

## "Demystifying Least Square Adjustment Using Android Smartphone and Graphic Calculator"

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## Abstract:

"Least Square Adjustment" is recommended as the best method for adjusting various surveying observations and computations used in map making. Its mathematical complexity and analysis remains however, a mystery to some students of Surveying, Cartography or Geoinformatics, who are not using high end, costly and branded soft wares. This paper therefore will attempt to demystify this epitome of survey adjustment by presenting a review of mathematical subjects like Matrix Arithmetic, Linear Algebra, Statistics and Differential Equations as foundation for understanding. Derived equations from this subjects and other learning materials is presented with complimentary explanation. Practical sample problems are solved using Casio Graphic Calculators programmed by the author and its results compared.. More advanced Least Square operations is introduced using "BIGLINE" an Android application for smartphones developed by the author. Programs developed were used to solve problems in Resection, Traverse and Coordinate Transformations. Comparative solutions present the same results against sample problems figured in books or published research papers. Challenges to its application and future developments will cap the discussion as well as its potential as a learning and practical problem solving tool necessary for a competent cartographer or GIS professional.

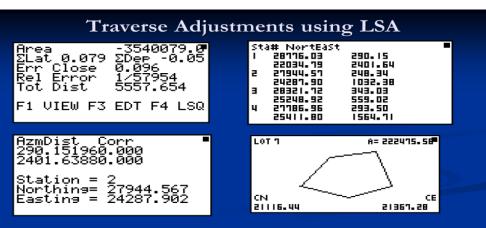


Fig. 1 Screenshots of Casio Graphic Calculator used in Traverse Computation Adjustment

				Arı	ivin	ig at	the	same	val	ues						
Gaussian Normal Equation				Cholesky Decomposition				QR Decomposition				Singular Value Decomposition				
Multiply A' * A				Transpose Matrix A'				Orthogonal factors Q				Left Singular Vectors (U)				
420.0000	144.0000	20.0000	88.0000	20	4	0	2	-0.7428	0.0123	-0.6145	-0.2656	0.2958	-0.7943	0.4158	0.3296	
144.0000	276.0000	64.0000	20.0000	4	16	2	0	-0.3714	-0.7095	0.1890	0.5683	0.1736	-0.5013	-0.6467	-0.5480	
20.0000	64.0000	296.0000	240.0000	0	2	16	6	0.0000	0.5367	-0.3257	0.7784	0.4448	0.1485	-0.5685	0.6759	
88.0000	20.0000	240.0000	616.0000	2	0	6	24	0.5571	-0.4565	-0.6933	0.0247	0.8273	0.3093	0.2927	-0.3663	
Matinverse (A'xA)`				Cholesky Decomposition				Upper Tri	Upper Triangular Factor R				Right Singular Vectors (V)			
0.0031	-0.0017	0.0007	-0.0007	Triangula	r Factor X			-5.3852	-2.7854	4.4567	3.5282	0.2958	-0.7943	0.4158	0.3296	
-0.0017	0.0048	-0.0015	0.0007					0.0000	-5.5894	0.4627	1.1043	0.1736	-0.5013	-0.6467	-0.548	
0.0007	-0.0015	0.0054	-0.0022	4.4721	0.0000	0.0000	0.0000	0.0000	0.0000	-5.3781	-2.0016	0.4448	0.1485	-0.5685	0.6759	
-0.0007	0.0007	-0.0022	0.0025	0.8944	3.8987	0.0000	0.0000	0.0000	0.0000	0.0000	6.1095	0.8273	0.3093	0.2927	-0.3663	
Multiply A' * B				0.0000	0.5130 -0.1026	3.9670 1.5258	0.0000 4.6327	Least Square R`Q'B				Diagonal Matrix Singular Values (S)				
3808.0000				Matrix is symmetric and positive				5.0000			27 9408	0.0000	0.0000	0.0000		
2984.0000				definite				6.0000				0.0000	21.7455	0.0000	0.0000	
4476.0000				Solve LSQ A*X = B					7.0000				0.0000	15,1864	0.0000	
7168.0000									8.0000				0.0000	0.0000	11.127	
Ordinary LSQ = (A'A) <sup>-</sup> * A'B				5.0000 6.0000				Residuals	Residuals V= AX - L				Least square X=VS'U'*B			
	5.0	000		7.0000					0.0000				5.0000			
		000		8.0000					0.0000				6.0000			
7.0000				Internet Intel				0.0000				7.0000				
8.0000				Submit OK				0.0000					8.0000			

Fig. 2 Screenshots of Android Smartphone with various Least Square Computation Methods