Cost Optimized Trends in Contouring using Hand-Held GPS

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Abstract- This paper reveals the use of hand – held Global Positioning System for the purpose of contouring. In this research, major stress is laid on the use of cheaper and accurate GPS along with the conventional instruments. A hand – held GPS is used to determine the position of the particular station and the corresponding reduced level of the occupied station is determined with respect to a Temporary Bench Mark. The data collected is interpolated using Surfer 8.0 software. The profile of the surface generated was found to be in accordance with the actual topography of the site.

The accuracy of the hand – held GPS is also taken into account from the data collected from some of the researches undertaken by various organizations. Thus, the use of hand – held GPS along with the cheaper conventional leveling instruments for the purpose of contouring prove to be very cost effective and considerably accurate.

I. INTRODUCTION

GPS is a satellite navigation system designed to provide instantaneous position, velocity and time information almost anywhere on the globe at any time, and in any weather. (NAVSTAR GPS stands for the *NAV*igation *S*atellite *T*iming *A*nd *R*anging Global Positioning System).

Global Positioning System satellites transmit signals to equipment on the ground. GPS receivers passively receive satellite signals; they do not transmit. GPS receivers require an unobstructed view of the sky, so they are used only outdoors and they often do not perform well within forested areas or near tall buildings. GPS operations depend on a very accurate time reference, which is provided by atomic clocks at the U.S. Naval Observatory. Each GPS satellite has atomic clocks on board. High precision GPS observations with accuracy up to centimeter and even millimeter can now be achieved effectively for 24 hours a day and anywhere on the earth's surface. Four GPS satellite signals are used to compute positions in three dimensions and the time offset in the receiver clock.

GPS has three distinct segments:

The Space Constellation (a system of satellites).
The Control Segment (a network of ground stations).
The User Segment (Applications of GPS).
All GPS positions are based on measuring the distance from the satellite to the GPS receiver on the Earth. The GPS receiver can determine the distance to each satellite.

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Obtaining a position using a GPS:

The basic idea is that of Resection, which many surveyors use in their daily work. From the distance to one satellite we know that the position of the receiver must be at some point on the surface of an imaginary sphere that has it's origin at the satellite. By intersecting three imaginary spheres the receiver position can be determined.

GPS Co-ordinate System:

The GPS uses a Geodesic Co-ordinate system for measurements. It uses the World Geodetic System 1984.The system is also called as the WGS-84 geodetic system because it is based on the WGS-84 ellipsoid mode.

A point on the surface of the earth can be defined by using Latitude, Longitude and Ellipsoidal height. An alternative method for defining the position of a point is the Cartesian coordinate system, using distances in the X, Y and Z axes from the origin or the center of the spheroid. This is the method primarily used by the GPS for defining the location of a point in space.

II. CONTOURING USING HAND – HELD GPS AND DUMPY LEVEL

Determination of position of points:

Firstly, for carrying out contour work on the field, a probable site is chosen. Now, a temporary Bench Mark is fixed. The corresponding reading of the position of the point is taken by the hand – held GPS. Now, the instrument station is fixed and the position noted. Points are taken randomly on the field; the position i.e. latitude and longitude (in degrees) or easting and northing (in metres) values of the points are taken by the GPS, the distance between the points varying from 5 to 15 metres. The distance between the points is taken depending upon the undulations in the field. For approximately leveled surface the distance between points is increased for the ease of the work.

Determination of Reduced Level (elevation) of the points:

At the time of recording the position, the Reduced Level (R.L) of the point is taken by the staff reading using the Dumpy Level, the least count of leveling-staff being 5 mm.

III. DATA INTERPRETATION AND PLOTTING

The position recorded by the hand – held GPS is measured in latitude and longitude in degrees, also the easting and northing of the point is also obtained in

metres. The points are numbered appropriately.

The corresponding staff readings by the dumpy level are recorded. The position recorded by the GPS and the elevation by the dumpy level are fed in the form of Microsoft Excel Worksheet of type *.xls on Surfer 8.0 software. The data is stored in the form of *.dat file. Once the database is been created, a grid file is to be created by the provided options of the software. The grid file created is in the form of *.grd. Along with the creation of *.grd file, the information of the surface i.e. the maximum and minimum coordinates, the cut and fill volume, the maximum and minimum elevation, the total surface area, etc. is being computed by creating a database of the grid information. The various perspective views of the surface and maps that can be obtained by contour map, base map, post map, image map, vector map, shaded relief map, wireframe map, surface map, etc.

The various maps obtained admit the close agreement of the actual topography and the plotted profile of the site. Thus, the results obtained give the actual view of the site.

The table below gives the values of the data collected by the Dumpy Level and the Hand – held GPS. The values of Easting and Northing are in metres. The Reduced Level of Temporary Bench Mark is taken as 100 metres.

S.no	Easting	Northing	Elevation
1	745550.4	2568772	100.74
2	745553.9	2568765	100.845
3	745567.6	2568763	101.505
4	745572.8	2568759	102.54
5	745581.3	2568761	102.69
6	745586.3	2568765	102.055
7	745593.1	2568773	101.1
8	745594.8	2568773	99.395
9	745600	2568765	101.7
10	745608.4	2568771	99.39
11	745608.4	2568773	100.175
12	745606.8	2568765	101.73
13	745617	2568769	100.795
14	745618.6	2568779	99.945
15	745630.5	2568777	100.455
16	745632	2568790	99.845
17	745625	2568801	99.285
18	745613.2	2568793	99.34
19	745604.8	2568782	99.455
20	745592.7	2568791	99.3
21	745579.4	2568772	100.495
22	745577.5	2568785	99.365
23	745570.4	2568802	99.27
24	745561.9	2568796	99.615
25	745558.5	2568800	100.545
26	745553.3	2568803	101.83
27	745558.2	2568814	101.985
28	745566.8	2568813	100.03
29	745582	2568824	99.52
30	745613	2568802	99.995
31	745630	2568812	99.905
32	745633.6	2568799	99.695
33	745645.4	2568805	99.665
34	745657.6	2568794	99.585
35	745642.4	2568781	100.47
36	745664.7	2568776	100.55
37	745686.4	2568804	99.69
38	745682.7	2568820	101.3
39	745651.8	2568831	101.205
40	745636.3	2568840	100.725
41	745607.3	2568837	99.835
42	745598.6	2568852	99.405
43	745569.7	2568840	100.055
44	745564.7	2568837	100.765
45	745561.2	2568839	101.985
46	745566.2	2568848	101.565
47	745577.9	2568861	99.445
48	745576	2568876	102.485
49	745585.9	2568896	102.585
50	745636.6	2568825	101.3
51	745644.5	2568864	100.285
52	745630.6	2568877	99.8
53	745644	2568890	99.99
54	745651	2568882	100.61
55	745659.8	2568868	100.765
56	745676.8	2568866	100.95
57	745697	2568887	101.21
58	745678	2568900	100.81
59	745659.4	2568890	100.605
60	745669.1	2568816	100.835
61	745691.3	2568817	101.155
62	745698.3	2568809	100.46
63	745680	2568778	101.365
64	745666.5	2568770	101.75
65	745678.2	2568785	100.33
66	745704.2	2568763	102.04
67	745717.9	2568760	102.86
68	745717.6	2568776	101.7
69	745707	2568795	100.85
70	745741.7	2568764	101.53
71	745760.9	2568740	102.53
72	745764.2	2568748	101.7
73	745774.2	2568761	102.62
74	745782.9	2568750	103
75	745770.1	2568801	102.09
76	745659.4	2568892	99.79
77	745676.2	2568903	99.8
78	745678.1	2568896	100.92
79	745691.7	2568898	100.28
80	745707.2	2568889	101.56

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81	745719	2568895	102
82	745730.8	2568904	101.505
83	745722.2	2568909	101
84	745715.1	2568928	101.065
85	745710	2568924	100.105
86	745693.1	2568915	99.9
87	745694.6	2568928	101.455
88	745704.7	2568935	102.05
89	745691.2	2568929	101.86
90	745677.7	2568920	100.86
91	745669.2	2568918	100.505
92	745662.5	2568907	100.865
93	745648.8	2568914	100.815
94	745637	2568904	100.305
95	745659.3	2568897	99.81
96	745642.4	2568886	99.75
97	745618.5	2568886	99.77
98	745618	2568917	100.475
99	745611.1	2568919	101.43
100	745597.8	2568898	99.81
101	745590.9	2568900	103.07
102	745587.7	2568892	102.95
103	745592.9	2568885	99.78
104	745586.2	2568876	99.9
105	745645.1	2568929	100.7
106	745650.2	2568927	99.8
107	745650.2	2568930	99.76
108	745650.1	2568938	100.8
109	745631.4	2568928	100.805
110	745660.5	2568929	99.755

3 - D Wireframe map:

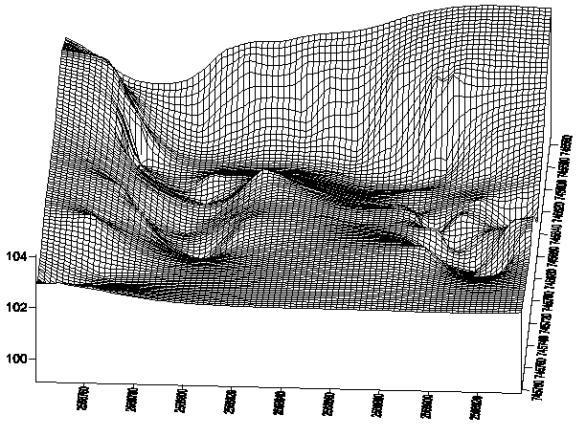
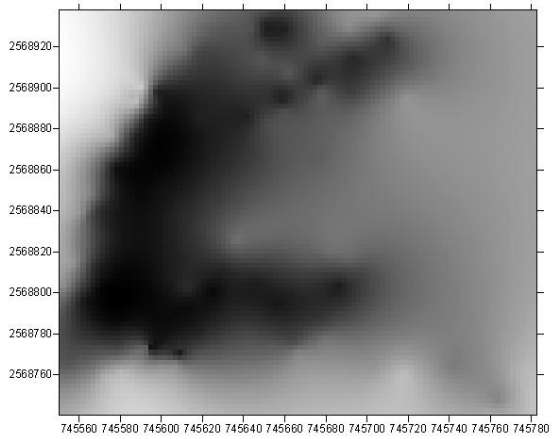
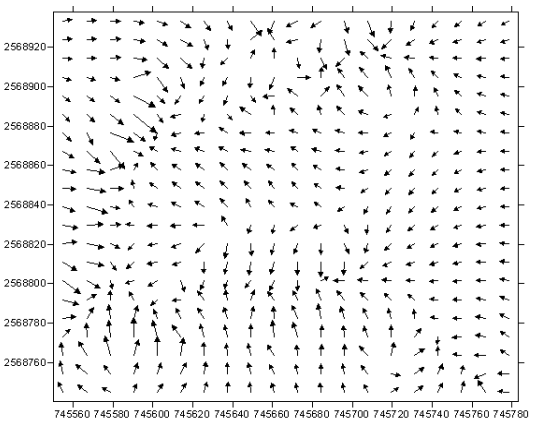


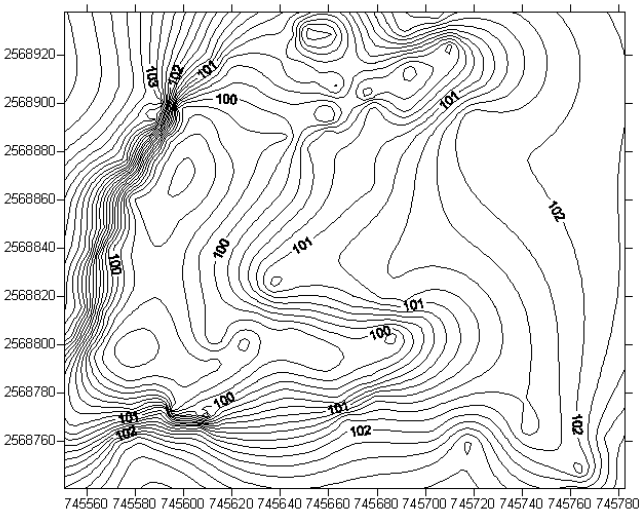
Image map:



Vector map:



Contour map of the site:



RESULTS OF THE RESEARCH

Least count of Levelling Staff: 5mm.

Accuracy of hand – held GPS: 5 – 7 m.

Details of contouring done at Neori Hills area in Bhopal conducted by a survey team:

Total area: 380 acres.

Total number of days: 46.

Details of manpower engaged:

Engineers: 3.

Skilled labour: 3.

Unskilled labour: 3.

Details of contouring done at the site:

Total area: 11.3531 acres.

Time: 5 hours.

Details of manpower engaged:

Engineers: 2

Skilled labour: 1.

Relative comparison of both the field works:

Time required: 64 % less.

Labour cost: 67 % less.

Thus, from the above results it is justified that there is a significant reduction in the time for the total fieldwork and the cost is also considerably reduced. In addition to this, the procedural simplicities are attained which eliminates the laborious Grid laying work in the conventional methods.

IV. CONCLUSIONS

Hand - held GPS has proven to be a very accurate and cost effective tool for the surveys of today. Though GPS will not completely replace conventional equipment, it will definitely revolutionize the way, land, engineering and mine surveys are now performed. Precise positioning receivers and versatile GPS softwares are available in our country itself at affordable prices. Awareness about the utility of this space geodetic technique has also increased many folds amongst various scientific organizations in India today including Survey of India. With the proven capability of this technique to provide precise control network with least cost of time and money and the cost of equipment decreasing dramatically with increased users, the days are not far when the utility of GPS is going to be felt in every sphere of an activity including Large Scale Surveying.

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