

Solution of Minimization Problems from MINPACK-2 Collection by means of Limited Memory L-BFGS Algorithm

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In this work I present the characteristics of LBFGS program for solving 7 unconstrained optimization problems from MINPACK-2 Collection. LBFGS is the limited memory BFGS quasi-Newton program of Jorge Nocedal. The algorithm is described in "*On the limited memory BFGS method for large scale optimization*", by D. Liu and J. Nocedal, Mathematical Programming B 45 (1989) 503-528. The stopping criteria used in this numerical experiment is $\|\nabla f(x_k)\| \leq 10^{-6}$. For each application I have considered three numerical experiments for $M = 3, 5, 7$, where M is the number of stored corrections used in the BFGS update. This numerical experiments are to be considered into the book: "*Criticism of the Unconstrained Optimization Algorithms Reasoning*" - ("Critica Rațiunii Algoritmilor de Optimizare fără Restricții"), Chapter 9.

Application L1 Elastic-Plastic Torsion (c=5) (nx=200, ny=200)

L-BFGS Algorithm. Elastic-Plastic Torsion Problem
Number of BFGS updates M= 3 February 8, 2007

n	iter	fgcnt	time	fxnew	gnorm2
40000	322	338	5559	-.4392676802134E+00	.5929712245329E-04

L-BFGS Algorithm. Elastic-Plastic Torsion Problem
Number of BFGS updates M= 5 February 8, 2007

n	iter	fgcnt	time	fxnew	gnorm2
40000	328	677	5838	-.4392677871500E+00	.5530757837201E-04

L-BFGS Algorithm. Elastic-Plastic Torsion Problem
Number of BFGS updates M= 7 February 8, 2007

n	iter	fgcnt	time	fxnew	gnorm2
40000	340	1027	6278	-.4392677701748E+00	.4669990455733E-04

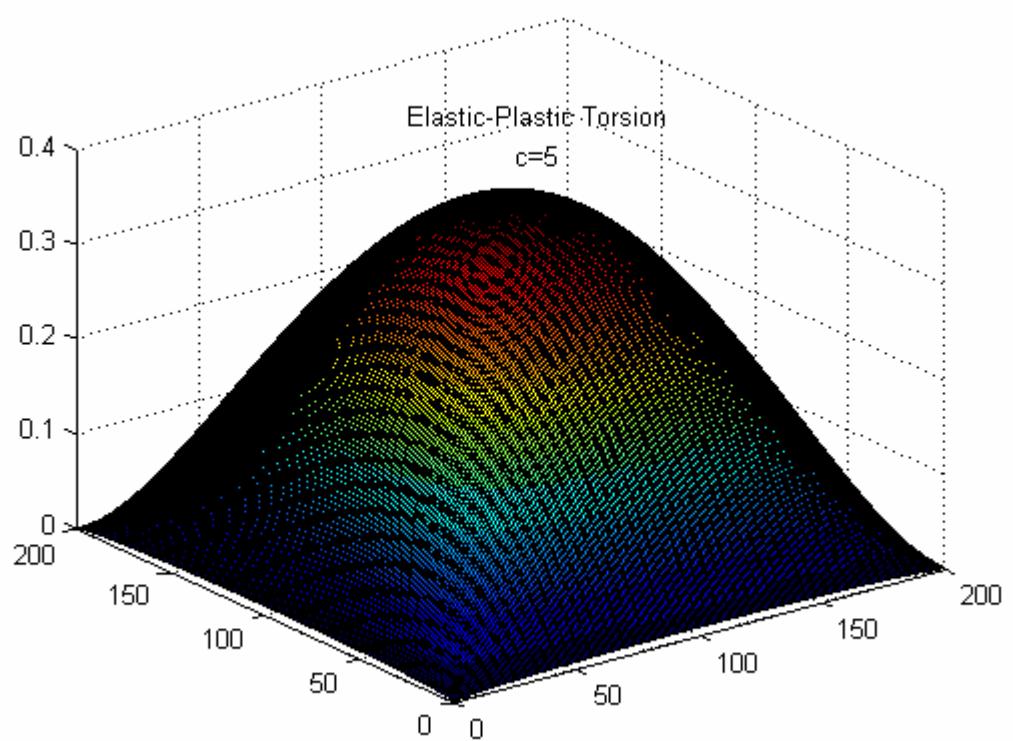


Fig. A1.1. Solution of the Elastic-Plastic Torsion Problem for $c = 5$.

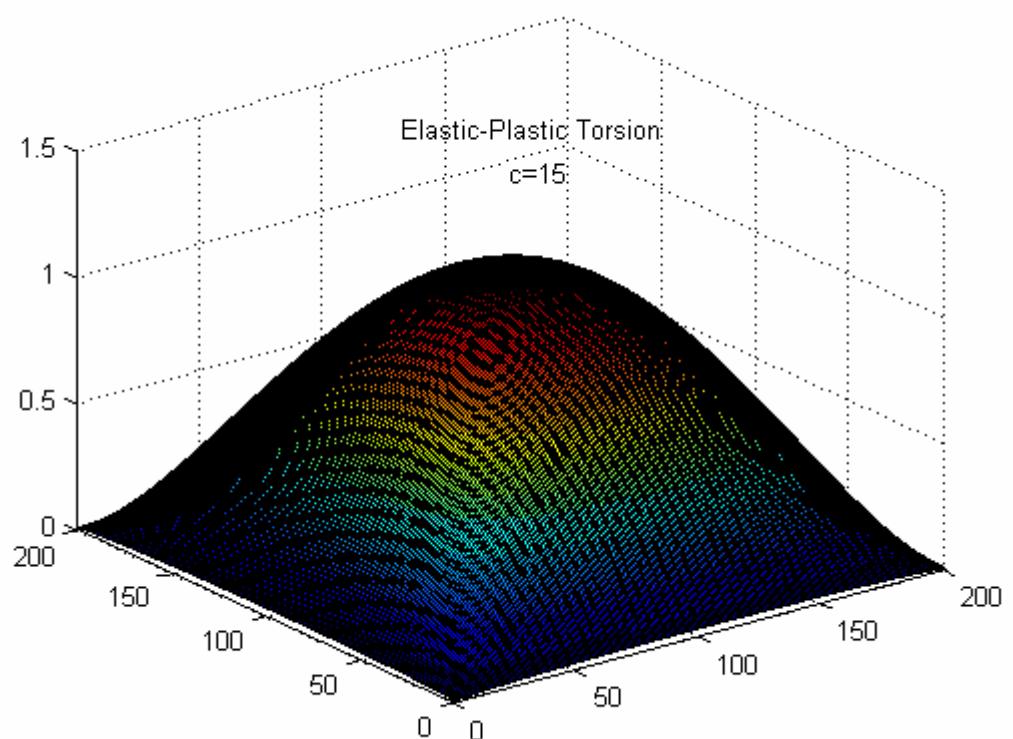


Fig. A1.2. Solution of the Elastic-Plastic Torsion Problem for $c = 15$.

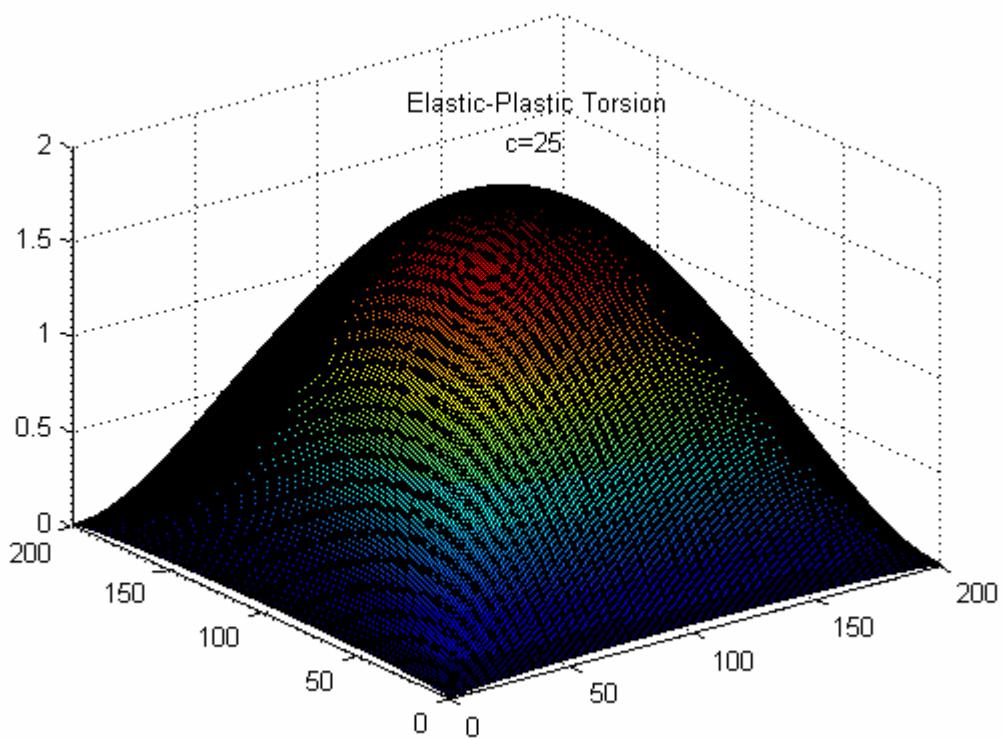


Fig. A1.3. Solution of the Elastic-Plastic Torsion Problem for $c = 25$.

Application A2 Pressure Distribution in a Journal Bearing (ecc=0.1 b=10) (nx=200, ny=200)

L-BFGS Algorithm. Pressure Distribution Problem
Number of BFGS updates M= 3 February 8, 2007

n	iter	fgcnt	time	fxnew	gnorm2
40000	898	935	15907	-.2828928216913E+00	.3628206699826E-04

L-BFGS Algorithm. Pressure Distribution Problem
Number of BFGS updates M= 5 February 8, 2007

n	iter	fgcnt	time	fxnew	gnorm2
40000	788	1750	14429	-.2828929324908E+00	.3397134823236E-04

L-BFGS Algorithm. Pressure Distribution Problem
Number of BFGS updates M= 7 February 8, 2007

n	iter	fgcnt	time	fxnew	gnorm2
40000	813	2584	15406	-.2828929398859E+00	.3090705561618E-04

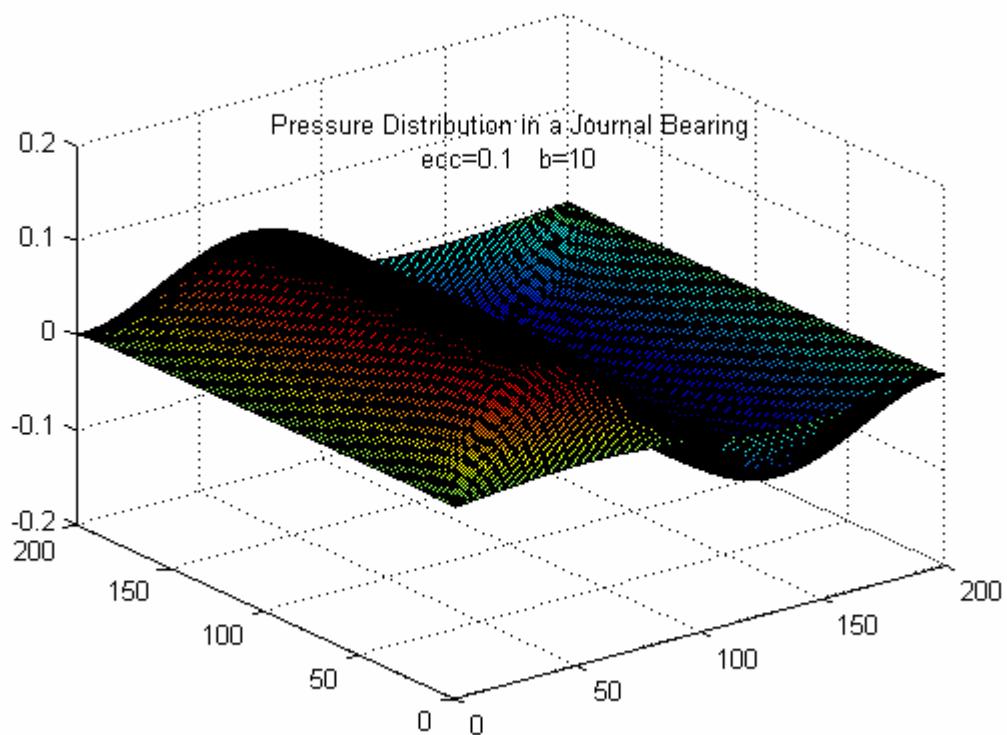


Fig. A2. Solution of the Pressure Distribution in a Journal Bearing (ecc=0.1 b=10)

Application A3. Optimal Design with Composite Materials ($\lambda = 0.008$)

L-BFGS Algorithm. Optimal Design with Composite Materials
Number of BFGS updates M= 3 February 8, 2007

n	iter	fgcnt	time	fxnew	gnorm2
40000	1468	1482	34147	-.1138127247704E-01	.2275735443840E-04

L-BFGS Algorithm. Optimal Design with Composite Materials
Number of BFGS updates M= 5 February 8, 2007

n	iter	fgcnt	time	fxnew	gnorm2
40000	856	2343	20432	-.1138129227830E-01	.3527219016842E-04

L-BFGS Algorithm. Optimal Design with Composite Materials
Number of BFGS updates M= 7 February 8, 2007

n	iter	fgcnt	time	fxnew	gnorm2
40000	864	3210	21261	-.1138128007165E-01	.1704591630646E-04

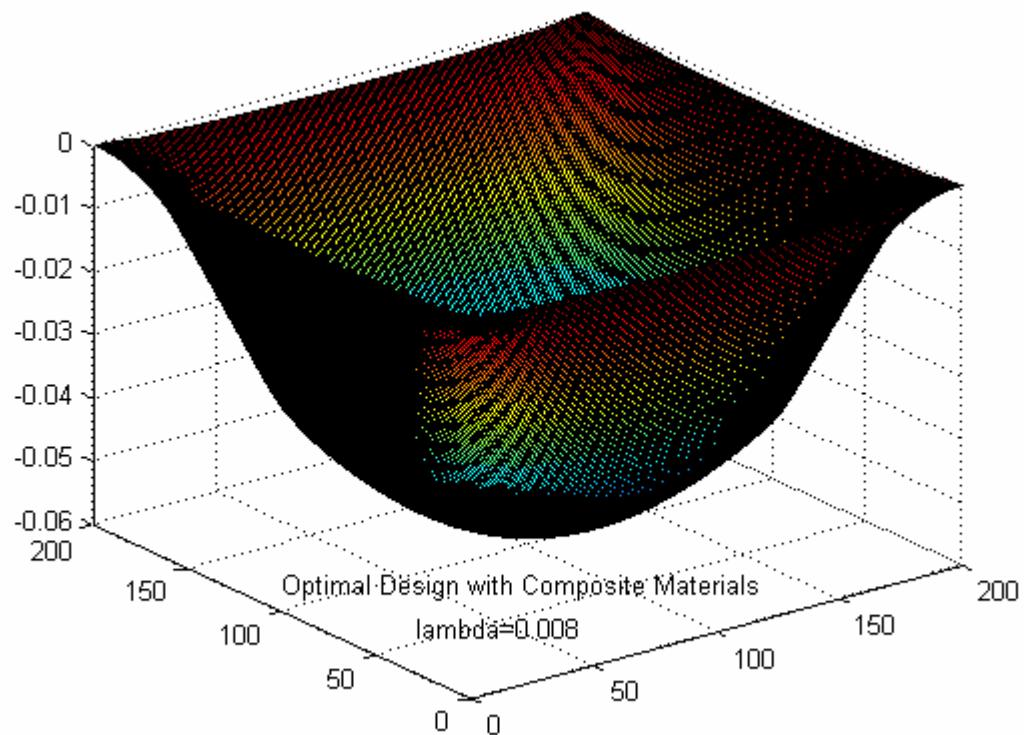


Fig. A3. Solution of the optimal design with composite materials $\lambda = 0.008$.

Application L4 Ginzburg-Landau (1-dimensional)

L-BFGS Algorithm. Ginzburg-Landau (1-dimensional) (t=5)
Number of BFGS updates M= 3 February 8, 2007

n	iter	fgcnt	time	fxnew	gnorm2
1000	1906	2001	2928	-.1698024743787E-03	.1978294717532E-01

L-BFGS Algorithm. Ginzburg-Landau (1-dimensional) (t=1)
Number of BFGS updates M= 3 February 8, 2007

n	iter	fgcnt	time	fxnew	gnorm2
1000	1895	2001	2735	-.6157489435675E-03	.4988431952151E-01

L-BFGS Algorithm. Ginzburg-Landau (1-dimensional) (t=15)
Number of BFGS updates M= 3 February 8, 2007

n	iter	fgcnt	time	fxnew	gnorm2
1000	1900	2001	2707	.1780489958062E-04	.2350440217140E+00

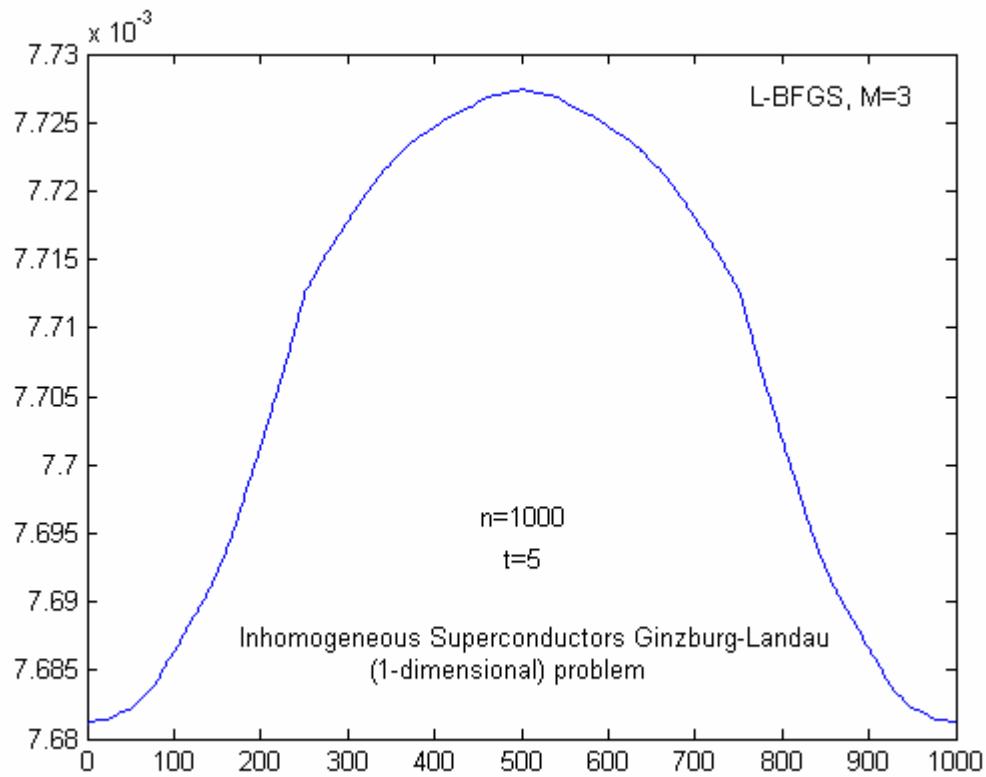


Fig. A4. Solution of the Ginzburg-Landau (1-dimensional) ($t=5$)

Aplication L5 Steady State Combustion - Bratu Problem ($\lambda = 5$)

L-BFGS Algorithm. Steady State Combustion - Bratu
Number of BFGS updates M= 3 February 8, 2007

n	iter	fgcnt	time	fxnew	gnorm2
40000	721	763	23920	-.5611448046064E+01	.4083570097058E-04

L-BFGS Algorithm. Steady State Combustion - Bratu
Number of BFGS updates M= 5 February 8, 2007

n	iter	fgcnt	time	fxnew	gnorm2
40000	523	1308	17461	-.5611448481156E+01	.3323370738454E-04

L-BFGS Algorithm. Steady State Combustion - Bratu
Number of BFGS updates M= 7 February 8, 2007

n	iter	fgcnt	time	fxnew	gnorm2
40000	524	1846	17648	-.5611448440657E+01	.3596646792732E-04

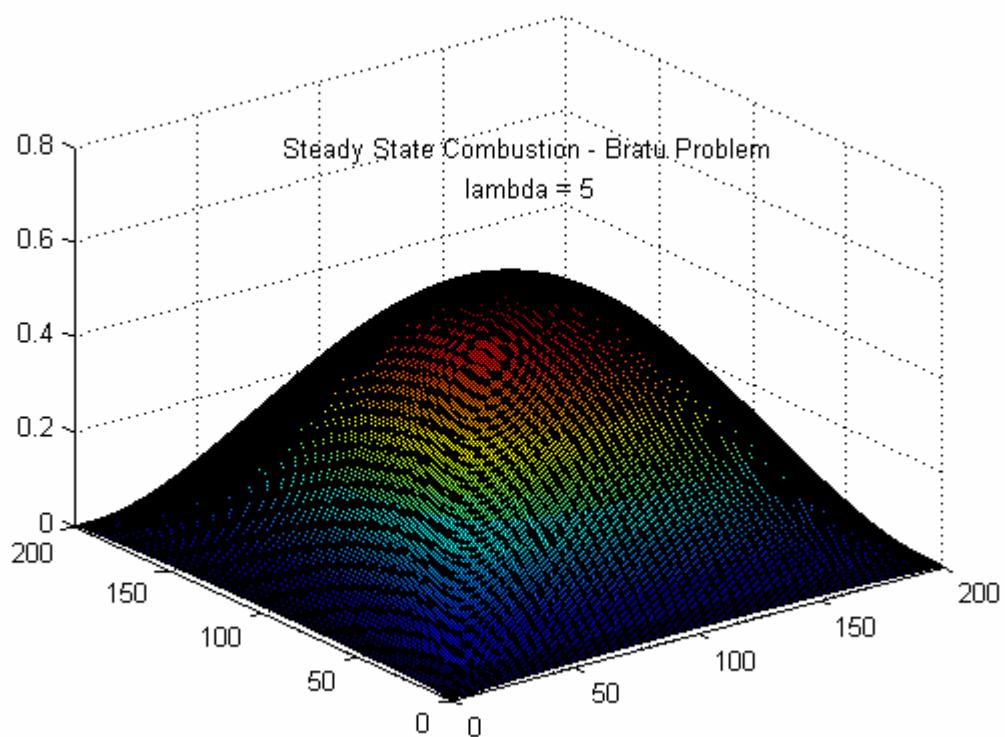


Fig. A4. Solution of the Steady State Combustion - Bratu. $\lambda = 5$.

Application L6. Jones Clusters (Molecular Conformation)

L-BFGS Algorithm. Jones Clusters (Molecular Conformation)
Number of BFGS updates M= 3 February 8, 2007

n	iter	fgcnt	time	fxnew	gnorm2
3000	1673	1755	58314	-.6601110525593E+04	.2917575361231E-03

L-BFGS Algorithm. Jones Clusters (Molecular Conformation)
Number of BFGS updates M= 5 February 8, 2007

n	iter	fgcnt	time	fxnew	gnorm2
3000	1944	3756	66575	-.6631206392675E+04	.5073205149512E-02

L-BFGS Algorithm. Jones Clusters (Molecular Conformation)
Number of BFGS updates M= 7 February 8, 2007

n	iter	fgcnt	time	fxnew	gnorm2
3000	1134	4950	39816	-.6613129492660E+04	.3666087664123E-03

Application L7. Minimal surface area problem with Enneper boundary conditions

L-BFGS Algorithm. Minimal surface area problem
Number of BFGS updates M= 3 February 8, 2007

n	iter	fgcnt	time	fxnew	gnorm2
40000	484	507	10952	.1421353230223E+01	.3672031986360E-04
L-BFGS Algorithm. Minimal surface area problem					
Number of BFGS updates M= 5 February 8, 2007					
n	iter	fgcnt	time	fxnew	gnorm2
40000	459	977	10502	.1421353228007E+01	.2113823748693E-04
L-BFGS Algorithm. Minimal surface area problem					
Number of BFGS updates M= 7 February 8, 2007					
n	iter	fgcnt	time	fxnew	gnorm2
40000	424	1408	9947	.1421353230116E+01	.2673432190418E-04

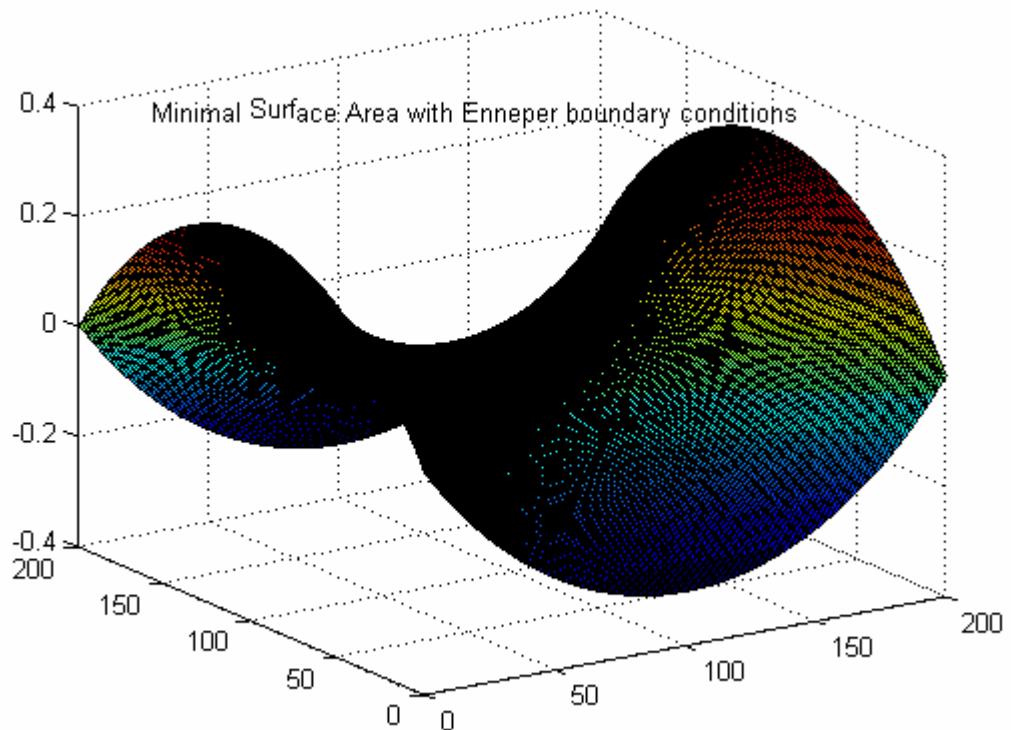


Fig. A4. Solution of the Minimal Surface Area Problem.

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