APPENDIX A

PUBLICATIONS

Conferences

1. Oyas Wahyunggoro, N. Saad. "Development of Fuzzy-Scheduled PID Controller for DC Servomotor". National Postgraduate Conference on Engineering, Science, and Technology (NPC 2008), Universiti Teknologi PETRONAS, Perak, Malaysia, 31 March 2008.

2. O. Wahyunggoro, N. Saad. "Evaluations of Fuzzy-Logic-Based Self Tuning PI Controller and Fuzzy-Scheduled PID Controller for DC Servomotor". 3rd International Symposium on Information Technology 2008 (ITSIM 2008), Kuala Lumpur, 26-29 August 2008.

3. Oyas Wahyunggoro, N. Saad. "Development of Fuzzy-Logic-Based Self Tuning PI Controller for Servomotor". 10th International Conference on Automation, Robotics, Control and Vision (ICARCV 2008), Hanoi, Vietnam, 17-19 December 2008.

4. O. Wahyunggoro, N. Saad. "Genetic Algorithm Optimization of I/O Scales for FLIC in Servomotor Control". Conference on Innovative Technology in Intelligent Systems and Industrial Applications (CITISIA 2009), Monash University, Sunway Campus, Selangor, Malaysia, 25-26 July 2009

5. O. Wahyunggoro, N. Saad. "Genetic Algorithm Optimization of I/O Scales and Parameters for FLIC in Servomotor Control". 2009 IEEE Symposium on Industrial Electronics and Applications (ISIEA 2009), Kuala Lumpur, Malaysia, October 4-6, 2009.

6. O. Wahyunggoro, N. Saad. "Development and Performance Evaluations of Classical and Hybrid-Fuzzy Control Approaches to the Control of Servomotors". International Conference on Robotics, Visions, Signal Processing and Power Applications (RoViSP 2009), Langkawi, Malaysia, 19-20 December 2009.

7. O. Wahyunggoro, N. Saad. "Analysis and Evaluation of Real-Time and s-Domain Model of A DC Servomotor". 3rd International Conference on Intelligent and Advanced System (ICIAS 2010), Kuala Lumpur, Malaysia, 15-17 June 2010.

Book Chapter

1. Oyas Wahyunggoro, and Nordin Saad. "Development of Fuzzy-Logic-Based Self Tuning PI Controller for Servomotor", pp 311-328, Chapter 15, in S.E. Shafiei (Eds), Advanced Strategies for Robot Manipulators, ISBN 978-953-3-7-099-5, Published by Sciyo, Rijeka, Croatia, 2010.

Journal

1. Oyas Wahyunggoro and Nordin Saad. "SPOGA Optimization of I/O Scales and Parameters for FLIC in Servomotor Control". IEEE Transaction on Control System Technology (submitted for review).

APPENDIX B

PERFORMANCES OF GA AND SPOGA

B.1 Introduction

This appendix presents the simulation results of GA and SPOGA with minimum specification as a detail result of Table 4. 10. There are four simulations :

i. Simulation of GA with 40 bit, 30 populations, 20 generations, crossover rate 0.9, mutation rate 0.01, namely Simulation B1
ii. Simulation of SPOGA with 40 bit, 30 populations, 20 generations, crossover rate 0.9, mutation rate 0.01, namely Simulation B2
iii. Simulation of GA with 40 bit, 30 populations, 20 generations, crossover rate 0.9, mutation rate 0.1, namely Simulation B3
iv. Simulation of SPOGA with 40 bit, 30 populations, 20 generations, crossover rate 0.9, mutation rate 0.1, namely Simulation B4

B.2 Results

Table B. 1 shows the result of Simulation B1.

Table B. 2 shows the result of Simulation B2.

Table B. 3 shows the result of Simulation B3.

Table B. 4 shows the result of Simulation B4.

Table B. 1 Result of Simulation B1

EXP. NO.	GA RESULT	TRUTH	ERROR	NO. OF FALSE
1	29.8437	30.0000	0.52%	0
2	28.3185	30.0000	5.61%	1
3	29.5720	30.0000	1.43%	0
4	29.5041	30.0000	1.65%	0
5	29.7587	30.0000	0.80%	0
6	29.3484	30.0000	2.17%	0
7	29.2565	30.0000	2.48%	0
8	29.5738	30.0000	1.42%	0
9	27.7416	30.0000	7.53%	1
10	28.7822	30.0000	4.06%	0
11	28.8199	30.0000	3.93%	0
12	28.6575	30.0000	4.48%	0
13	29.8046	30.0000	0.65%	0
14	28.9659	30.0000	3.45%	0
15	28.7481	30.0000	4.17%	0
16	29.9084	30.0000	0.31%	0
17	29.5716	30.0000	1.43%	0
18	29.0910	30.0000	3.03%	0
19	28.9577	30.0000	3.47%	0
20	29.4241	30.0000	1.92%	0
21	29.0596	30.0000	3.13%	0
22	28.6801	30.0000	4.40%	0
23	28.5467	30.0000	4.84%	0
24	29.3767	30.0000	2.08%	0
25	28.9777	30.0000	3.41%	0
26	28.4434	30.0000	5.19%	1
27	28.5466	30.0000	4.84%	0
28	28.5480	30.0000	4.84%	0
29	29.3501	30.0000	2.17%	0
30	28.4042	30.0000	5.32%	1
31	29.1682	30.0000	2.77%	0
32	29.5917	30.0000	1.36%	0
33	28.7929	30.0000	4.02%	0
34	29.2028	30.0000	2.66%	0
35	29.5146	30.0000	1.62%	0
36	29.6278	30.0000	1.24%	0
37	28.9661	30.0000	3.45%	0
38	28.8872	30.0000	3.71%	0
39	29.9284	30.0000	0.24%	0
40	28.8041	30.0000	3.99%	0
41	28.6898	30.0000	4.37%	0
42	26.9924	30.0000	10.03%	1
43	28.7905	30.0000	4.03%	0
44	29.4981	30.0000	1.67%	0
45	28.5358	30.0000	4.88%	0
46	28.8238	30.0000	3.92%	0
47	28.8341	30.0000	3.89%	0
48	29.3108	30.0000	2.30%	0
49	28.9786	30.0000	3.40%	0
50	28.8276	30.0000	3.91%	0
51	29.1241	30.0000	2.92%	0
52	29.0790	30.0000	3.07%	0
53	29.2293	30.0000	2.57%	0

Table B. 1 Result of Simulation B1 (Cont'd)

EXP. NO.	GA RESULT	TRUTH	ERROR	NO. OF FALSE
54	28.7995	30.0000	4.00%	0
55	28.7686	30.0000	4.10%	0
56	29.1053	30.0000	2.98%	0
57	28.7115	30.0000	4.30%	0
58	28.6439	30.0000	4.52%	0
59	29.3829	30.0000	2.06%	0
60	28.8780	30.0000	3.74%	0
61	29.8428	30.0000	0.52%	0
62	29.1071	30.0000	2.98%	0
63	29.7198	30.0000	0.93%	0
64	28.3800	30.0000	5.40%	1
65	28.7665	30.0000	4.11%	0
66	28.8666	30.0000	3.78%	0
67	28.6932	30.0000	4.36%	0
68	29.2092	30.0000	2.64%	0
69	28.4406	30.0000	5.20%	1
70	29.3785	30.0000	2.07%	0
71	29.5870	30.0000	1.38%	0
72	27.8692	30.0000	7.10%	1
73	28.2160	30.0000	5.95%	1
74	28.0448	30.0000	6.52%	1
75	29.8868	30.0000	0.38%	0
76	29.5358	30.0000	1.55%	0
77	28.9708	30.0000	3.43%	0
78	29.9336	30.0000	0.22%	0
79	27.4913	30.0000	8.36%	1
80	28.3162	30.0000	5.61%	1
81	29.2569	30.0000	2.48%	0
82	29.4870	30.0000	1.71%	0
83	29.3605	30.0000	2.13%	0
84	28.1403	30.0000	6.20%	1
85	28.4661	30.0000	5.11%	1
86	29.6127	30.0000	1.29%	0
87	28.8491	30.0000	3.84%	0
88	29.6560	30.0000	1.15%	0
89	29.6565	30.0000	1.15%	0
90	29.4005	30.0000	2.00%	0
91	27.9046	30.0000	6.98%	1
92	28.1761	30.0000	6.08%	1
93	29.9362	30.0000	0.21%	0
94	26.1185	30.0000	12.94%	1
95	29.6396	30.0000	1.20%	0
96	29.4247	30.0000	1.92%	0
97	29.7406	30.0000	0.86%	0
98	29.4626	30.0000	1.79%	0
99	28.5663	30.0000	4.78%	0
100	28.3113	30.0000	5.63%	1
	TOTAL OF ERRORS		338.36%	
	AVERAGE OF ERROR		2.99%	
	NUMBER OF FALSE			18
	ACCURACY		82.00%	

Table B. 2 Result of Simulation B2

EXP. NO.	GA RESULT	TRUTH	ERROR	NO. OF FALSE
1	29.6607	30.0000	1.13%	0
2	29.2803	30.0000	2.40%	0
3	29.1468	30.0000	2.84%	0
4	29.5800	30.0000	1.40%	0
5	28.7373	30.0000	4.21%	0
6	29.8637	30.0000	0.45%	0
7	29.3654	30.0000	2.12%	0
8	29.3754	30.0000	2.08%	0
9	29.1036	30.0000	2.99%	0
10	28.8554	30.0000	3.82%	0
11	28.6206	30.0000	4.60%	0
12	29.6459	30.0000	1.18%	0
13	29.4059	30.0000	1.98%	0
14	28.8557	30.0000	3.81%	0
15	29.5910	30.0000	1.36%	0
16	29.4284	30.0000	1.91%	0
17	29.4806	30.0000	1.73%	0
18	29.6791	30.0000	1.07%	0
19	29.6113	30.0000	1.30%	0
20	28.9647	30.0000	3.45%	0
21	29.2206	30.0000	2.60%	0
22	28.9273	30.0000	3.58%	0
23	28.7933	30.0000	4.02%	0
24	29.4753	30.0000	1.75%	0
25	29.5533	30.0000	1.49%	0
26	29.5228	30.0000	1.59%	0
27	29.4411	30.0000	1.86%	0
28	29.5451	30.0000	1.52%	0
29	29.6904	30.0000	1.03%	0
30	29.5775	30.0000	1.41%	0
31	29.1156	30.0000	2.95%	0
32	29.5909	30.0000	1.36%	0
33	29.5521	30.0000	1.49%	0
34	28.8862	30.0000	3.71%	0
35	29.5253	30.0000	1.58%	0
36	28.3261	30.0000	5.58%	1
37	28.8915	30.0000	3.69%	0
38	29.4479	30.0000	1.84%	0
39	29.2916	30.0000	2.36%	0
40	28.3716	30.0000	5.43%	1
41	29.5167	30.0000	1.61%	0
42	29.4357	30.0000	1.88%	0
43	29.4317	30.0000	1.89%	0
44	28.7414	30.0000	4.20%	0
45	29.5907	30.0000	1.36%	0
46	29.3449	30.0000	2.18%	0
47	29.5311	30.0000	1.56%	0
48	28.7985	30.0000	4.01%	0
49	29.4312	30.0000	1.90%	0
50	29.6774	30.0000	1.08%	0
51	29.7219	30.0000	0.93%	0
52	29.2287	30.0000	2.57%	0
53	29.3104	30.0000	2.30%	0

Table B. 2 Result of Simulation B2 (Cont'd)

EXP. NO.	GA RESULT	TRUTH	ERROR	NO. OF FALSE
54	29.5629	30.0000	1.46%	0
55	28.6979	30.0000	4.34%	0
56	29.5192	30.0000	1.60%	0
57	28.7045	30.0000	4.32%	0
58	29.1073	30.0000	2.98%	0
59	29.5592	30.0000	1.47%	0
60	27.7505	30.0000	7.50%	1
61	28.8502	30.0000	3.83%	0
62	28.9897	30.0000	3.37%	0
63	29.0611	30.0000	3.13%	0
64	28.4729	30.0000	5.09%	1
65	29.3472	30.0000	2.18%	0
66	28.7008	30.0000	4.33%	0
67	29.7085	30.0000	0.97%	0
68	29.7968	30.0000	0.68%	0
69	29.3797	30.0000	2.07%	0
70	29.6074	30.0000	1.31%	0
71	29.0925	30.0000	3.03%	0
72	29.8420	30.0000	0.53%	0
73	28.9735	30.0000	3.42%	0
74	29.0528	30.0000	3.16%	0
75	29.3122	30.0000	2.29%	0
76	29.5661	30.0000	1.45%	0
77	29.6179	30.0000	1.27%	0
78	28.9886	30.0000	3.37%	0
79	28.5761	30.0000	4.75%	0
80	29.7197	30.0000	0.93%	0
81	29.1581	30.0000	2.81%	0
82	28.9721	30.0000	3.43%	0
83	29.6963	30.0000	1.01%	0
84	29.1878	30.0000	2.71%	0
85	28.6665	30.0000	4.45%	0
86	29.5676	30.0000	1.44%	0
87	28.5489	30.0000	4.84%	0
88	29.8825	30.0000	0.39%	0
89	29.6169	30.0000	1.28%	0
90	29.6372	30.0000	1.21%	0
91	28.6855	30.0000	4.38%	0
92	29.5154	30.0000	1.62%	0
93	29.3948	30.0000	2.02%	0
94	29.5671	30.0000	1.44%	0
95	29.6101	30.0000	1.30%	0
96	28.6767	30.0000	4.41%	0
97	29.5038	30.0000	1.65%	0
98	29.4902	30.0000	1.70%	0
99	28.9247	30.0000	3.58%	0
100	29.3367	30.0000	2.21%	0
	TOTAL OF ERRORS		246.82%	
	AVERAGE OF ERROR		2.42%	
	NUMBER OF FALSE			4
	ACCURACY		96.00%	

Table B. 3 Result of Simulation B3

EXP. NO.	GA RESULT	TRUTH	ERROR	NO. OF FALSE
1	28.8068	30.0000	3.98%	0
2	29.4407	30.0000	1.86%	0
3	28.3762	30.0000	5.41%	1
4	29.9940	30.0000	0.02%	0
5	29.5502	30.0000	1.50%	0
6	29.3194	30.0000	2.27%	0
7	28.8421	30.0000	3.86%	0
8	29.2544	30.0000	2.49%	0
9	29.4075	30.0000	1.98%	0
10	28.7845	30.0000	4.05%	0
11	28.7156	30.0000	4.28%	0
12	28.8922	30.0000	3.69%	0
13	28.7041	30.0000	4.32%	0
14	29.2867	30.0000	2.38%	0
15	28.9256	30.0000	3.58%	0
16	29.2341	30.0000	2.55%	0
17	29.3421	30.0000	2.19%	0
18	28.7643	30.0000	4.12%	0
19	29.0758	30.0000	3.08%	0
20	29.4808	30.0000	1.73%	0
21	29.0043	30.0000	3.32%	0
22	29.3688	30.0000	2.10%	0
23	29.0586	30.0000	3.14%	0
24	29.0053	30.0000	3.32%	0
25	28.5885	30.0000	4.71%	0
26	29.2330	30.0000	2.56%	0
27	28.5181	30.0000	4.94%	0
28	29.7807	30.0000	0.73%	0
29	29.7985	30.0000	0.67%	0
30	29.6710	30.0000	1.10%	0
31	29.8162	30.0000	0.61%	0
32	29.2216	30.0000	2.59%	0
33	28.8342	30.0000	3.89%	0
34	29.4034	30.0000	1.99%	0
35	29.7079	30.0000	0.97%	0
36	29.4324	30.0000	1.89%	0
37	29.2917	30.0000	2.36%	0
38	29.1722	30.0000	2.76%	0
39	29.7813	30.0000	0.73%	0
40	29.6210	30.0000	1.26%	0
41	29.8103	30.0000	0.63%	0
42	29.1428	30.0000	2.86%	0
43	29.9379	30.0000	0.21%	0
44	29.0283	30.0000	3.24%	0
45	29.6865	30.0000	1.04%	0
46	29.5671	30.0000	1.44%	0
47	29.3945	30.0000	2.02%	0
48	28.0581	30.0000	6.47%	1
49	29.2213	30.0000	2.60%	0
50	29.1848	30.0000	2.72%	0
51	29.6247	30.0000	1.25%	0
52	28.5831	30.0000	4.72%	0
53	29.3125	30.0000	2.29%	0

Table B. 3 Result of Simulation B3 (Cont'd)

EXP. NO.	GA RESULT	TRUTH	ERROR	NO. OF FALSE
54	28.8157	30.0000	3.95%	0
55	29.4856	30.0000	1.71%	0
56	29.0077	30.0000	3.31%	0
57	28.7603	30.0000	4.13%	0
58	28.9001	30.0000	3.67%	0
59	28.4915	30.0000	5.03%	1
60	28.6613	30.0000	4.46%	0
61	29.6853	30.0000	1.05%	0
62	29.5359	30.0000	1.55%	0
63	29.2119	30.0000	2.63%	0
64	29.6012	30.0000	1.33%	0
65	29.5126	30.0000	1.62%	0
66	28.8165	30.0000	3.95%	0
67	28.6938	30.0000	4.35%	0
68	29.2500	30.0000	2.50%	0
69	28.9575	30.0000	3.48%	0
70	29.2176	30.0000	2.61%	0
71	28.6682	30.0000	4.44%	0
72	29.7027	30.0000	0.99%	0
73	29.6599	30.0000	1.13%	0
74	29.2118	30.0000	2.63%	0
75	29.0588	30.0000	3.14%	0
76	29.1579	30.0000	2.81%	0
77	29.4082	30.0000	1.97%	0
78	28.1850	30.0000	6.05%	1
79	28.7129	30.0000	4.29%	0
80	29.8992	30.0000	0.34%	0
81	29.2038	30.0000	2.65%	0
82	29.8020	30.0000	0.66%	0
83	28.9390	30.0000	3.54%	0
84	29.6751	30.0000	1.08%	0
85	29.5747	30.0000	1.42%	0
86	29.3295	30.0000	2.24%	0
87	28.8020	30.0000	3.99%	0
88	28.9320	30.0000	3.56%	0
89	29.7699	30.0000	0.77%	0
90	28.8864	30.0000	3.71%	0
91	29.6183	30.0000	1.27%	0
92	28.9905	30.0000	3.37%	0
93	29.8212	30.0000	0.60%	0
94	29.2878	30.0000	2.37%	0
95	28.4907	30.0000	5.03%	1
96	29.5749	30.0000	1.42%	0
97	29.7131	30.0000	0.96%	0
98	28.6106	30.0000	4.63%	0
99	29.2889	30.0000	2.37%	0
100	28.8715	30.0000	3.76%	0
	TOTAL OF ERRORS		264.97%	
	AVERAGE OF ERROR		2.62%	
	NUMBER OF FALSE			5
	ACCURACY		95.00%	

Table B. 4 Result of Simulation B4

EXP. NO.	GA RESULT	TRUTH	ERROR	NO. OF FALSE
1	29.0541	30.0000	3.15%	0
2	29.0830	30.0000	3.06%	0
3	29.4037	30.0000	1.99%	0
4	28.9250	30.0000	3.58%	0
5	29.5700	30.0000	1.43%	0
6	29.5311	30.0000	1.56%	0
7	29.5415	30.0000	1.53%	0
8	29.8607	30.0000	0.46%	0
9	29.0111	30.0000	3.30%	0
10	28.8446	30.0000	3.85%	0
11	29.4288	30.0000	1.90%	0
12	29.4000	30.0000	2.00%	0
13	28.9390	30.0000	3.54%	0
14	29.5232	30.0000	1.59%	0
15	29.4651	30.0000	1.78%	0
16	29.5240	30.0000	1.59%	0
17	29.6997	30.0000	1.00%	0
18	28.5739	30.0000	4.75%	0
19	29.8519	30.0000	0.49%	0
20	29.2640	30.0000	2.45%	0
21	29.4859	30.0000	1.71%	0
22	28.8930	30.0000	3.69%	0
23	29.3511	30.0000	2.16%	0
24	29.8793	30.0000	0.40%	0
25	29.3826	30.0000	2.06%	0
26	29.9444	30.0000	0.19%	0
27	29.5034	30.0000	1.66%	0
28	29.2226	30.0000	2.59%	0
29	29.7748	30.0000	0.75%	0
30	28.8771	30.0000	3.74%	0
31	28.6735	30.0000	4.42%	0
32	28.9719	30.0000	3.43%	0
33	28.7125	30.0000	4.29%	0
34	29.2128	30.0000	2.62%	0
35	29.6197	30.0000	1.27%	0
36	28.6044	30.0000	4.65%	0
37	28.4849	30.0000	5.05%	1
38	28.7234	30.0000	4.26%	0
39	29.3134	30.0000	2.29%	0
40	29.6139	30.0000	1.29%	0
41	28.7254	30.0000	4.25%	0
42	29.6972	30.0000	1.01%	0
43	29.2351	30.0000	2.55%	0
44	29.4966	30.0000	1.68%	0
45	28.8866	30.0000	3.71%	0
46	29.0195	30.0000	3.27%	0
47	29.2444	30.0000	2.52%	0
48	29.1849	30.0000	2.72%	0
49	29.4227	30.0000	1.92%	0
50	29.4546	30.0000	1.82%	0
51	28.9808	30.0000	3.40%	0
52	29.8940	30.0000	0.35%	0
53	29.3743	30.0000	2.09%	0

Table B. 4 Result of Simulation B4 (Cont'd)

EXP. NO.	GA RESULT	TRUTH	ERROR	NO. OF FALSE
54	29.0472	30.0000	3.18%	0
55	29.1322	30.0000	2.89%	0
56	29.2042	30.0000	2.65%	0
57	29.5306	30.0000	1.56%	0
58	28.8251	30.0000	3.92%	0
59	29.1209	30.0000	2.93%	0
60	29.6269	30.0000	1.24%	0
61	28.8686	30.0000	3.77%	0
62	29.5850	30.0000	1.38%	0
63	29.3935	30.0000	2.02%	0
64	29.3942	30.0000	2.02%	0
65	29.5781	30.0000	1.41%	0
66	29.5246	30.0000	1.58%	0
67	29.2673	30.0000	2.44%	0
68	28.9816	30.0000	3.39%	0
69	28.9926	30.0000	3.36%	0
70	28.9202	30.0000	3.60%	0
71	29.4956	30.0000	1.68%	0
72	29.5140	30.0000	1.62%	0
73	29.4856	30.0000	1.71%	0
74	29.1702	30.0000	2.77%	0
75	29.0887	30.0000	3.04%	0
76	29.4100	30.0000	1.97%	0
77	29.4520	30.0000	1.83%	0
78	29.9184	30.0000	0.27%	0
79	29.7842	30.0000	0.72%	0
80	28.6888	30.0000	4.37%	0
81	29.0839	30.0000	3.05%	0
82	29.3528	30.0000	2.16%	0
83	29.4760	30.0000	1.75%	0
84	29.0660	30.0000	3.11%	0
85	29.2872	30.0000	2.38%	0
86	28.7527	30.0000	4.16%	0
87	29.7277	30.0000	0.91%	0
88	29.5930	30.0000	1.36%	0
89	29.7194	30.0000	0.94%	0
90	28.7895	30.0000	4.04%	0
91	28.8602	30.0000	3.80%	0
92	28.9926	30.0000	3.36%	0
93	29.4396	30.0000	1.87%	0
94	29.2921	30.0000	2.36%	0
95	29.0255	30.0000	3.25%	0
96	29.8934	30.0000	0.36%	0
97	29.7583	30.0000	0.81%	0
98	29.5445	30.0000	1.52%	0
99	28.6943	30.0000	4.35%	0
100	28.4357	30.0000	5.21%	1
	TOTAL OF ERRORS		242.87%	
	AVERAGE OF ERROR		2.44%	
	NUMBER OF FALSE			2
	ACCURACY		98.00%	

APPENDIX C

CHROMOSOMES IN SPOGA PROCESS

C.1 Duplicate Chromosomes

Table C.1 Duplicate chromosomes in the second generation of FLBPI optimization

No.	CHROMOSOME																									
1	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
2	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
3	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
4	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
5	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0
6	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
7	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
8	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
9	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
10	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
11	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
12	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
13	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
14	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
15	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
16	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
17	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
18	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
19	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
20	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
21	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
22	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
23	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1
24	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
25	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
26	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
27	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
28	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
29	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
31	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
32	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
33	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
34	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
35	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

In the Table C.1, the fit value of duplicate chromosomes are 45.36. There are 27 duplicate chromosomes or 77.14 % are occupied by the same chromosome.

Table C.2 Duplicate chroms in the second generation of FLBPID optimization

	CHROMOSOME																														
1	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
2	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
3	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
4	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
5	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	0	1	0	1	1	1	1
6	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1
7	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	0	1	1	1	1
8	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
9	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1
10	1	0	0	0	0	1	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1
11	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
12	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	1	0	1	1	1	1
13	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1
14	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
15	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0
16	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
17	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
18	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
19	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
20	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
21	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
22	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
23	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
24	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
25	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	0	1	0	1	1	1	0
26	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**

Table C.2 Duplicate chroms in the second generation of FLBPID optimization (Cont'd)

	CHROMOSOME																													
27	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1
28	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
29	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
30	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
31	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
32	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
33	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	1	0	0	0	0	1	0	1	1	1	1
34	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	1	0	0	1	0	1	1	1	1
35	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
36	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
37	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
38	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1
39	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
40	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
41	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
42	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**

In the Table C.2, the fit value of duplicate chromosomes are 60.21. There are 29 duplicate chromosomes or 69.05 % which are occupied by the same chromosome.

C.2 Homogenous Chromosomes

Table C.3 Homogeneous chroms in the 16th generation of FLBPI optimization

No.	CHROMOSOME																									
1	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1
2	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	1	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
4	0	1	1	0	0	0	1	0	1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
5	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
6	0	1	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
8	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
10	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
11	0	1	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
13	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	1	1	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	1	0	1	0	0
18	0	1	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	1	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	1
22	0	1	1	0	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0
24	0	1	1	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
25	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
26	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	1	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0
29	0	1	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	1	1	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
33	0	1	1	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0

The maximum average fit (homogeneous chromosomes) generation has the average fit of 55.02.

Table C.4 Homogeneous chroms in the 19th generation of FLBPID optimization

	CHROMOSOME																														
1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1
2	1	0	0	0	0	0	1	1	0	0	0	1	1	1	1	0	0	0	1	0	0	0	1	0	0	1	1	1	1	1	1
3	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	1
4	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1
5	1	0	0	0	0	0	0	0	1	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1
6	1	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	1	0	1	1	1	1
7	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	1	0	0	0	0	0	0	1	0	1	1	1	1
8	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1
9	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
10	1	0	0	0	0	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1
11	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1
12	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	1
13	1	0	0	0	0	0	1	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	1	0	0	1	0	1	1	1	1
14	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
15	1	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1
16	1	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1
17	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
18	1	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	1
19	1	0	0	0	0	0	1	0	1	0	0	0	1	1	1	0	0	0	1	0	0	0	0	0	0	1	0	1	1	1	1
20	1	0	0	0	0	0	1	0	1	0	0	1	1	1	1	0	1	0	0	0	0	0	1	0	0	1	0	1	1	1	1
21	1	0	0	0	1	0	0	0	0	0	0	0	1	1	1	0	0	0	1	1	1	0	0	0	0	1	1	1	1	0	1
22	1	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	0
23	1	0	0	0	0	0	1	0	0	0	0	0	1	1	1	0	1	0	1	0	0	0	0	1	0	0	1	1	0	1	1
24	1	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	1	0	0	0	0	1	0	0	0	1	0	1	1	0	1
25	1	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	1	0	1	1	0	0
26	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	0	1	1	1	1

Table C.4 Homogeneous chroms in the 19th generation of FLBPID optimization (Cont'd)

	CHROMOSOME																													
27	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1
28	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	0	1	0	1	1	1	1
29	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	1	0	0	0	1	0	1	1	1	1	1	0	1
30	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1
31	1	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	1	0	1	0	0	0	1	0	0	1	0	1	1	0	1
32	1	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	0	1	0	1	1	1	1
33	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	1	0	0	0	1	0	0	1	0	1	1	1	1
34	1	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1
35	1	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1
36	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	0	1	0	1	1	1	1
37	1	0	0	0	0	0	0	1	0	0	0	1	1	1	1	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1	1
38	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	0	1	0	1	1	1	0
39	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	1	1	1	1	0	1
40	1	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	1	1	1	1	0	1
41	1	0	0	0	0	0	1	0	0	0	0	0	1	1	1	0	0	0	1	0	0	0	1	0	0	1	1	0	1	1	1
42	1	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	0	1	1	1	0	1	1

The maximum average fit (homogeneous chromosomes) generation as in Table C.4 has the average fit of 60.36.

Table C.5 Homogeneous chromosomes in the 10^{th} generation of FLC part in the FLIC optimization

NO.	CHROMOSOME																				
1	1	1	1	1	1	1	0	1	1	0	1	1	1	0	1	1	0	1	0	1	1
2	1	1	1	1	1	1	0	0	0	1	1	1	1	0	1	0	1	0	0	1	1
3	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	0	0	1	1	1
4	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	0	0	1	1	1	1
5	1	1	1	1	1	1	0	1	1	0	1	1	1	0	1	0	0	1	1	1	1
6	1	0	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	1	1	1	1
7	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	0	1	1
8	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	1	1
9	0	1	1	1	1	1	0	1	1	1	1	1	1	0	1	0	1	0	0	1	1
10	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1
11	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	0	0	1	1	1	1
12	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	0	0	1	1	1	1
13	0	1	1	1	1	1	0	1	1	1	1	0	0	0	1	0	1	0	1	1	1
14	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	1	1	1	1
15	0	1	1	1	1	1	0	0	1	0	1	1	1	0	0	1	0	1	0	1	1
16	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	0	1	1	1	1
17	0	0	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	0	1	1	1
18	0	1	1	1	1	1	1	0	1	0	1	1	1	0	0	0	0	1	1	1	1
19	0	1	1	1	1	1	1	0	1	0	1	1	1	1	0	1	0	0	1	1	1
20	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	1	1
21	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	0	0	1	1	1	1
22	0	1	1	1	1	1	1	0	0	1	1	0	0	0	0	0	1	0	1	1	1
23	1	0	1	1	1	1	0	1	1	1	1	1	1	0	1	0	0	1	1	1	1
24	1	1	1	1	1	0	0	1	1	0	1	1	0	0	1	0	1	0	1	1	1
25	1	1	0	1	1	1	0	1	1	0	1	1	1	1	1	1	0	0	1	1	1
26	0	1	1	1	1	1	1	0	1	0	1	1	1	1	0	0	0	1	1	1	1
27	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	0	0	1	1	1
28	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	0	0	1	1	1	1
29	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	0	0	1	0
30	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	0	1	1	1	1	1

In the Table C.5, the average fit chromosome is 2.90 and the fitness values of chromosome are relatively the same (homogenous chromosome).

Table C.6 Homogeneous chromosomes in the 3rd generation of I/O scales and constant in the FLIC optimization

NO.	CHROMOSOME																				
1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
2	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0
3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
5	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
6	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
8	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
9	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
10	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0
11	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
12	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	1
13	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0
14	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
15	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
16	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
17	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
18	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
19	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
20	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
21	1	1	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0
22	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
23	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
24	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
25	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
26	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0
27	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
28	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
29	1	1	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0
30	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0

In the Table C.6, the average fit chromosome is 3.24 and the fitness values of chromosome are relatively the same (homogenous chromosome).

C.3 Maximum Fit Chromosomes

Table C.7 Maximum fit chromosome generation in the 17th generation of FLBPI optimization

No.	CHROMOSOME																										
1	0	1	1	0	0	0	1	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
2	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	1	1	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
6	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0
7	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	1	1	0	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
12	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	1	1	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
15	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	**0**	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
17	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	1	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	1	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	1	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
24	0	1	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
25	0	1	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
27	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	
28	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	1	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
31	0	1	1	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
32	0	1	1	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
33	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	1	0	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0

Table C.8 Maximum fit chromosome generation in the 17th generation of FLBPID optimization

	CHROMOSOME																													
1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	1	1	0	0	1
2	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	1	0	1	1	1	1
3	1	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	0	0	0	0	1	0	0	1	0	0	0	1	1	1	1
4	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1	0	1	1	1	1	1	0	1
5	1	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	1	1	1	1
6	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	1	0	0	0	1	0	0	1	0	1	1	1	1
7	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	0	1
8	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	1
9	1	0	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	1	0	0	0	1	1	1	1	1
10	1	0	0	0	0	0	0	1	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1
11	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	1	0	0	0	0	1	0	1	1	1	1	1	1
12	1	0	0	0	0	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1
13	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
14	1	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
15	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**1**
16	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1
17	1	0	0	0	0	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	1
18	1	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	1	0	1	0	0	0	0	1	0	1	0	1	1	1	1
19	1	0	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	1	0	1	1	1	1	0	1
20	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1
21	1	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	1
22	1	0	0	0	0	0	1	0	1	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	1	0	1	1	1	1
23	1	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1
24	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0	1	1
25	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1
26	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	1

Table C.8 Maximum fit chromosome generation in the 17th generation of FLBPID optimization (Cont'd)

	CHROMOSOME																													
27	1	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	1
28	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	1	0	1	1	0	1
29	1	0	0	0	1	0	1	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1
30	1	0	0	0	0	0	0	1	0	0	0	1	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1
31	1	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	1	1	1	1	0	1
32	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	1	0	1	1	1	0
33	1	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	0	0	1	0	1	0	1	0	0	0	0	1	0	1	0
34	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1
35	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	1	0	1	1	1	1
36	1	0	0	0	0	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	1	1	1	0	1
37	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0	0	0	0	0	0	1	0	1	1	1	1
38	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	0
39	1	0	0	0	0	0	1	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1
40	1	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	1	0	0	1	0	1	0	1	1
41	1	0	0	0	0	1	0	0	1	0	0	1	1	1	1	0	0	0	0	0	1	0	0	1	0	0	0	1	0	1	1
42	1	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	1	1	1	0	1

Table C.9 Maximum fit chromosome generation in the 11th generation of FLC part in the FLIC optimization

NO.	CHROMOSOME																				
1	1	1	1	1	1	1	0	1	1	0	1	1	0	1	1	1	0	0	1	1	1
2	1	1	1	1	1	1	0	1	1	0	1	1	1	0	1	0	0	1	1	1	1
3	1	1	1	1	1	1	0	0	1	1	1	0	0	0	1	0	0	0	1	1	1
4	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	0	0	1	1	1	1
5	0	1	1	1	1	1	0	0	1	0	1	1	1	0	0	0	1	0	1	1	1
6	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1	0	0	0	1	0
7	1	1	1	1	1	1	1	1	0	1	1	0	0	0	1	0	0	0	0	1	0
8	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	1	1
9	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1
10	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	0	0	1	0
11	1	1	0	1	1	1	0	1	1	0	1	1	0	0	1	0	1	0	1	1	1
12	0	1	1	1	1	1	0	1	1	1	1	1	1	0	1	0	1	1	1	1	1
13	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	0	0	1	1
14	1	1	1	1	1	1	0	1	1	0	1	1	1	0	1	0	0	1	1	1	1
15	1	1	1	1	1	0	0	1	1	0	1	1	1	0	1	0	0	0	0	1	1
16	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	0	0	1	1	1	1
17	0	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	0	1	1	1
18	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1
19	1	1	1	1	1	0	0	1	1	0	1	0	0	0	1	1	0	1	0	1	1
20	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	0
21	1	1	1	1	1	0	0	1	1	0	1	1	1	0	1	1	1	0	1	1	1
22	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	0	1	1	1
23	1	1	1	1	1	1	0	1	1	0	1	1	1	0	1	1	0	1	1	1	1
24	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	0	1	1	1	0
25	1	1	1	1	1	1	0	1	1	0	1	1	1	0	1	1	0	0	1	1	1
26	**1**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**1**	**1**	**1**
27	0	1	1	1	1	1	1	0	1	0	1	1	1	1	0	0	0	1	1	1	1
28	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1	1	1
29	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	1	1
30	1	1	1	1	1	1	0	1	1	0	1	1	1	0	1	0	0	1	1	1	1

Table C.10 Maximum fit chromosome generation in the 10th generation of IO scales and constant in the FLIC optimization

NO.	CHROMOSOME																				
1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
2	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
13	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
22	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX D

SPEED CONTROL RESPONSES

D.1Simulation of SPOGA and non-SPOGA Optimized Controllers

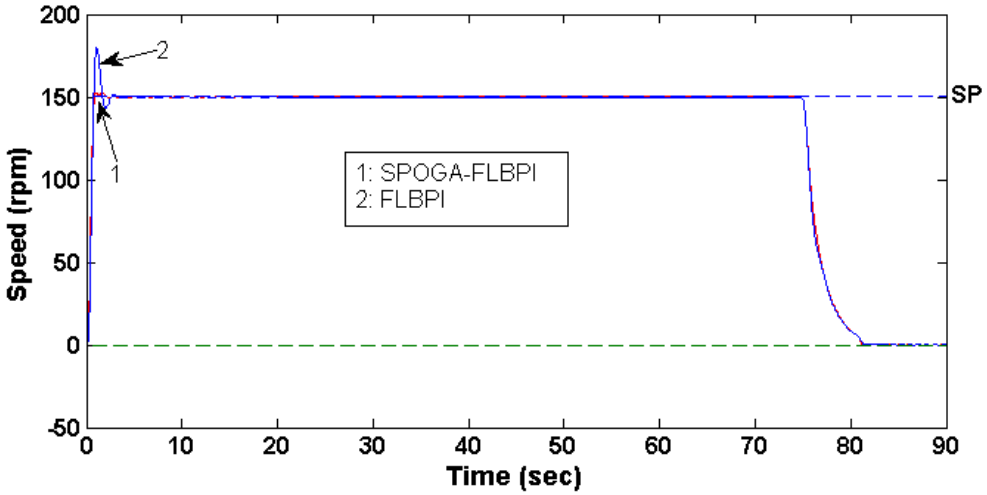

Fig. D.1 Speed control of DC servomotor using SPOGA-FLBPI vs. FLBPI for simulation 1a

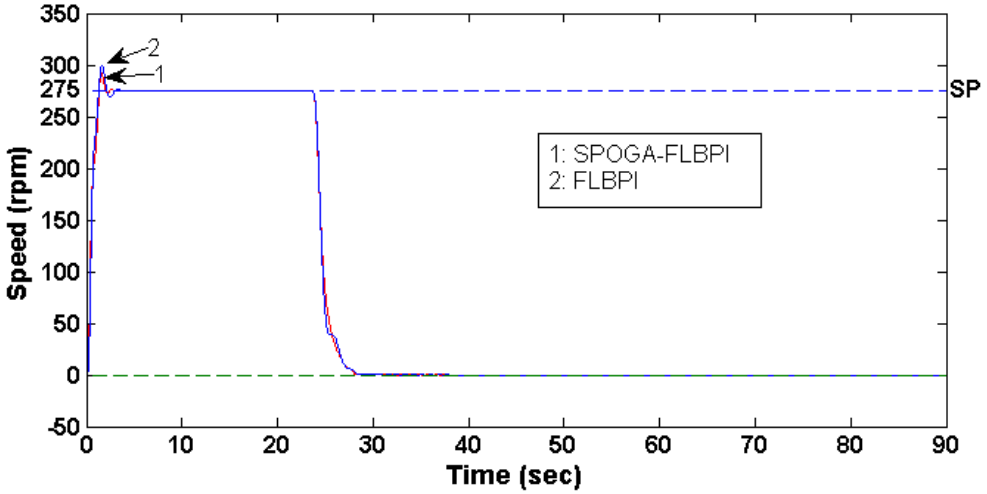

Fig. D.2 Speed control of DC servomotor using SPOGA-FLBPI vs. FLBPI for simulation 2

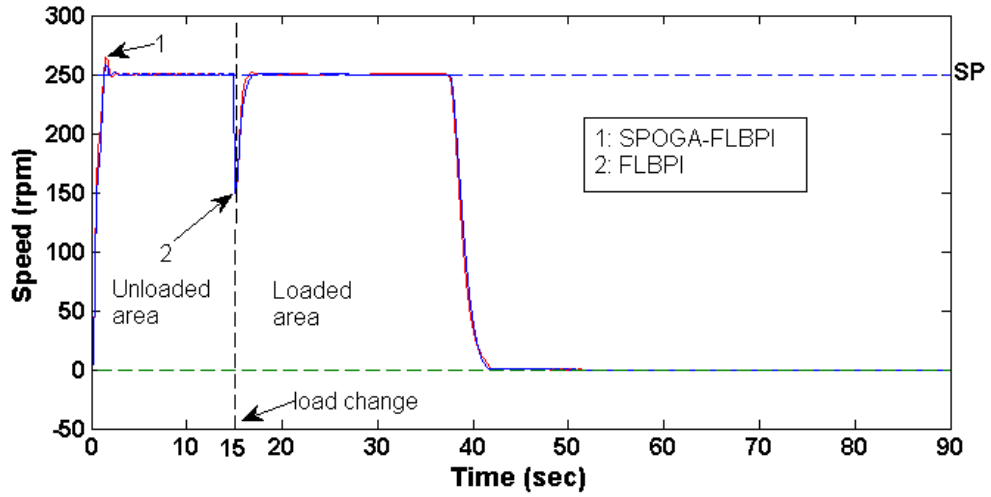

Fig. D.3 Speed control of DC servomotor using SPOGA-FLBPI vs. FLBPI for simulation 3a

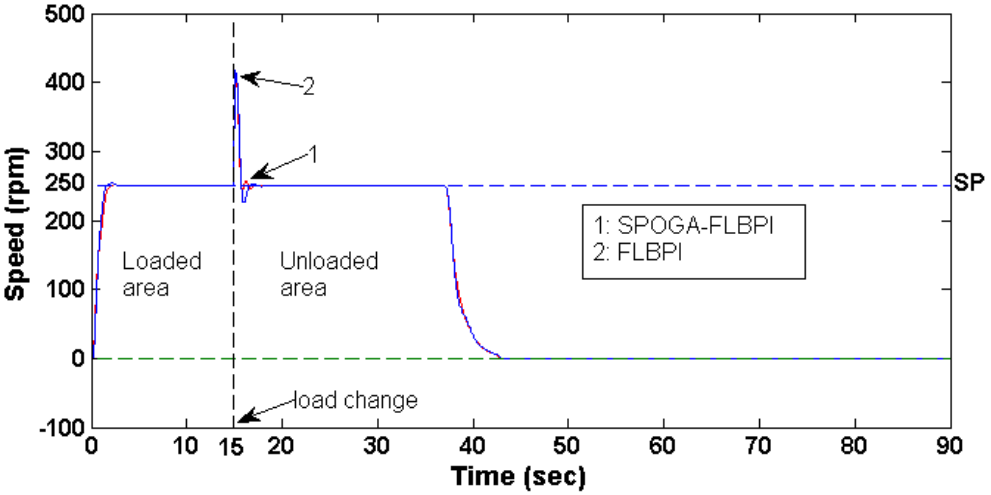

Fig. D.4 Speed control of DC servomotor using SPOGA-FLBPI vs. FLBPI for simulation 3b

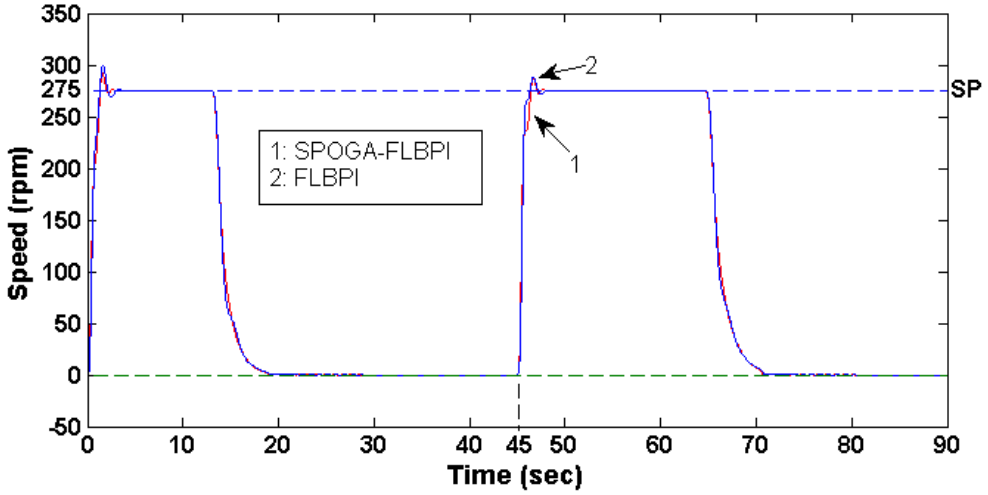

Fig. D.5 Speed control of DC servomotor using SPOGA-FLBPI vs. FLBPI for simulation 4b

D.2Real-time Implementation of SPOGA and non-SPOGA Optimized Controllers

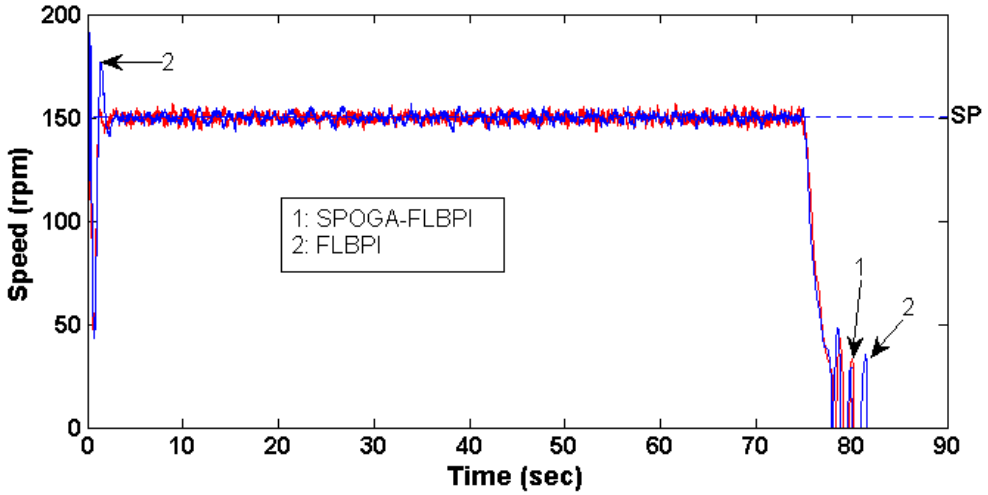

Fig. D.6 Speed control of DC servomotor using SPOGA-FLBPI vs. FLBPI for experiment 1a

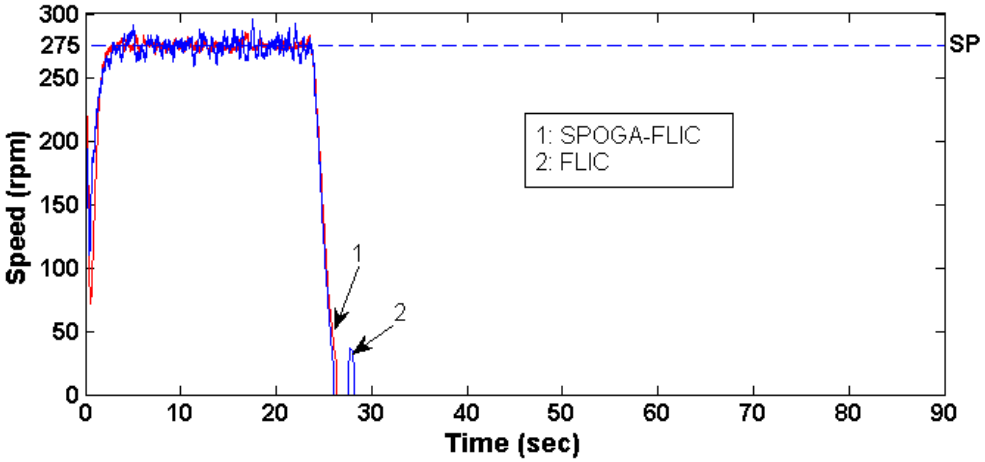

Fig. D.7 Speed control of DC servomotor using SPOGA-FLIC vs. FLIC for experiment 2

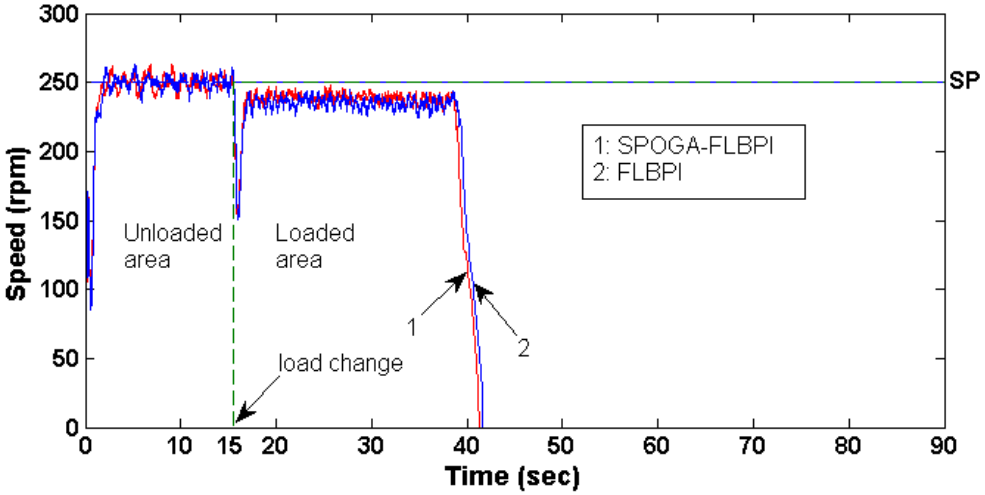

Fig. D.8 Speed control of DC servomotor using SPOGA-FLBPI vs. FLBPI for experiment 3a

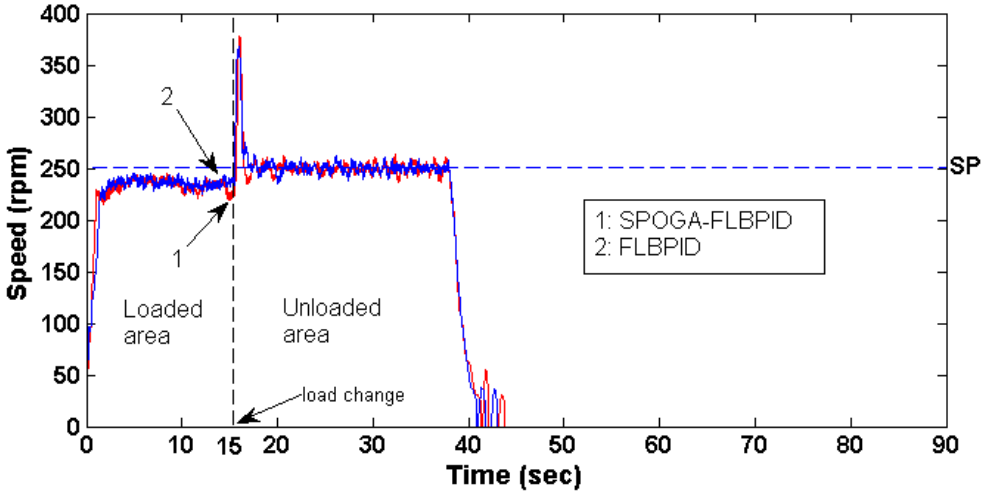

Fig. D.9 Speed control of DC servomotor using SPOGA-FLBPID vs. FLBPID for experiment 3b

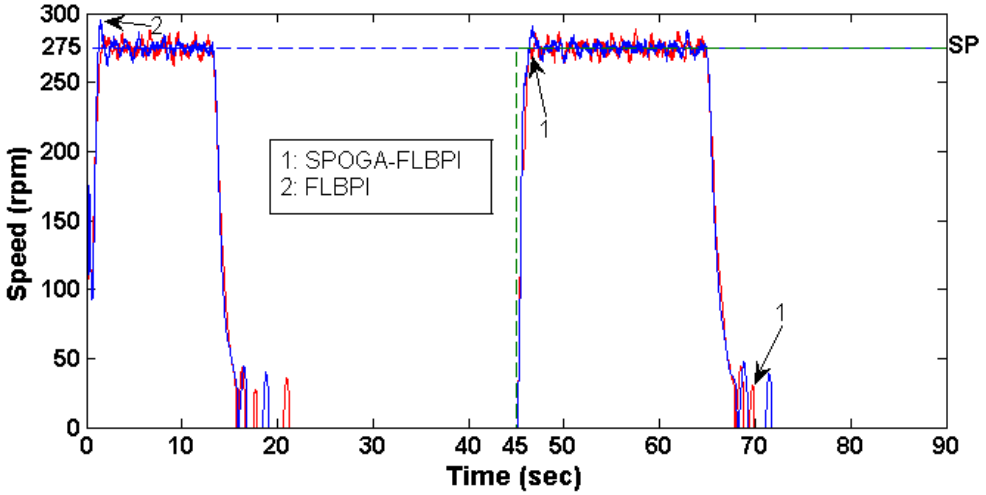

Fig. D.10 Speed control of DC servomotor using SPOGA-FLBPI vs. FLBPI for experiment 4b

D.3Real-time Implementation of SPOGA Optimized and Conventional Controllers

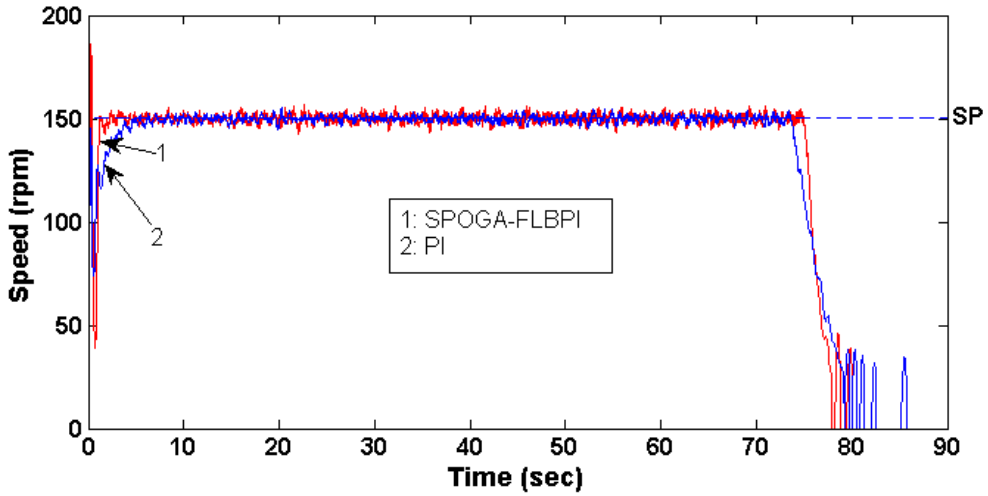

Fig. D.11 Speed control of DC servomotor using SPOGA-FLBPI vs. PI for experiment 1a

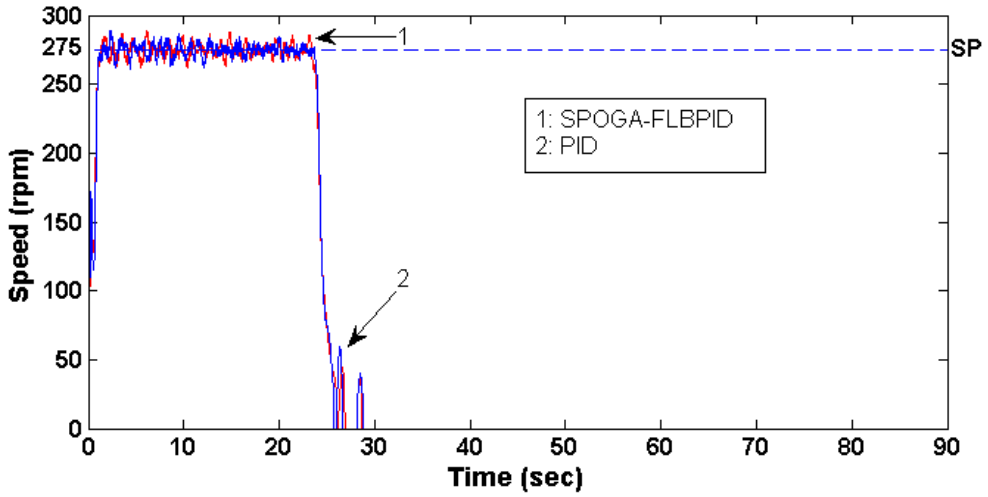

Fig. D.12 Speed control of DC servomotor using SPOGA-FLBPID vs. PID for experiment 2

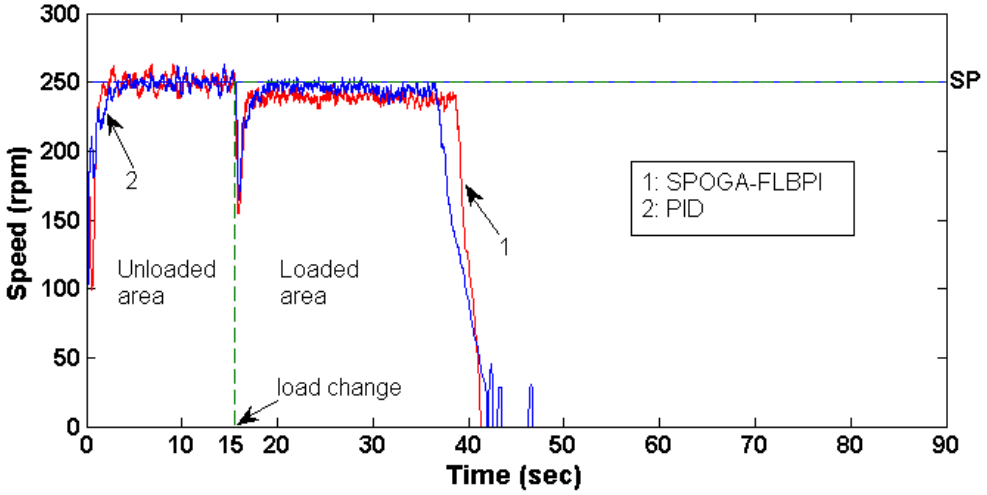

Fig. D.13 Speed control of DC servomotor using SPOGA-FLBPI vs. PID for experiment 3a

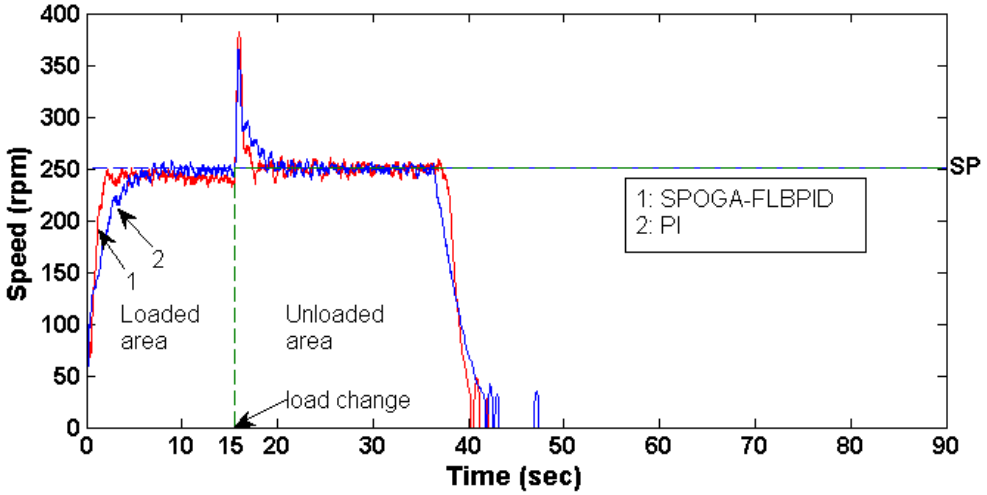

Fig. D.14 Speed control of DC servomotor using SPOGA-FLBPID vs. PI for experiment 3b

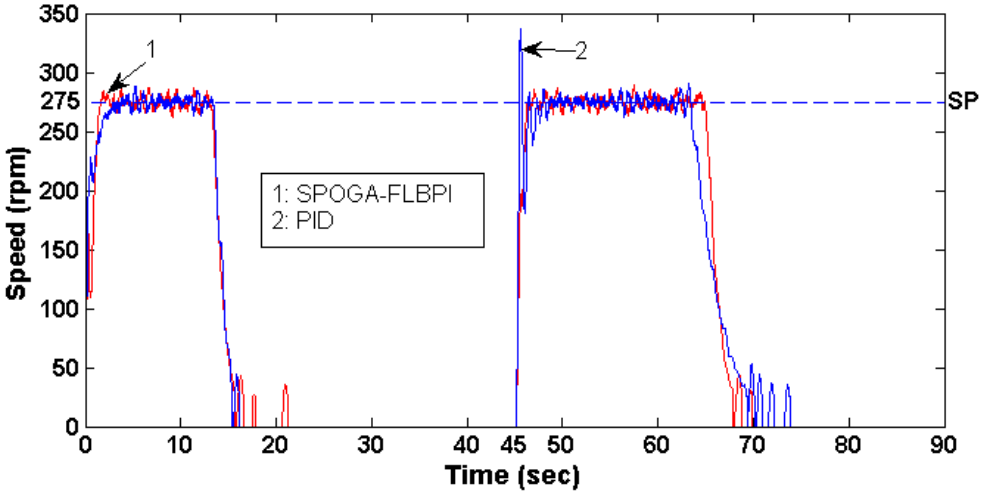

Fig. D.15 Speed control of DC servomotor using SPOGA-FLBPI vs. PID for experiment 4b