

Indirect Adaptive Regulation Strategy for the Attenuation of 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 ($\times 10^{-3}$)	N ² R ($\times 10^{-3}$)	MV ($\times 10^{-3}$)	TD (ratio)
50	34.5	46.8	6.4@59.4	21.0	3.6	18.1	1.09
55	34.5	50.0	4.2@68.8	24.1	3.7	20.7	1.08
60	34.4	48.1	3.9@68.8	25.7	3.7	21.8	1.09
65	34.4	48.5	3.6@76.6	18.9	3.7	19.4	1.07
70	34.5	54.1	2.8@79.7	11.3	3.8	21.3	1.07
75	34.8	54.3	3.1@67.2	7.8	3.7	22.8	1.07
80	35.1	49.1	3.3@67.2	7.6	3.5	23.5	1.08
85	34.9	50.0	3.4@70.3	8.7	3.5	23.6	1.09
90	32.7	43.7	4.1@78.1	149.9	3.7	40.9	1.08
95	23.8	40.4	7.9@87.5	200.9	4.6	38.8	1.07
LEVEL 2							
Frequency (Hz)	GA (dB)	DA (dB)-(dB)	MA (dB@Hz)	N ² T ($\times 10^{-3}$)	N ² R ($\times 10^{-3}$)	MV ($\times 10^{-3}$)	TD (ratio)
50-70	39.7	45.5 - 50.3	7.5@59.4	115.6	4.0	43.1	1.06
55-75	40.0	48.2 - 50.8	6.3@67.2	261.5	3.9	51.8	1.07
60-80	40.5	45.9 - 46.4	5.8@68.8	476.3	3.7	53.4	1.10
65-85	40.4	46.3 - 47.4	5.7@73.4	375.3	3.7	49.4	1.09
70-90	39.0	52.1 - 43.3	5.4@76.6	245.4	4.0	42.4	1.07
75-95	35.3	52.0 - 40.5	8.5@87.5	144.1	4.7	49.3	10.11
LEVEL 3							
Frequency (Hz)	GA (dB)	DA (dB)-(dB)-(dB)	MA (dB@Hz)	N ² T ($\times 10^{-3}$)	N ² R ($\times 10^{-3}$)	MV ($\times 10^{-3}$)	TD (ratio)
50-65-80	43.3	44.0 - 42.7 - 43.6	7.5@56.3	29.8	4.0	50.4	1.07
55-70-85	43.3	46.3 - 47.8 - 45.5	6.6@62.5	56.6	4.0	53.3	1.08
60-75-90	42.6	45.4 - 50.1 - 42.1	6.8@68.8	131.4	4.1	65.4	1.08
65-80-95	40.5	45.3 - 42.2 - 33.7	8.6@87.5	205.4	4.4	82.1	1.07

TABLE II
SIMULATION RESULTS - CHIRP TEST

Profile	Mean Square $\times 10^{-6}$		Maximum $\times 10^{-3}$	
	↗	↘	↗	↘
Level 1	39.2	53.7	13.2	18.7
Level 2	26.0	29.7	13.4	16.5
Level 3	15.8	17.2	12.5	12.8

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	43.3	23.2
	70→60	40.2	21.0
	60→50	31.5	18.8
	50→60	50.9	30.2
	Sequence - 2		
	75→85	44.7	21.2
	85→75	52.2	21.3
	75→65	45.1	19.9
	65→75	43.3	22.9
	Sequence - 3		
	85→95	56.0	23.2
	95→85	104.2	36.6
	85→75	51.7	22.2
	75→85	44.1	21.1
Level 2	Sequence - 1		
	[55-75]→[60-80]	37.7	34.8
	[60-80]→[55-75]	36.9	33.4
	[55-75]→[50-70]	38.4	32.5
	[50-70]→[55-75]	46.7	36.2
	Sequence - 2		
	[70-90]→[75-95]	40.4	28.9
	[75-95]→[70-90]	64.1	40.6
	[70-90]→[65-85]	38.1	31.2
	[65-85]→[70-90]	37.4	31.4
Level 3	Sequence - 1		
	[55-70-85]→[60-75-90]	87.7	58.4
	[60-75-90]→[55-70-85]	86.1	59.3
	[55-70-85]→[50-65-80]	90.8	58.0
	[50-65-80]→[55-70-85]	91.9	63.2
	Sequence - 2		
	[60-75-90]→[65-80-95]	86.0	53.6
	[65-80-95]→[60-75-90]	113.3	62.2
[60-75-90]→[55-70-85]	85.5	60.8	
[55-70-85]→[60-75-90]	84.2	58.7	

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 ($\times 10^{-3}$)	N ² R ($\times 10^{-3}$)	MV ($\times 10^{-3}$)	TD (ratio)
50	36.2	37.5	11.6@65.6	62.1	6.6	23.6	1.013
55	38.5	49.4	8.2@120.3	33.3	3.6	21.8	1.310
60	36.7	49.2	9.5@46.9	26.1	4.1	20.6	1.088
65	36.3	48.5	8.0@134.4	15.2	3.6	22.4	0.875
70	34.2	52.8	10.7@134.4	9.9	3.7	19.4	1.097
75	33.3	46.9	6.0@134.4	8.5	3.6	18.6	1.029
80	32.7	48.3	7.5@276.6	16.1	3.7	20.6	0.985
85	32.6	48.1	12.0@73.4	20.9	3.6	22.3	1.120
90	31.2	47.4	8.5@14.1	21.2	3.6	24.8	1.071
95	28.8	38.5	10.9@82.2	21.4	3.7	27.2	1.094
LEVEL 2							
Frequency (Hz)	GA (dB)	DA (dB)-(dB)	MA (dB@Hz)	N ² T ($\times 10^{-3}$)	N ² R ($\times 10^{-3}$)	MV ($\times 10^{-3}$)	TD (ratio)
50-70	38.4	39.7 - 47.3	9.3@56.3	50.4	7.7	34.6	0.983
55-75	40.2	48.9 - 40.7	9.1@270.3	435.2	4.7	63.4	0.982
60-80	39.1	49.9 - 47.2	10.0@68.8	51.7	3.5	36.0	0.939
65-85	35.9	43.7 - 43.9	9.8@104.7	25.1	5.1	48.5	0.939
70-90	35.4	47.2 - 39.0	8.7@134.4	230.8	4.2	84.2	0.923
75-95	35.4	47.2 - 39.0	8.4@81.3	131.2	4.0	37.7	1.019
LEVEL 3							
Frequency (Hz)	GA (dB)	DA (dB)-(dB)-(dB)	MA (dB@Hz)	N ² T ($\times 10^{-3}$)	N ² R ($\times 10^{-3}$)	MV ($\times 10^{-3}$)	TD (ratio)
50-65-80	41.9	32.5 - 35.0 - 43.7	8.0@71.7	44.0	6.5	45.7	1.052
55-70-85	42.53	46.7 - 46.2 - 48.4	11.0@62.5	92.3	4.9	58.6	0.890
60-75-90	47.8	49.6 - 42.1 - 42.4	8.7@67.2	173.5	5.4	64.7	0.972
65-80-95	41.4	44.9 - 43.7 - 36.5	9.9@87.5	340.1	4.5	57.4	0.973

TABLE V
REAL TIME RESULTS - CHIRP TEST

Profile	Mean Square $\times 10^{-6}$		Maximum $\times 10^{-3}$	
	↗	↘	↗	↘
Level 1	31.8	35.9	16.7	11.8
Level 2	34.0	35.6	16.3	16.3
Level 3	19.9	20.5	13.7	13.7

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	49.8	24.7
	70→60	50.8	24.7
	60→50	63.8	23.5
	50→60	81.4	39.4
	Sequence - 2		
	75→85	47.4	20.1
	85→75	52.8	20.1
	75→65	52.6	23.4
	65→75	48.3	24.7
	Sequence - 3		
	85→95	59.2	15.8
	95→85	95.3	32.0
	85→75	52.5	19.8
75→85	46.4	19.8	
Level 2	Sequence - 1		
	[55-75]→[60-80]	46.4	19.8
	[60-80]→[55-75]	33.7	37.4
	[55-75]→[50-70]	50.7	36.7
	[50-70]→[55-75]	45.6	41.6
	Sequence - 2		
	[70-90]→[75-95]	44.2	35.5
	[75-95]→[70-90]	54.6	36.8
	[70-90]→[65-85]	38.2	34.3
	[65-85]→[70-90]	41.2	34.4
Level 3	Sequence - 1		
	[55-70-85]→[60-75-90]	97.3	65.1
	[60-75-90]→[55-70-85]	86.4	64.8
	[55-70-85]→[50-65-80]	103.9	62.6
	[50-65-80]→[55-70-85]	115.2	68.7
	Sequence - 2		
	[60-75-90]→[65-80-95]	96.5	57.8
	[65-80-95]→[60-75-90]	100.7	61.4
[60-75-90]→[55-70-85]	85.0	61.4	
[55-70-85]→[60-75-90]	96.5	63.6	