

Direct Adaptive Rejection of Unknown Time-varying Narrow Band Disturbances applied to a Benchmark Problem

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I. SIMULATION RESULTS

TABLE I
SIMULATION RESULTS - SIMPLE STEP TEST

LEVEL 1							
Frequency (Hz)	GA (dB)	DA (dB)	MA (dB@Hz)	N ² T (×10 ⁻³)	N ² R (×10 ⁻³)	MV (×10 ⁻³)	TD (ratio)
50	34.2	44.4	7.2@67.2	14.5	3.8	17.7	1.11
55	32.8	46.8	6.7@78.1	10.2	4.4	19.9	1.08
60	32.3	46.9	6.8@82.8	10.2	4.7	20.1	1.07
65	32.8	48.4	7.0@50.0	9.3	4.5	19.9	1.07
70	33.3	50.0	7.8@53.1	8.3	4.3	19.9	1.07
75	34.0	51.9	7.3@53.1	7.9	4.1	19.8	1.08
80	34.6	51.6	7.7@93.8	8.2	3.8	21.8	1.09
85	34.4	52.3	6.7@64.1	9.8	3.7	23.9	1.11
90	31.9	45.0	7.5@68.8	13.3	4.0	26.8	1.11
95	23.9	35.7	6.2@87.5	20.8	4.6	29.1	1.06
LEVEL 2							
Frequency (Hz)	GA (dB)	DA (dB)-(dB)	MA (dB@Hz)	N ² T (×10 ⁻³)	N ² R (×10 ⁻³)	MV (×10 ⁻³)	TD (ratio)
50-70	39.2	41.8 - 47.5	6.1@79.7	25.0	4.3	29.4	1.06
55-75	38.4	48.3 - 47.7	7.7@87.5	23.4	4.8	34.7	1.06
60-80	39.4	50.1 - 49.3	7.9@50.0	19.4	4.2	34.2	1.11
65-85	39.8	49.1 - 51.0	7.2@53.1	18.3	3.9	36.6	1.12
70-90	38.5	51.5 - 42.6	7.6@59.4	27.3	4.2	40.6	1.08
75-95	36.5	54.0 - 37.3	6.1@87.5	35.6	4.1	44.5	1.06
LEVEL 3							
Frequency (Hz)	GA (dB)	DA (dB)-(dB)-(dB)	MA (dB@Hz)	N ² T (×10 ⁻³)	N ² R (×10 ⁻³)	MV (×10 ⁻³)	TD (ratio)
50-65-80	42.8	43.9 - 44.9 - 41.3	7.7@87.5	136.0	4.2	72.5	1.11
55-70-85	43.0	48.8 - 49.6 - 46.8	7.6@76.6	352.3	4.1	133.4	1.11
60-75-90	42.0	47.7 - 49.7 - 42.4	8.5@51.6	655.8	4.4	209.2	1.12
65-80-95	40.9	44.5 - 42.3 - 37.9	7.9@73.4	1615.7	4.1	295.9	1.15

TABLE II
SIMULATION RESULTS - CHIRP TEST

Profile	Mean Square ×10 ⁻⁶		Maximum ×10 ⁻³	
	↗	↘	↗	↘
Level 1	14.5	14.0	14.0	14.9
Level 2	42.5	42.1	19.4	19.9
Level 3	93.1	87.6	39.4	42.3

TABLE III
SIMULATION RESULTS - STEP FREQUENCY CHANGES TEST

	Frequency (Hz)	N ² T ($\times 10^{-3}$)	MV ($\times 10^{-3}$)
Level 1	Sequence - 1		
	60→70	17.1	22.2
	70→60	17.0	16.1
	60→50	46.2	18.7
	50→60	41.8	30.7
	Sequence - 2		
	75→85	16.7	15.7
	85→75	15.4	18.6
	75→65	14.2	15.1
	65→75	14.3	17.1
	Sequence - 3		
	85→95	39.3	23.8
	95→85	32.9	28.1
	85→75	15.5	21.1
75→85	16.3	15.8	
Level 2	Sequence - 1		
	[55-75]→[60-80]	38.3	34.7
	[60-80]→[55-75]	36.2	30.4
	[55-75]→[50-70]	78.0	35.5
	[50-70]→[55-75]	70.1	39.1
	Sequence - 2		
	[70-90]→[75-95]	61.0	30.9
	[75-95]→[70-90]	66.7	40.3
	[70-90]→[65-85]	39.5	34.6
	[65-85]→[70-90]	39.4	29.4
Level 3	Sequence - 1		
	[55-70-85]→[60-75-90]	154.7	52.5
	[60-75-90]→[55-70-85]	141.2	56.7
	[55-70-85]→[50-65-80]	253.5	62.5
	[50-65-80]→[55-70-85]	147.7	63.8
	Sequence - 2		
	[60-75-90]→[65-80-95]	180.2	51.5
	[65-80-95]→[60-75-90]	166.4	78.2
[60-75-90]→[55-70-85]	136.2	56.0	
[55-70-85]→[60-75-90]	144.9	51.9	

II. REAL TIME RESULTS

TABLE IV
REAL TIME RESULTS - SIMPLE STEP TEST

LEVEL 1							
Frequency (Hz)	GA (dB)	DA (dB)	MA (dB@Hz)	N ² T (×10 ⁻³)	N ² R (×10 ⁻³)	MV (×10 ⁻³)	TD (ratio)
50	34.6	38.5	9.8@65.6	14.5	4.9	13.9	0.941
55	34.5	50.5	9.5@118.8	13.3	4.9	20.2	0.990
60	33.3	49.5	8.2@79.7	14.7	5.2	21.2	0.945
65	32.8	50.0	9.7@90.6	14.2	4.5	20.5	1.125
70	30.5	47.9	9.0@89.1	14.7	4.9	23.0	0.905
75	29.5	45.5	8.9@50.0	11.2	4.9	19.3	0.869
80	30.3	48.7	8.5@95.3	8.1	4.2	21.1	0.964
85	28.5	45.9	10.7@57.8	10.1	6.9	25.1	0.959
90	28.0	42.7	8.2@73.4	17.1	6.9	25.1	1.089
95	24.6	34.6	9.1@82.8	50.1	8.3	32.4	1.638
LEVEL 2							
Frequency (Hz)	GA (dB)	DA (dB)-(dB)	MA (dB@Hz)	N ² T (×10 ⁻³)	N ² R (×10 ⁻³)	MV (×10 ⁻³)	TD (ratio)
50-70	34.4	33.6 - 42.9	8.3@59.4	32.1	9.4	29.0	0.911
55-75	33.3	44.9 - 44.2	11.9@115.6	32.5	8.0	30.2	1.518
60-80	33.4	45.6 - 41.7	7.8@118.8	31.4	7.1	29.0	0.943
65-85	31.7	40.0 - 43.7	8.0@106.3	22.8	7.6	31.4	1.019
70-90	32.9	41.4 - 38.6	7.5@59.4	21.4	6.1	33.9	1.112
75-95	31.0	48.9 - 34.7	7.1@87.5	28.3	6.7	38.4	0.998
LEVEL 3							
Frequency (Hz)	GA (dB)	DA (dB)-(dB)-(dB)	MA (dB@Hz)	N ² T (×10 ⁻³)	N ² R (×10 ⁻³)	MV (×10 ⁻³)	TD (ratio)
50-65-80	41.7	38.4 - 46.9 - 42.4	9.4@117.2	250.8	6.2	81.9	0.997
55-70-85	40.6	44.8 - 45.0 - 38.3	8.8@76.6	357.5	5.7	143.2	0.957
60-75-90	37.7	44.7 - 46.4 - 43.9	6.7@82.2	338.8	7.2	141.1	0.999
65-80-95	38.6	43.6 - 41.1 - 38.7	9.2@54.7	561.6	5.6	141.1	1.112

TABLE V
REAL TIME RESULTS - CHIRP TEST

Profile	Mean Square ×10 ⁻⁶		Maximum ×10 ⁻³	
	↗	↘	↗	↘
Level 1	13.7	13.9	15.0	15.0
Level 2	41.3	42.4	21.6	21.2
Level 3	93.1	90.8	41.7	37.9

TABLE VI
REAL TIME RESULTS - STEP FREQUENCY CHANGES TEST

	Frequency (Hz)	N ² T ($\times 10^{-3}$)	MV ($\times 10^{-3}$)
Level 1	Sequence - 1		
	60→70	16.8	21.2
	70→60	16.8	19.3
	60→50	69.2	20.1
	50→60	46.1	33.4
	Sequence - 2		
	75→85	16.0	15.1
	85→75	15.5	18.7
	75→65	14.6	18.0
	65→75	14.2	18.7
	Sequence - 3		
	85→95	40.8	16.8
	95→85	30.7	23.7
	85→75	15.2	20.0
	75→85	16.0	14.3
Level 2	Sequence - 1		
	[55-75]→[60-80]	38.6	35.2
	[60-80]→[55-75]	38.5	31.0
	[55-75]→[50-70]	117.3	40.1
	[50-70]→[55-75]	69.2	43.3
	Sequence - 2		
	[70-90]→[75-95]	66.5	32.7
	[75-95]→[70-90]	60.0	33.8
	[70-90]→[65-85]	42.6	35.2
	[65-85]→[70-90]	43.0	28.6
Level 3	Sequence - 1		
	[55-70-85]→[60-75-90]	141.5	57.7
	[60-75-90]→[55-70-85]	186.3	61.2
	[55-70-85]→[50-65-80]	251.5	75.9
	[50-65-80]→[55-70-85]	224.6	67.5
	Sequence - 2		
	[60-75-90]→[65-80-95]	213.0	56.5
	[65-80-95]→[60-75-90]	181.0	68.5
	[60-75-90]→[55-70-85]	128.8	58.7
[55-70-85]→[60-75-90]	150.0	54.0	