Comparison Between The Use of Modern and Old Surveying Equipment Through The Updating of Digital Maps

[I]Asma Th. Ibraheem, [II]Zainab H. Mahdi, [III]ThikraNajah
[I]Dept. of Civil Engineering, College of Engineering, Al-Nahrain University/Iraq
[II]Dept. of Building and Construction Technology Engg., Middle Technical University, Baghdad/ Iraq
[III]Dept. of surveying Technology Engineering, Middle Technical University, Baghdad, Iraq

Abstract

Considering the fast technological evolution many instruments are available to the user to achieve various goals and pick the right instruments for the right purpose depending on many factors such as (time, cost, accuracy) and this what is this research is dealing with by the use and the comparison among these three instruments (Differential Global Positioning System (DGPS), total station, theodolite)in the Middle Technical University (MTU), and as a result it was found that the in the case of time consumption DGPS was least consuming, as for the relative error DGPS produced the least error followed by total station and theodolite.

Keywords

DGPS,TotalStation, Theodolite, Accuracy,Digital Maps.

Introduction

1. General

Digital mapping is known as the process of producing maps throughout the use of computerized data and approaches, the increase use of digital maps is to keep up with the rapid growth of the world and because of the many advantages provided by it such as: saving time and the gain of productivity, cost saving, more credibility and authority of map production, better service, high accuracy and high consistency. These advantages can overcome the disadvantages of digital maps which are: cost-effective in some cases and requires advanced analysis tools.**Emeribeole**, and **Iheaturu** (2015)

2. Objectives

The main objectives of the research are: -

1- To produce an up to date digital map for the area of study that contains all its facilities.

2-To show the importance and the efficiency of digital mapping compared to the tedious conventional method.

3-To show the efficiency and the accuracy of the modern surveying techniques.

4- To provide the study area with data (digital map) that would be beneficial to any future work.

2. The used instruments

The used instruments in this research are (DGPS, total station, theodolite) and their characteristics and qualities are as follows:

1- Total station: - Which is a very crucial surveying instrument that measures horizontal and vertical angles as well as distances which goes back to the reason that it combines both an Electronic Distance Measurement (EDM) device and the function of the theodolite.**Arora** (2010), **Chandra** (2017).And consequently the coordinates of any unknown point can be acquired as long as there are two known points to form a (base line).**Hill** (2008).

Also total station provides the perk of saving the measured data in two ways: either by the its internal memory or by an external memory. This data can be easily exported to any computer device. The used device in this work was (Topcon GTS-751 series). **BASAK** (2010).**Mitchell** and **Jolley** (2009).

2-Theodolite: -the fundamental use of the theodolite is to measure horizontal and vertical angles. The used theodolite was (Leica builder 109).**Kennie** and **Petrie** (1990),**Anderson** (1989),**Bossler** (1984).

There are two main kinds of theodolite out there which are: digital and non-digital theodolite which is rarely used right now, the digital kind involves a base mounted telescope and the reading are displayed on a digital screen.**Zeiske** (2004).

3-Differential Global Positioning System (DGPS): -

The general concept of DGPS is that any two receivers relatively in the same location are going under the influence of the same atmospheric error.**Wolf**, **Charles** and **Giuliani (2006).**

And one of the two receivers (which is called the base) is set up on a known location then it computes its location based on the satellite signal and then compares it with the reference station and the difference is applied on the captured data by the other receiver (the rover).**Leick**, **Rapoport** and **Tatarnikov**(2015).

That difference can be applied on the captured data right in the field or later by post processing programs. these two ways are known as (Real Time Kinematic) (RTK) and (Static) respectively. **Kaplan** and **Hegarty**(2006)

2-CASE STUDY

The area of study is the Middle Technical University (MTU) that's located in Baghdad/Zaafaraniya as illustrated in **Fig.1**, which is going under quite deal of developments in many sectors and any surveying work that goes in it will be very lucrative for any future expansion the university will go under.

Fig.1: the area of the case study (MTU)

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3. Field Work

Which involves the following steps: -

3.1 Reconnaissance

An obvious step to explore the study area to estimate what it takes to carry out work from materials to the time period.

3.2 Casting

Casting the needed control points were needed all over the study area which would form the points of the traverses as in **Fig.2**:

Fig.2: sample of the casted control points

3.3 Surveying and correcting

Which includes surveying the coordinates of the previously mentioned control points that were in a form of traverses by the use of Total Station as illustrated in **Fig.3**.And then correcting those coordinated by {Compass Rule} to eliminate the error in each point.

Fig.3: Three main traverses and one sub-traverse

3.4 Surveying the buildings

surveying all the coordinates of the buildings which are located in the study area by the meansof (Total station) and then surveying a sample of these the

the chosen buildings are: 1- department of civil technologies, 2- department of water resources technologies 3-the mosque 4-W.C. And the compare the results which are acquired by these instruments: DGPS, total station and theodolite.

Fig.3: Three main traverses and one sub-traverse

4. RESULTS

After completing the surveying process, it is time to compute the relative error of the of each traverse which is formed by the surveyed coordinates of each building, the results of surveying the sampled buildings are as follows:

1-Results of DGPS: -

-Department of civil technologies: -

Table 1: coordinates of department of civil technologies

POINTS	EASTING	NORTHING	ΔE	ΔN	AZ.	DIS.	DEP.	LAT.
1	452510.112	3680341.981	-84.956	-3.664	267 31 49.68	85.035	-84.956	-3.664
2	452425.156	3680338.317	0.805	-18.969	177 34 11.85	18.986	0.804	-18.969
3	452425.961	3680319.348	84.151	2.93	88 0 21.1	84.202	84.151	2.929
4	452510.112	3680322.278	0	19.703	0	19.703	0	19.703
					SUM	207.926	-0.001	-0.001

Linear misclosure= $\sqrt{(e(dep.))^2} + \sqrt{(e(lat.))^2} = \sqrt{(-0.001)^2 + (-0.001)^2} = 0.001414$

Relative error= $\frac{e}{\sum L} = \frac{0.001414}{207.926} = \frac{1}{140000}$

2-Department of water resources technologies: -

Table 2: coordinates of department of water resources technologies

POINTS	EASTING	NORTHING	ΔE	ΔN	AZ.	DIS.	DEP.	LAT.
1	452585.32	3680309.72	-45.461	-57.771	218 11 59.35	73.513	-45.461	-57.771
2	452539.859	3680251.949	6.431	-5.769	131 53 38.56	8.639	6.43	-5.768
3	452546.29	3680246.18	48.435	54.69	41 31 44.41	73.054	48.434	54.689
4	452594.725	3680300.87	-9.405	8.85	313 15 30.94	12.914	-9.405	8.849
					SUM	168.121	-0.001	0

Linear misclosure= $\sqrt{(e(dep.))^2} + \sqrt{(e(lat.))^2} = \sqrt{(-0.001)^2 + (0)^2} = 0.001$

Relative error= $\frac{e}{\sum L} = \frac{0.001}{168.121} = \frac{1}{168000}$

3. The mosque

Table 3: coordinates of the mosque

POINTS	EASTING	NORTHING	ΔE	ΔN	AZ.	DIS.	DEP.	LAT.
1	452473.519	3680291.82	2.896	7.51	21 5 15.34	8.049	2.896	7.509
2	452476.415	3680299.33	-7.545	2.79	290 17 36.43	8.044	-7.544	2.789
3	452468.87	3680302.12	-3.11	-7.635	202 9 45.97	8.244	-3.109	-7.634
4	452465.76	3680294.485	7.759	-2.665	108 57 22.2	8.204	7.759	-2.665
					SUM	32.541	0	-0.001

Linear misclosure= $\sqrt{(e(dep.))^2} + \sqrt{(e(lat.))^2} = \sqrt{(0)^2 + (-0.001)^2} = 0.001$

Relative error= $\frac{e}{\sum L} = \frac{0.001}{32.541} = \frac{1}{32500}$

4. Water cycle

Table 4: coordinates of the water cycle

POINTS	EASTING	NORTHING	ΔE	ΔN	AZ.	DIS.	DEP.	LAT.
1	452599.914	3680345.655	7.267	-6.343	131 6 57.88	9.646	7.267	-6.343
2	452607.181	3680339.312	6.19	8.35	36 33 0.66	10.394	6.19	8.35
3	452613.371	3680347.662	-7.046	5.238	306 37 37.67	8.780	-7.046	5.238
4	452606.325	3680352.9	-6.411	-7.245	221 30 18.61	9.674	-6.41	-7.244
					SUM	38.494	0.001	0.001

Linear misclosure= $\sqrt{(e(dep.))^2} + \sqrt{(e(lat.))^2} = \sqrt{(0.001)^2 + (0.001)^2} = 0.00141$

Relative error= $\frac{e}{\sum L} = \frac{0.00141}{38.494} = \frac{1}{27000}$

2. Results of total station

Department of civil technologies: -

Table 5: coordinates of department of civil technologies

POINTS	EASTING	NORTHING	ΔE	ΔN	AZ.	DIS.	DEP.	LAT.
1	452510.107	3680341.977	-84.956	-3.656	267 32 9.07	85.035	-84.956	-3.656
2	452425.151	3680338.321	0.808	-18.98	177 33 44.37	18.997	0.807	-18.98
3	452425.959	3680319.341	84.149	2.931	88 0 18.48	84.200	84.148	2.93
4	452510.108	3680322.272	-0.001	19.705	359 59 49.53	19.705	-0.001	19.704
					SUM	207.937	-0.002	-0.002

Linear misclosure= $\sqrt{(e(dep.))^2} + \sqrt{(e(lat.))^2} = \sqrt{(-0.002)^2 + (-0.002)^2} = 0.00283$

Relative error= $\frac{e}{\sum L} = \frac{0.00283}{207.937} = \frac{1}{73000}$

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2-Department of water resources technologies: -

Table 6: coordinates of department of water resources technologies

POINTS	EASTING	NORTHING	ΔE	ΔN	AZ.	DIS.	DEP.	LAT.
1	452585.323	3680309.716	-45.472	-57.773	218 12 20.13	73.522	-45.472	-57.773
2	452539.851	3680251.943	6.433	-5.756	131 49 15.42	8.632	6.432	-5.756
3	452546.284	3680246.187	48.439	54.681	41 32 9.71	73.050	48.438	54.68
4	452594.723	3680300.868	-9.4	8.848	313 16 2.41	12.909	-9.399	8.847
					SUM	168.113	-0.001	-0.002

Linear misclosure= $\sqrt{(e(dep.))^2} + \sqrt{(e(lat.))^2} = \sqrt{(-0.001)^2 + (-0.002)^2} = 0.00224$

Relative error= $\frac{e}{\sum L} = \frac{0.00224}{168.113} = \frac{1}{75000}$

3. The mosque

Table 7: coordinates of the mosque

POINTS	EASTING	NORTHING	ΔE	ΔN	AZ.	DIS.	DEP.	LAT.
1	452473.513	3680291.819	2.906	7.515	21 8 28.14	8.057	2.905	7.514
2	452476.419	3680299.334	-7.542	2.77	290 10 1.57	8.035	-7.542	2.77
3	452468.877	3680302.104	-3.112	-7.614	202 13 51.08	8.225	-3.112	-7.613
4	452465.765	3680294.49	7.748	-2.671	109 1 14.95	8.195	7.747	-2.67
					SUM	32.513	-0.002	0.001

Linear misclosure= $\sqrt{(e(dep.))^2} + \sqrt{(e(lat.))^2} = \sqrt{(-0.002)^2 + (0.001)^2} = 0.00224$

Relative error= $\frac{e}{\sum L} = \frac{0.00224}{32.513} = \frac{1}{14000}$

4. Water cycle

Table 8: coordinates of the water cycle

POINTS	EASTING	NORTHING	ΔE	ΔN	AZ.	DIS.	DEP.	LAT.
1	452599.915	3680345.651	7.269	-6.342	131 6 13.65	9.647	7.269	-6.342
2	452607.184	3680339.309	6.182	8.358	36 29 18.62	10.396	6.182	8.358
3	452613.366	3680347.667	-7.038	5.238	306 39 29.89	8.773	-7.037	5.238
4	452606.328	3680352.905	-6.413	-7.254	221 28 43.46	9.682	-6.412	-7.253
					SUM	38.498	0.002	0.001

Linear misclosure= $\sqrt{(e(dep.))^2} + \sqrt{(e(lat.))^2} = \sqrt{(0.002)^2 + (0.001)^2} = 0.00224$

Relative error= $\frac{e}{\sum L} = \frac{0.00224}{38.498} = \frac{1}{17000}$

3. Results of theodolite

-Department of civil technologies: -

Table 9: coordinates of department of civil technologies

POINTS	EASTING	NORTHING	ΔE	ΔN	AZ.	DIS.	DEP.	LAT.
1	452510.103	3680341.975	-84.936	-3.647	267 32 28.79	85.014	-84.935	-3.646
2	452425.167	3680338.328	0.783	-18.991	177 38 20.5	19.007	0.782	-18.99
3	452425.95	3680319.337	84.154	2.931	88 0 81.91	84.205	84.154	2.931
4	452510.104	3680322.268	-0.001	19.707	359 59 49.53	19.707	0.001	19.707
					SUM	207.933	0.002	0.002

Linear misclosure= $\sqrt{(e(dep.))^2} + \sqrt{(e(lat.))^2} = \sqrt{(0.002)^2 + (0.002)^2} = 0.00283$

Relative error= $\frac{e}{\sum L} = \frac{0.00283}{207.933} = \frac{1}{73000}$

2-Department of water resources technologies: -

Table 10: coordinates of department of water resources technologies

POINTS	EASTING	NORTHING	ΔE	ΔN	AZ.	DIS.	DEP.	LAT.
1	452585.324	3680309.709	-45.479	-57.773	218 12 35.56	73.526	-45.479	-57.772
2	452539.845	3680251.936	6.436	-5.745	131 45 11.6	8.627	6.435	-5.744
3	452546.281	3680246.191	48.44	54.672	41 32 28.68	73.044	48.439	54.672
4	452594.721	3680300.863	-9.397	8.846	313 16 12	12.906	-9.397	8.846
					SUM	168.103	-0.002	0.002

Linear misclosure= $\sqrt{(e(dep.))^2} + \sqrt{(e(lat.))^2} = \sqrt{(-0.002)^2 + (0.002)^2} = 0.00283$

Relative error= $\frac{e}{\sum L} = \frac{0.00283}{168.103} = \frac{1}{59000}$

3- The mosque: -

Table 11: coordinates of the mosque

POINTS	EASTING	NORTHING	ΔE	ΔN	AZ.	DIS.	DEP.	LAT.
1	452473.51	3680291.812	2.912	7.526	21 9 9.78	8.070	2.912	7.526
2	452476.422	3680299.338	-7.543	2.763	290 7 4	8.033	-7.542	2.763
3	452468.879	3680302.101	-3.111	-7.608	202 14 24.81	8.219	-3.11	-7.607
4	452465.768	3680294.493	7.742	-2.681	109 6 2.19	8.193	7.741	-2.68
					SUM	32.515	0.001	0.002

Linear misclosure= $\sqrt{(e(dep.))^2} + \sqrt{(e(lat.))^2} = \sqrt{(0.001)^2 + (0.002)^2} = 0.00224$

Relative error= $\frac{e}{\sum L} = \frac{0.00224}{32.515} = \frac{1}{14000}$

4-Water cycle:

Table 12: coordinates of the water cycle

POINTS	EASTING	NORTHING	ΔE	ΔN	AZ.	DIS.	DEP.	LAT.
1	452599.903	3680345.648	7.284	-6.343	131 2 59.15	9.659	7.284	-6.344
2	452607.187	3680339.305	6.173	8.365	36 25 32.47	10.396	6.173	8.364
3	452613.36	3680347.67	-7.029	5.236	306 40 58.58	8.765	-7.029	5.236
4	452606.331	3680352.906	-6.428	-7.258	221 31 46.18	9.695	-6.427	-7.258
					SUM	38.515	0.001	-0.002

Linear misclosure= $\sqrt{(e(dep.))^2} + \sqrt{(e(lat.))^2} = \sqrt{(0.001)^2 + (-0.002)^2} = 0.00224$

Relative error= $\frac{e}{\sum L} = \frac{0.00224}{38.515} = \frac{1}{17000}$

5. Conclusions

1-In the matter of time consumption, DGPS consumed the least time followed by total station then theodolite.

2- Total station and theodolite needed many control points covering the area of study in order to survey the buildings unlike DGPS which did not.

3-the resulting error from the work was at its least value when DGPS was used followed by both total station and theodolite.

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Author's Profile

Thikra Najah Munshid., Master student at The Technical College/Baghdad in the Middle Technical University.