020.0	1030.0	1034.0	1045.5	1059.0	1066.5	1073.5	1072.5	1059.8	1052.0
	953.5	959.0	965.8	975.0	982.5	986.5	987.0	988.7	993.5	1000.0	1006.0	1010.0	1013.0	1024.0	1031.5	1047.0	1057.5	1060.8	1064.0	1056.5	1048.0
0	949.0	956.2	965.3	975.0	982.5	987.5	982.5	986.5	990.0	995.0	999.0	1003.5	1010.0	1017.5	1026.0	1037.8	1048.2	1054.5	1060.0	1052.5	1045.0
	0				100				200				300				400				500

(Table-4) Grid node elevations from profiles along Y-axes.

500	1045.0	1057.0	1059.5	1067.5	1073.0	1067.0	1056.0	1045.5	1040.0	1039.0	1038.0	1039.0	1035.0	1038.0	1036.5	1034.0	1037.5	1038.0	1038.5	1042.0	1045.0
	1040.0	1049.0	1053.0	1061.0	1071.0	1069.0	1067.0	1055.0	1045.5	1041.0	1039.0	1040.0	1039.0	1041.0	1046.0	1047.0	1046.0	1048.0	1050.0	1049.5	1052.0
	1032.5	1037.5	1043.0	1051.5	1061.5	1064.0	1064.0	1069.5	1050.0	1042.5	1041.0	1040.0	1041.0	1046.0	1050.0	1054.0	1056.0	1056.0	1055.0	1057.0	1059.0
	1024.5	1030.5	1033.5	1042.5	1051.0	1056.0	1057.5	1065.0	1057.5	1045.0	1040.5	1040.5	1041.0	1044.0	1052.0	1062.0	1070.0	1070.0	1070.0	1071.0	1068.5
400	1017.0	1021.0	1025.0	1033.5	1043.0	1048.0	1049.0	1056.0	1059.5	1048.0	1041.0	1041.0	1041.5	1044.0	1051.0	1061.0	1068.0	1077.0	1078.0	1083.5	1084.5
	1011.0	1014.0	1016.5	1025.5	1034.5	1041.5	1042.5	1049.0	1054.0	1048.0	1040.5	1041.0	1041.5	1044.0	1049.5	1057.0	1068.0	1075.0	1086.0	1088.5	1091.8
	1006.5	1005.5	1007.5	1015.0	1025.8	1034.0	1036.0	1040.0	1045.0	1042.0	1036.5	1039.0	1042.0	1045.0	1049.5	1054.5	1065.0	1072.0	1079.5	1089.0	1093.0
	1000.0	1000.0	1000.0	1006.0	1016.0	1026.0	1030.5	1032.5	1036.0	1033.0	1034.0	1038.0	1040.0	1044.0	1050.0	1056.0	1063.0	1069.0	1076.5	1084.0	1091.0
300	993.0	993.0	992.5	998.5	1009.0	1017.5	1020.5	1024.5	1025.0	1033.0	1040.5	1041.0	1043.0	1046.0	1049.0	1055.5	1061.5	1068.5	1074.5	1080.0	1085.0
	989.0	986.0	986.0	991.5	997.0	1000.0	1006.0	1010.0	1025.0	1036.0	1046.0	1047.0	1047.0	1050.0	1053.5	1056.5	1062.5	1067.0	1073.5	1077.5	1081.5
	980.5	979.5	978.5	980.0	986.0	992.0	998.0	1011.0	1026.0	1036.0	1046.0	1052.5	1054.0	1055.5	1057.0	1060.0	1064.0	1067.0	1073.0	1076.0	1078.0
	974.0	975.5	975.5	977.5	981.5	987.0	995.0	1005.5	1019.5	1031.5	1046.0	1056.0	1065.3	1065.0	1065.0	1065.0	1066.5	1067.0	1072.0	1071.0	1075.5
200	972.0	972.0	972.0	975.5	979.0	987.5	998.0	1010.0	1018.5	1030.0	1043.0	1054.0	1065.0	1072.0	1075.0	1071.0	1068.5	1068.0	1071.0	1072.0	1073.0
	968.5	965.0	968.0	974.0	980.0	987.5	994.5	1005.5	1018.5	1031.0	1042.0	1052.0	1060.0	1069.0	1078.5	1079.0	1072.0	1070.0	1069.0	1071.0	1071.0
	962.5	966.8	969.5	975.0	983.0	990.0	996.0	1003.5	1012.5	1026.0	1039.0	1050.5	1057.0	1064.0	1073.5	1079.0	1075.0	1072.5	1070.0	1069.5	1068.5
	961.5	966.8	970.0	978.0	985.0	990.5	996.0	1001.5	1008.0	1019.6	1030.5	1044.0	1053.0	1057.5	1068.0	1076.0	1079.0	1078.0	1069.8	1067.0	1064.5
100	960.5	964.5	970.5	980.0	986.1	990.5	996.0	1000.5	1006.0	1013.5	1024.5	1036.5	1046.0	1050.0	1060.0	1071.0	1077.5	1081.0	1070.2	1062.5	1059.5
	960.5	963.0	971.0	978.5	985.5	990.0	993.0	997.5	1002.5	1009.5	1017.5	1028.0	1034.5	1038.5	1054.0	1064.0	1074.0	1079.0	1074.0	1059.0	1054.5
	960.0	963.0	968.0	977.0	984.5	987.5	989.0	993.0	999.5	1005.5	1011.5	1020.0	1029.0	1034.0	1044.5	1059.5	1067.0	1073.5	1071.5	1060.0	1052.0
	953.0	959.5	966.0	975.0	982.5	987.0	984.5	988.5	993.5	1000.0	1006.0	1010.0	1011.5	1024.5	1031.0	1047.0	1058.0	1061.5	1064.0	1056.0	1048.0
0	948.5	957.2	969.0	974.0	982.0	987.0	982.0	986.0	990.0	994.0	999.5	1003.5	1009.5	1017.0	1025.0	1037.5	1048.0	1054.0	1060.0	1053.0	1044.5
	0				100				200				300				400				500



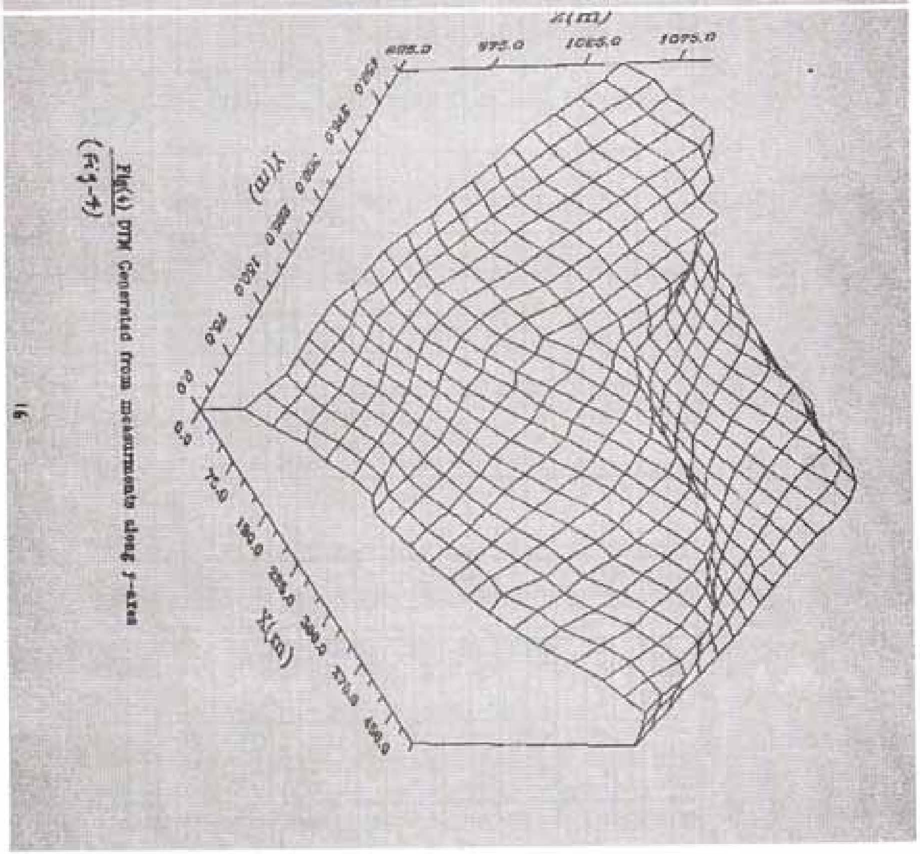


Fig.(3) DTM Generated from measurements along X-axis

Fig.(4) DTM Generated from measurements along Y-axis

(Table-5) Grid node elevations from Photogrammetric method.

500	1045.8	1056.7	1060.0	1067.5	1073.0	1067.0	1056.0	1046.0	1039.5	1039.5	1038.0	1038.0	1035.6	1038.0	1036.0	1034.0	1037.0	1038.0	1038.0	1041.8	1044.5
	1040.2	1049.8	1053.5	1062.0	1071.0	1068.0	1067.0	1055.0	1046.0	1041.1	1039.0	1040.2	1040.3	1041.2	1045.8	1046.0	1046.0	1047.8	1049.0	1049.0	1051.0
	1033.0	1038.0	1043.0	1052.5	1062.5	1064.5	1065.0	1070.0	1050.0	1042.5	1040.0	1040.0	1041.8	1046.0	1049.0	1054.0	1055.0	1055.0	1055.0	1057.0	1059.2
	1025.0	1030.5	1035.0	1042.8	1051.6	1056.0	1058.0	1065.3	1057.0	1045.0	1041.0	1041.0	1041.1	1044.0	1052.4	1062.5	1070.0	1070.0	1070.0	1070.0	1069.0
400	1017.5	1021.0	1025.2	1034.0	1042.8	1048.4	1049.1	1056.1	1059.0	1048.0	1041.2	1041.2	1041.0	1044.0	1050.5	1060.0	1067.5	1077.8	1078.2	1084.0	1085.0
	1010.5	1014.0	1017.0	1025.6	1035.0	1042.2	1043.0	1049.1	1054.6	1048.3	1041.5	1040.0	1040.8	1043.6	1049.0	1056.0	1067.5	1075.0	1086.0	1088.6	1091.8
	1006.5	1006.0	1007.0	1015.6	1025.8	1034.0	1035.0	1040.8	1045.0	1042.0	1037.8	1038.2	1041.6	1044.5	1049.1	1054.6	1065.0	1072.6	1080.0	1089.2	1093.0
	1000.0	1000.0	1000.0	1005.6	1016.0	1025.8	1031.0	1032.0	1035.6	1032.0	1034.0	1037.0	1040.2	1044.5	1049.5	1054.5	1062.4	1070.0	1075.8	1084.4	1091.0
300	993.0	993.0	993.1	999.0	1009.5	1018.5	1021.0	1025.0	1025.0	1033.0	1040.0	1041.0	1042.0	1045.0	1049.0	1055.5	1061.8	1069.2	1074.5	1079.5	1085.0
	989.0	986.8	986.8	992.0	998.0	1000.0	1007.0	1010.0	1025.0	1036.5	1046.0	1046.0	1046.5	1049.5	1052.5	1056.3	1063.1	1067.5	1074.6	1077.3	1081.5
	980.5	980.0	979.0	980.0	985.8	991.5	997.5	1011.8	1026.0	1036.5	1046.2	1052.0	1054.0	1055.0	1056.0	1058.7	1063.0	1067.5	1072.2	1075.0	1078.2
	974.0	975.8	975.8	978.5	982.0	986.5	994.5	1006.0	1019.1	1032.2	1046.0	1056.0	1065.8	1065.8	1065.8	1065.5	1066.0	1066.5	1071.0	1071.0	1075.0
200	972.0	972.5	972.5	976.5	978.8	987.0	998.0	1010.0	1018.3	1031.0	1041.8	1054.0	1065.0	1072.2	1075.0	1070.6	1068.0	1068.2	1070.8	1071.5	1073.0
	968.0	965.0	967.0	973.4	980.0	987.0	995.2	1006.0	1017.8	1031.8	1043.0	1052.0	1060.0	1068.4	1078.0	1079.0	1072.0	1069.0	1069.5	1071.5	1071.5
	963.0	966.0	969.0	975.2	983.0	990.0	996.0	1003.0	1012.1	1027.0	1039.2	1051.3	1056.6	1063.5	1073.2	1078.6	1075.8	1072.3	1070.0	1070.0	1069.5
	961.8	967.5	970.6	977.5	985.9	990.7	996.4	1001.0	1007.6	1020.5	1031.0	1044.8	1054.0	1057.9	1067.3	1075.6	1078.2	1078.0	1069.8	1067.3	1065.2
100	961.5	964.8	971.1	980.5	986.1	991.0	996.0	1000.5	1006.0	1014.2	1024.8	1036.7	1046.0	1050.5	1059.6	1070.3	1077.9	1081.3	1070.2	1063.3	1060.0
	961.5	963.4	971.2	978.8	985.5	990.5	993.8	998.0	1003.4	1010.0	1017.8	1027.3	1034.8	1038.0	1053.0	1063.5	1073.2	1078.8	1073.8	1060.5	1055.2
	960.0	963.0	968.8	977.0	984.5	988.1	989.0	993.0	999.8	1005.6	1011.5	1021.0	1030.0	1034.0	1046.0	1060.0	1067.0	1074.0	1072.8	1060.6	1052.5
	953.7	959.6	965.0	974.4	982.8	987.1	985.8	988.0	993.0	1000.1	1006.6	1010.5	1011.5	1025.3	1031.0	1046.0	1058.0	1061.8	1064.5	1057.0	1048.7
0	949.0	956.8	969.3	974.0	982.7	987.8	982.0	986.3	989.8	994.2	999.4	1004.0	1009.0	1017.0	1025.1	1037.2	1048.0	1054.5	1060.3	1053.0	1045.0
	0				100				200				300				400				500

(Table-6) Residuals (Elevations from X-axes profiles-photogrammetric elevations)

500	-0.3	-0.7	0.0	-1.0	0.0	0.0	0.5	0.0	0.5	0.5	0.5	0.0	0.9	0.0	-1.0	1.0	-0.5	0.0	0.5	-0.8	-0.5
	-0.7	-1.3	-1.0	-1.0	0.0	1.0	0.0	0.0	0.5	0.4	1.0	0.0	1.2	1.3	-0.8	-1.0	0.0	1.0	1.0	1.0	0.0
	0.0	-0.5	-0.5	-1.0	-1.5	0.0	-1.0	-0.5	0.0	1.0	0.0	0.0	0.2	0.5	1.5	1.0	1.0	0.0	0.0	0.0	-0.2
	0.0	-1.5	1.5	-0.8	-0.6	0.0	0.5	-0.8	1.5	1.0	0.0	-0.5	0.4	1.0	1.1	-0.5	0.0	0.0	0.0	0.0	1.0
400	0.0	0.0	-0.7	-1.0	-0.8	-1.0	0.9	-0.1	0.5	1.0	-0.2	0.0	0.2	1.0	0.5	1.0	1.5	1.2	0.8	-1.0	0.0
	-0.5	-1.0	-0.5	-1.6	-0.5	-0.7	0.0	-0.1	-0.6	-0.3	-0.5	0.0	0.2	0.4	0.5	1.0	0.5	0.0	-1.0	-0.1	-0.8
	-0.5	-0.5	0.5	-0.1	-1.3	1.0	0.9	-0.8	-1.0	-0.5	0.0	1.0	-0.1	0.5	0.9	-0.1	0.0	-0.1	0.0	-0.2	0.5
	0.0	0.0	0.0	-0.1	0.5	0.2	0.0	0.5	-0.6	0.0	1.0	0.0	0.3	0.5	0.5	0.5	0.1	0.5	-0.3	-0.4	-1.0
300	0.0	1.0	0.4	-0.5	-1.0	-0.7	0.5	-0.5	-0.5	-0.5	-0.5	0.0	0.5	1.0	0.5	0.5	0.2	0.8	0.0	0.0	-0.5
	0.0	1.2	0.0	-0.5	-1.0	0.0	-0.5	-0.5	-1.0	0.0	-0.5	0.5	0.5	0.0	0.5	0.7	-0.1	0.5	-0.1	0.2	0.5
	-1.0	-0.5	1.0	-0.5	-0.3	-1.0	-0.5	-0.8	-1.0	-1.0	-0.2	-0.5	-0.5	0.5	1.0	0.8	0.5	0.5	0.8	1.0	0.8
	0.5	-0.8	0.7	0.0	0.5	-0.5	0.0	-0.5	-0.1	0.0	0.0	0.0	-0.8	-0.8	-0.8	-0.5	0.5	0.0	0.0	0.5	0.5
200	0.5	0.0	0.5	-1.5	-0.3	-0.5	0.0	0.0	0.2	-1.0	0.0	-0.5	-0.5	0.3	-0.2	-0.6	1.0	0.8	-0.8	0.0	-0.5
	0.0	-1.5	0.5	0.1	0.0	-0.5	0.3	-0.5	0.2	-0.8	0.0	0.5	0.0	0.6	0.0	-0.5	0.5	0.5	-0.5	-0.5	-0.5
	-1.0	-1.0	0.5	-0.2	-0.5	-0.5	-0.5	-1.0	-0.1	-1.0	-0.2	-0.8	0.4	0.5	1.0	-0.6	-0.8	0.2	0.0	-1.5	-0.5
	0.2	-1.0	0.4	0.5	-0.4	-0.2	-0.2	0.0	-0.6	-1.5	0.0	-1.3	-0.8	0.6	0.7	-0.6	-0.2	0.0	-0.3	-0.8	-0.7
100	-1.0	-0.3	0.9	-0.5	-0.6	0.0	-0.2	-0.5	-0.2	-0.7	-0.3	-0.7	0.0	-0.5	0.4	0.7	0.1	-1.3	0.2	-0.7	-1.0
	-1.0	0.4	0.4	0.0	0.1	-0.5	0.2	0.5	-0.4	-0.5	-0.3	0.2	0.2	0.5	0.0	0.5	0.8	0.2	-1.0	0.0	0.3
	-0.5	0.3	0.7	0.5	-1.0	-0.6	0.5	0.0	-0.6	-0.2	0.0	-1.0	0.0	0.0	-0.5	-1.0	-0.5	-0.5	-0.3	-0.8	-0.5
	-0.2	-0.6	0.8	0.6	-0.3	-0.6	1.2	0.7	-0.5	-0.1	-0.6	-0.5	1.5	-1.3	0.5	1.0	-0.5	-0.1	-0.5	-0.5	-0.7
0	0.0	-0.6	0.0	1.0	-0.4	-0.3	0.5	0.2	0.2	0.8	-0.4	-0.5	1.0	0.5	0.9	0.6	0.2	0.0	-0.3	-0.5	0.0
	0				100				200				300				400				500

(Table-7) Residuals (Elevations from Y-axes profiles-photogrammetric elevations)

500	-0.8	0.3	0.5	0.0	0.0	0.0	0.0	-0.5	0.5	-0.5	0.0	1.0	-0.6	0.0	0.5	0.0	0.5	0.0	0.5	0.2	0.5
	-0.2	-0.8	-0.5	-1.0	0.0	1.0	0.0	0.0	-0.5	-0.1	0.0	-0.2	-1.3	0.0	0.2	1.0	0.0	0.2	1.0	0.5	1.0
	-0.5	-0.5	0.0	-1.0	-1.0	-0.5	-1.0	-0.5	0.0	0.0	1.0	0.0	-0.8	0.0	1.0	0.0	1.0	1.0	0.0	0.0	-0.2
	-0.5	0.0	0.5	-0.3	-0.6	0.0	-0.5	-0.3	0.5	0.0	-0.5	-0.5	-0.1	0.0	-0.4	-0.5	0.0	0.0	0.0	1.0	-0.5
400	-0.5	0.0	-0.2	-0.5	0.2	-0.4	-0.1	-0.1	0.5	0.0	-0.2	-0.2	0.5	0.0	0.5	1.0	0.5	-0.8	-0.2	-0.5	-0.5
	0.5	0.0	-0.5	-0.1	-0.5	-0.7	-0.5	-0.1	-0.6	-0.3	-1.0	1.0	0.7	0.4	0.5	1.0	0.5	0.0	0.0	-0.1	0.0
	0.0	-0.5	0.5	-0.6	0.0	0.0	0.4	-0.8	0.0	0.0	-1.3	0.8	0.4	0.4	0.4	-0.1	0.0	-0.6	-0.5	-0.2	0.0
	0.0	0.0	0.0	0.4	0.0	0.2	-1.0	0.5	0.4	1.0	0.0	1.0	-0.2	-0.5	0.5	1.5	0.6	-1.0	0.7	-0.4	0.0
300	0.0	0.0	-0.6	-0.5	-0.5	-1.0	-0.5	-0.5	0.0	0.0	0.5	0.0	1.0	1.0	0.0	0.0	-0.3	-0.7	0.0	0.5	0.0
	0.0	-0.8	-0.8	-0.5	-1.0	0.0	-1.0	0.0	0.0	-0.5	0.0	1.0	0.5	0.5	1.0	0.2	-0.6	-0.5	-0.9	0.2	0.0
	0.0	-0.5	-0.5	0.0	0.2	0.5	0.5	-0.8	0.0	-0.5	-0.2	0.5	0.0	0.5	1.0	1.3	1.0	-0.5	0.8	1.0	-0.2
	0.0	-0.3	-0.3	-1.0	-0.5	0.5	0.5	-0.5	0.4	-0.7	0.0	0.0	-0.5	-0.8	-0.8	-0.5	0.5	0.5	0.1	0.0	0.5
200	0.0	-0.5	-0.5	-1.0	0.2	0.5	0.0	0.0	0.2	-1.0	1.2	0.0	0.0	-0.2	0.0	0.4	0.5	-0.2	0.2	0.5	0.0
	0.5	0.0	1.0	0.6	0.0	0.5	-0.7	-0.5	0.7	-0.8	-1.0	0.0	0.0	0.6	0.5	0.0	0.0	1.0	-0.5	-0.5	-0.5
	-0.5	0.8	0.5	-0.2	0.0	0.0	0.0	0.5	0.4	-1.0	-0.2	-0.8	0.4	0.5	0.3	0.4	-0.8	0.2	0.0	-0.5	-1.0
	-0.3	-0.7	-0.6	0.5	-0.9	-0.2	-0.4	0.5	0.4	-0.9	-0.5	-0.8	-1.0	-0.4	0.7	0.4	0.8	0.0	0.0	-0.3	-0.7
100	-1.0	-0.3	-0.6	-0.5	0.0	-0.5	0.0	0.0	0.0	-0.7	-0.3	-0.2	0.0	-0.5	0.4	0.7	-0.4	-0.3	0.0	-0.8	-0.5
	-1.0	-0.4	-0.2	-0.3	0.0	0.0	-0.8	-0.5	-0.9	-0.5	-0.3	0.7	-0.3	0.5	1.0	0.5	0.8	0.2	0.2	-1.5	-0.7
	0.0	0.0	-0.8	0.0	0.0	-0.6	0.0	0.0	-0.3	-0.1	0.0	-1.0	-1.0	0.0	-1.5	-0.5	0.0	-0.5	-1.3	-0.6	-0.5
	-0.7	-0.1	1.0	0.6	0.0	-0.1	-0.7	0.5	0.5	-0.1	-0.6	-0.5	0.0	-0.8	0.0	1.0	0.0	-0.3	-0.5	-1.0	-0.7
0	-0.5	0.4	-0.3	0.0	-0.7	-0.8	0.0	-0.3	0.2	-0.2	0.1	-0.5	0.5	0.0	-0.1	0.3	0.0	-0.5	-0.3	0.0	-0.5
	0				100				200				300				400				500

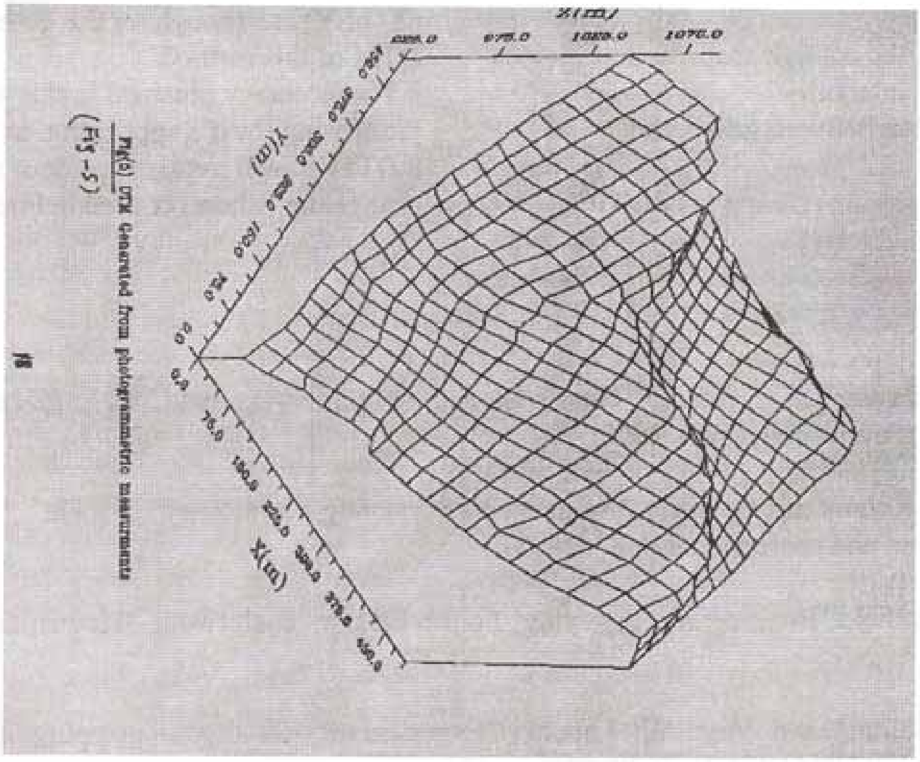


Fig.(5) DTM Generated from photogrammetric measurements

in the photogrammetric method (1) Above statement results to:

RMSE of heights derived from contour maps =3*(+ 0.43) =+1.29 m

4-2: Assesement of the case study.

Based on the comparison of height values (i.e.-residuals)derived from photogrammetric method (Table-5) with that derived one from profiles along X-axes (Table-3) and of profiles along Y-axes (Table-4), Two sets of residuals are obtained (Table-6 and Table-7)

RMSE Computed from (Table-6) = +0.64 m

RMSE Computed from (Table-7) = +0.49 m

It is very clear that the computed RMSE in both directions are falling within the primier stages of the range of the acceptable accuracy of the method.

5-CONCLUSIONS

1.Photogrammetric methods of data acquisition are the only practical means of acquiring high quality data over large area of terrain.

2.DTM gives a true and comperehensive visualisation of the area rather than contour maps,this would be of wide spread interest to engineers, landscape architects,planners,…etc.

3.DTM'S are useful tools in both design and excution of many Civil Engineering projects:Roads ,Canals ,Dam locations ,etc…

4.The technology employed is simple compared to the sophisticated types of automatic line followings.

5.The accuracy of the method is dependent on:
a-Scale of the contour map.
b-Vertical interval.
c-Seperation between grid nodes.

6.Measurements along one of the grid axis (X or Y) are enough for the generation of the DTM of this method
7.The accuracy,obtained in this study, is very promising for it's application in the future.
8.DTM'S will replace contour maps in very near future wherever used before.

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پەسەندكرا لە ٢٠٠٠/٤/١٦ دا

گورینی پلانە کەنتوریە کان بو DTM

قباد زکی هناری

بە شی شارستاني-کولیژی ئەندازیاری

زانکوی صلاح الدین – هە ولیر

کورتە

پیك هینانی Digital Terrain Model (DTM) بە چارە سەرکردنیکی ژمارەیی، ریگایکی نویٓ یە بو بە دیار خستنی شیوازی رووی زەووی. بۆ گورینی ئەو پلانە کەنتووریانەی هەن بو DTM بە چەند ریگایەك جیبە جی دە کریت.

ئەم ریگایە کە لەم توژینەوە بە کار هاتووە بریتیە لە :-

دانانی تۆریکی چوار گوشەیی لە سەر پلانە کەنتوریەکە و پیوانی پوتانی ئەم خالانەی کە هێلە کەنتوریەکان (کە بەرزایەتیان (Z) زانراوە) لەگەل پوتانی X و پوتانی Y تورەکە دەبرن.

لەم زانیاریانە دەتوانریت (Profile) لەسەرهەر یەك لە هیلەکانی تورەکە لە سەر پوتانی وپوتانی Y دروست بکریت وەلەمە بەرزایەتی سووچەکانی چوار گوشەکانی تۆرەکە بدوزریتەوە، وە بە هۆی بەرنامەییکی تایبەت لە کومبیوتر بکریت بە (DTM) .لەم توژینەوە ئەم ریگایە بەراوورد کرا بە ریگای فوتوغرامتری بو بەدی هینانی (DTM) وەئەنجامەکانی زۆر بە باشی هەلسەنگیرا.

ئەم ریگایە زۆر ئاسانە بو بەدي هینانی DTM لەو پلانە کەنتوریانەی کەهەن وە DTM شیوازی رووی زەوی زۆر بەئاشکرا وە بە بەرامبەر پیشلن دەدات کە ئەمە زۆر ئاسان نیە کە دیاري بکریت لە پلانی کەنتوري بەتەنها. وە دە بینت DTM شوینی پلانە کەنتوریەکان بگریتەوە لەدوا رۆژیکی نزیك و بەکار بهیندریت لە پروژە ئەندازیاریەکان لە رووی نەخشە دانان و جی بە جی کردنی.

تحويل الخرائط الكنتورية الى DTM

قباد زكي هناري

القسم المدني – كلية الهندسة

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الخلاصة

يعتبر Digital Terrain Model (DTM) طريقة حديثة للتمثيل الرقمي لطبيعة سطح الارض. هناك عدة طرق للقيام بذلك منها تحويل الخرائط الكنتورية الموجودة الى DTM.
وتتلخص الطريقة بوضع شبكة من المربعات على الخارطة الكنتورية وقياس الاحداثيات لنقاط تقاطع الخطوط الكنتورية مع الاحداثي X و الاحداثي Y لهذه الشبكة، ومن هذه المعلومات يمكن اعداد المقاطع الطولية لهذه المسارات ومن هذه المقاطع يمكن الحصول على ارتفاعات اركان شبكة المربعات ثم تحول هذه الارتفاعات بواسطة برامج خاصة الى DTM للمنطقة في الحاسبات الالكترونية.
تم في البحث مقارنة هذه الطريقة بطريقة الفوتوغرامتري لجمع المعلومات لاعداد DTM وكانت النتائج جيدة جداً ومشجعة، و تعتبر هذه الطريقة سهلة التطبيق وتعطي نظرة دقيقة وشاملة للمنطقة والتي لايمكن الحصول عليها من الخرائط الكنتورية بسهولة. وربما يحل DTM محل الخرائط الكنتورية في المستقبل القريب، لاغراض التصميم والتنفيذ لمشاريع الهندسة المدنية.