EE2800 – Digital Signal Processing

GROUP 7

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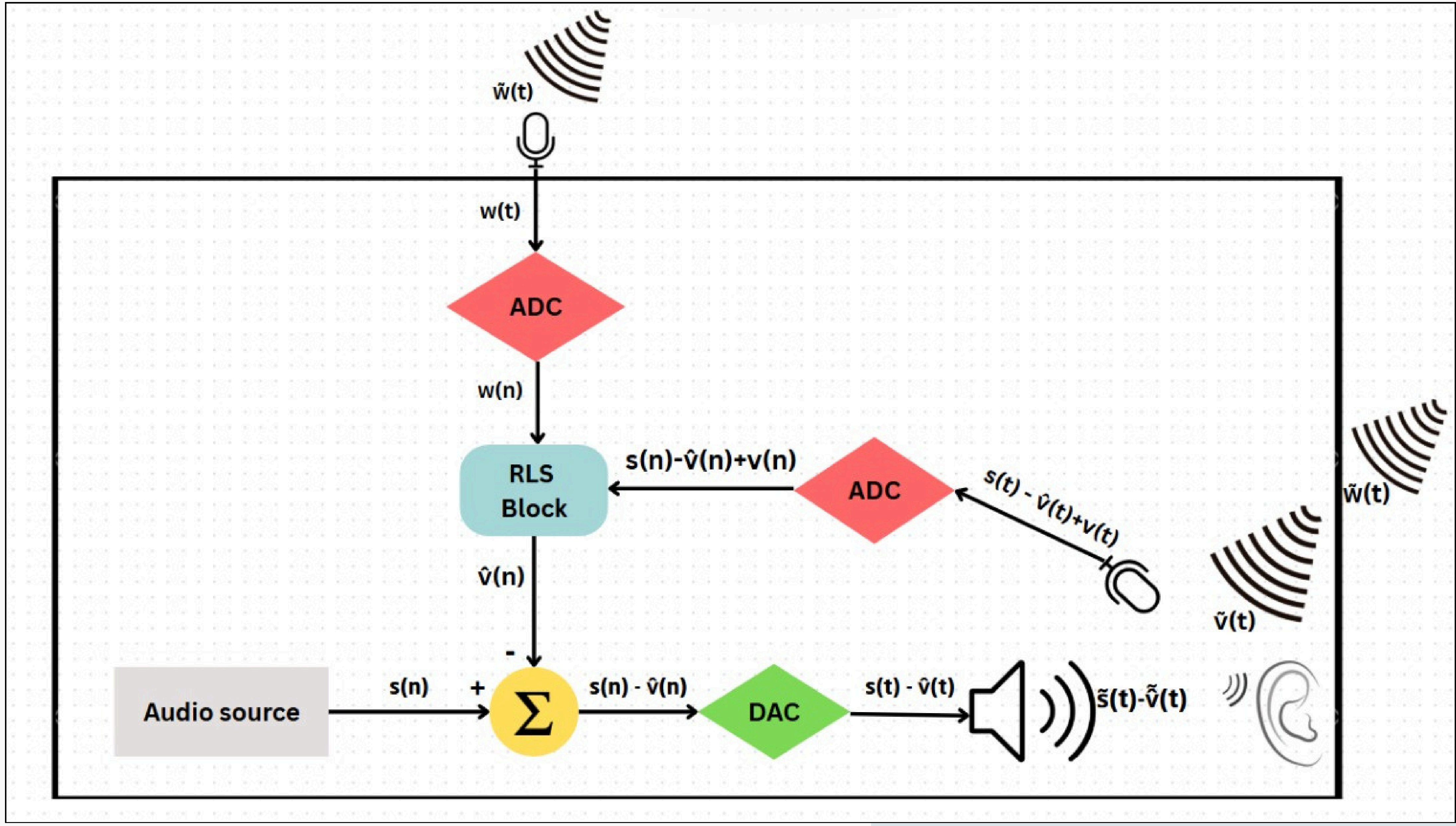
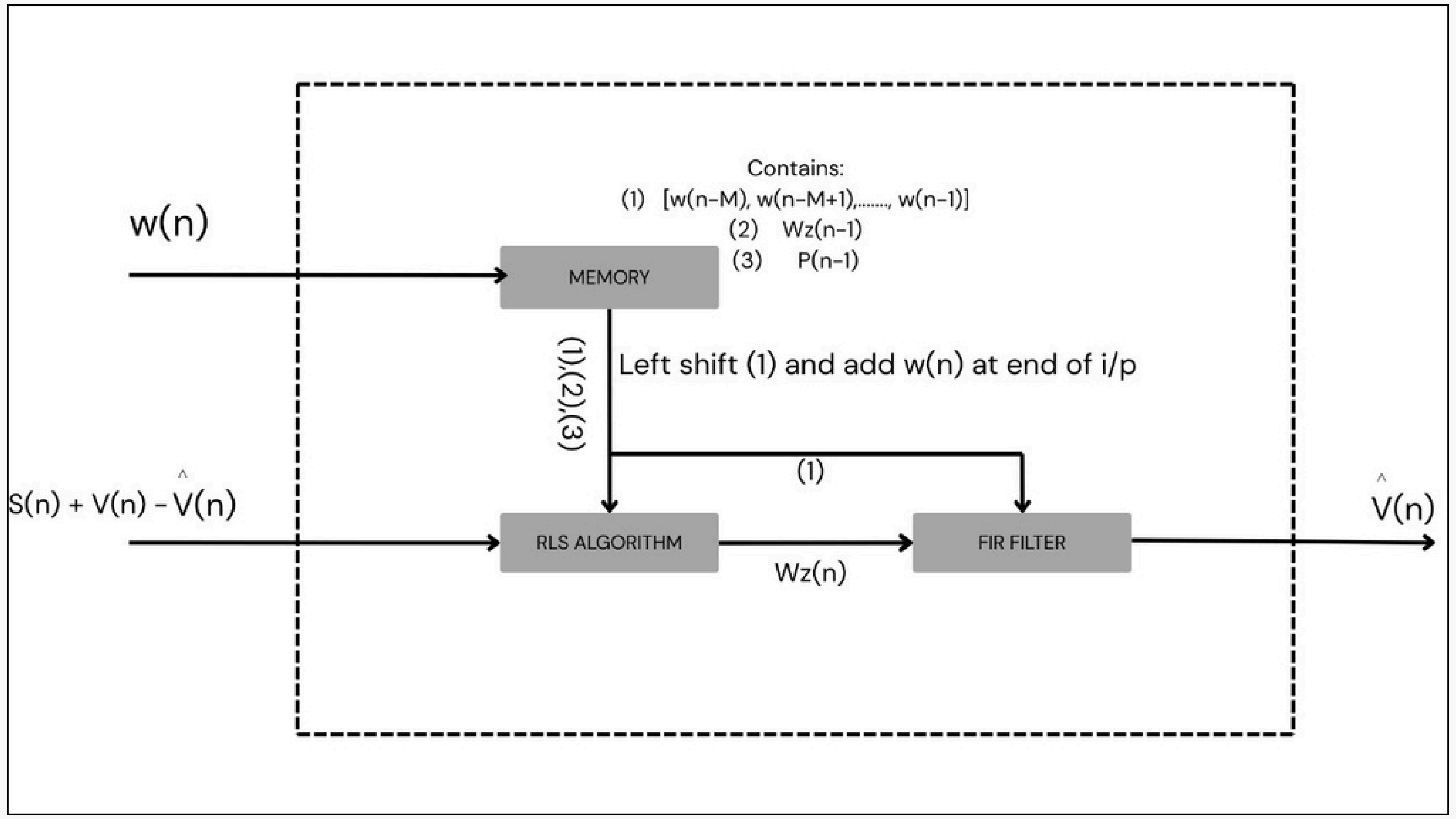
BLOCK DIAGRAMS

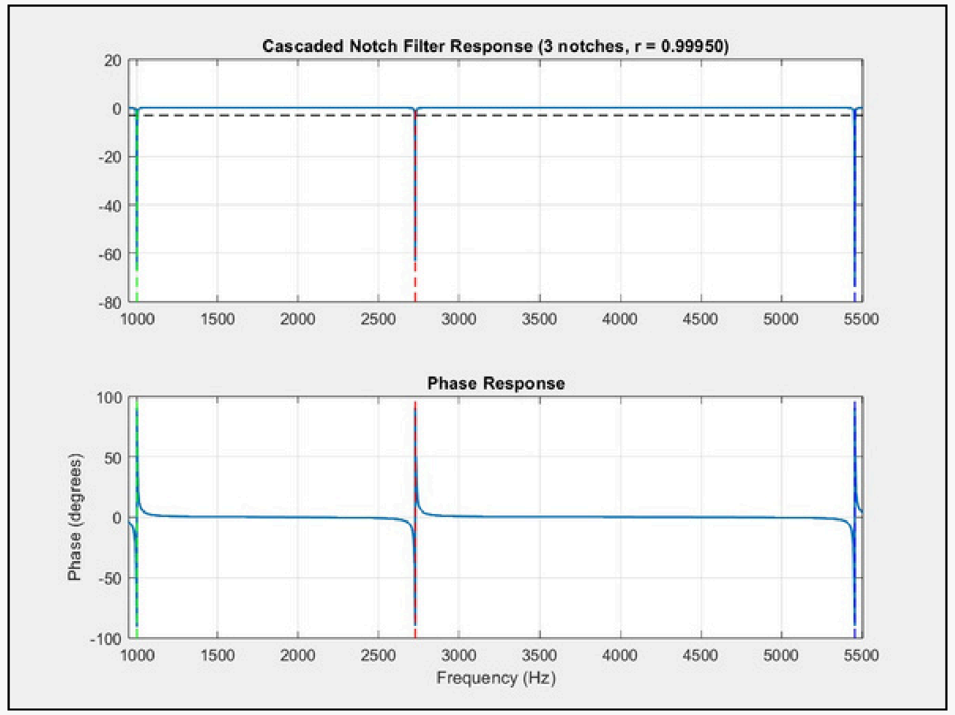




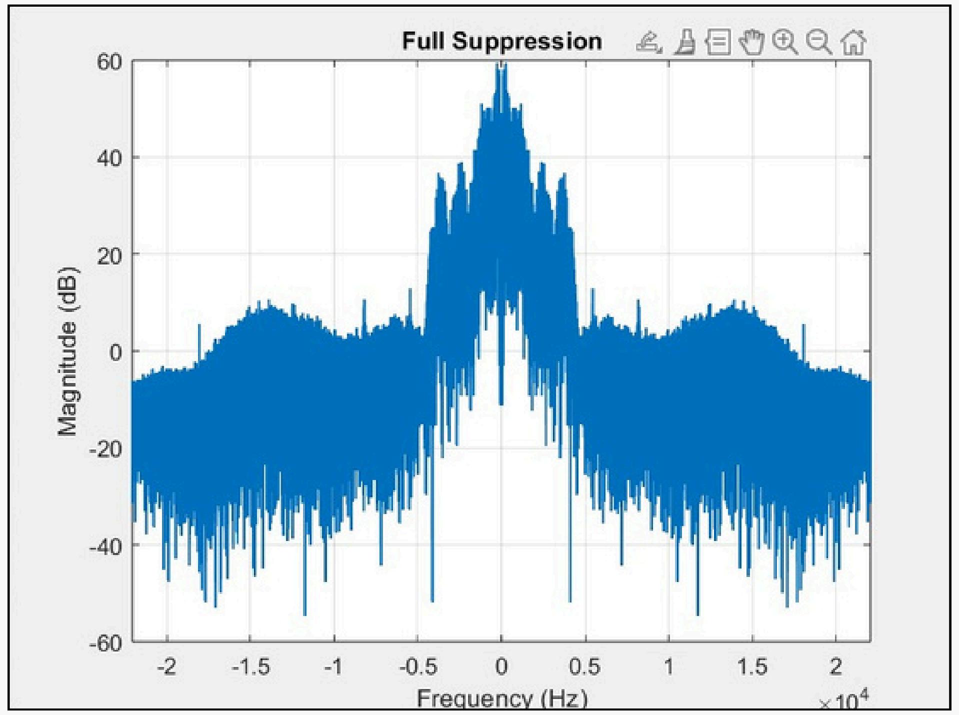
P(n) - inverse correleation matrix
w(n) - external noise
Wz(n) - filter weights

s(n) - digital clean speech
s(t) - analog clean speech
s̃(t) - acoustic clean speech
v(n) - digital leaky noise
v̂(n) - digital estimated leaky noise
ṽ(t) - acoustic leaky noise
ṽ̂(n) - analog estimated leaky noise
w̃(t) - acoustic external noise
w(t) - analog external noise
w(n) - digital external noise

Design choice and justification

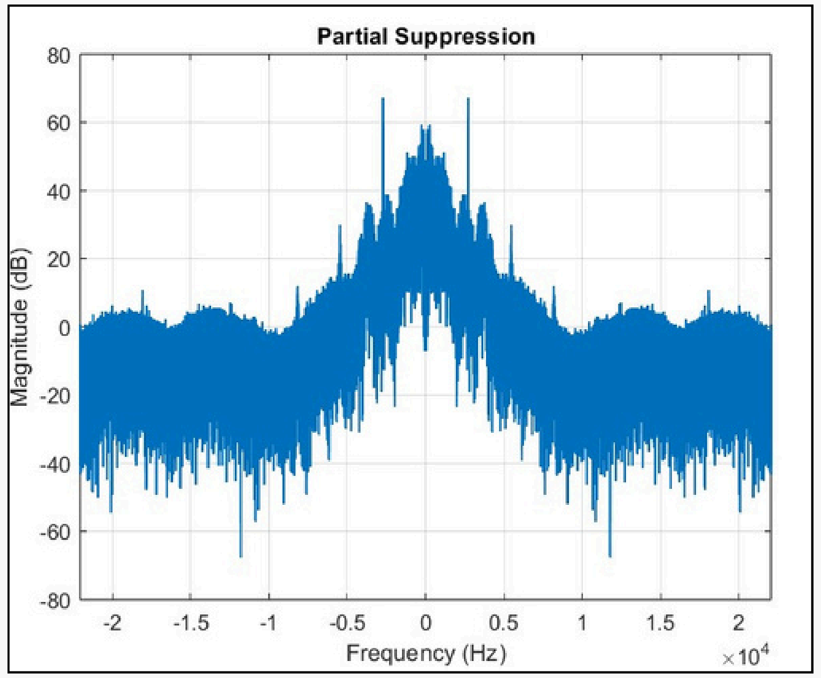


2nd order IIR 3-Notch Filter

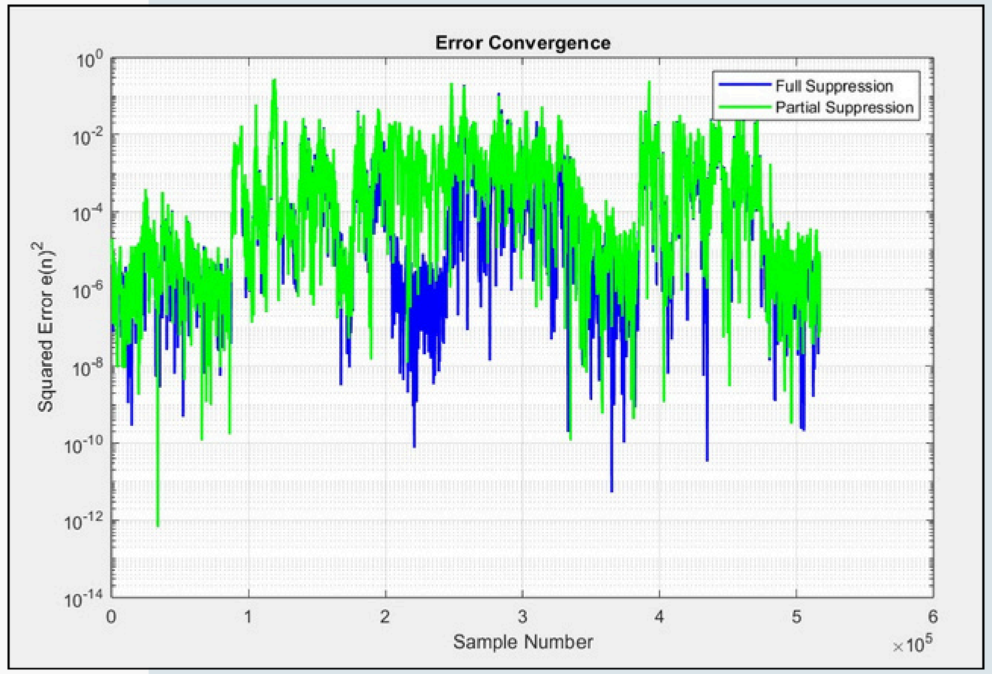


RLS-Full_Supp best params

Performance

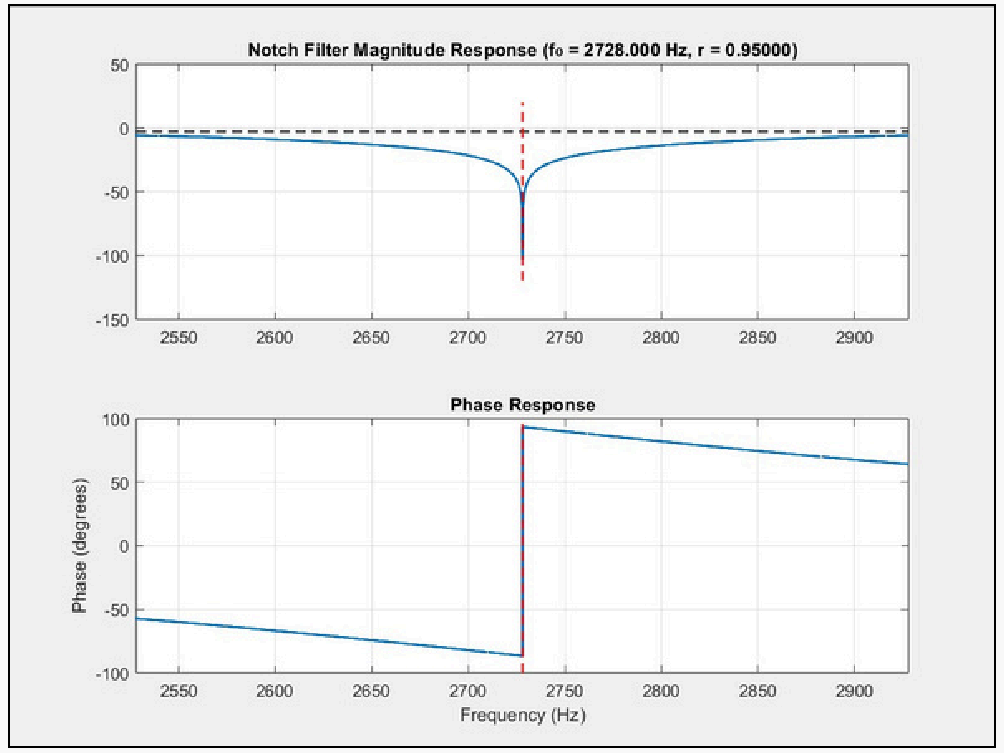


Notch at 2728.16 Hz, r=0.999

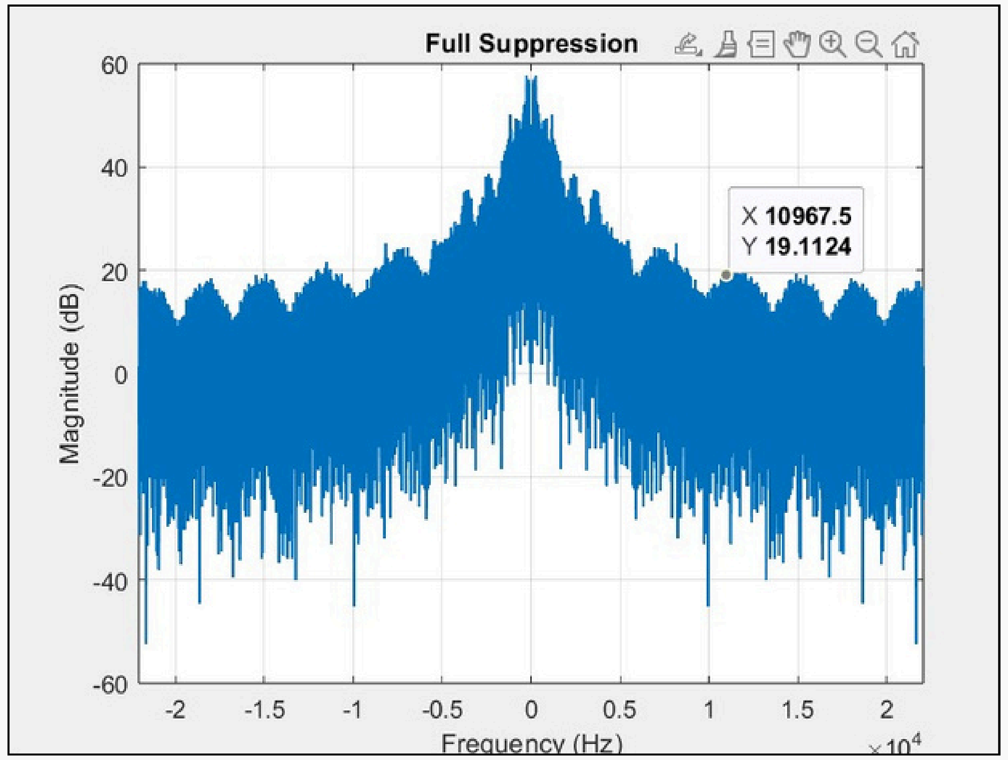


Convergence of Partial_Supp at 2728.16 Hz vs Best Full sup

Trade-offs



r=0.95 - large phase, mag away from notch



M=15 λ=0.99 δ=0.01
Bad SNR

Hyperparameters vs Performance

M	δ	λ	Notch freq (Hz)	r	SNR (dB)		Proposal (dB)	
					Full	Partial	P1	P2
5	0.001	0.9(6)	999.9	0.999	33.21	-16.38	8.605	0.0388
5	0.001	0.9(6)	2728.16	0.999	33.21	3.02	15.234	-0.0148
5	0.001	0.9(6)	2728.16	0.95	33.21	-0.51	5.28	-0.001
5	0.001	0.9(6)	999.96 ,2728.16, 5453.46	0.999	33.21	-16.43	10.545	0.025, -0,014,-0. 004
10	0.001	0.99	-	-	8.57	-	-	-
5	0.01	0.9(6)	-	-	22.22	-	-	-

RLS DESIGN

RLS Update equations (4)

g = (P(n-1) * xvec(n))/ (lambda + xvec(n)' * P(n-1)* xvec(n))
P(n) = (1/lambda) (P(n-1) - g * xvec' * P(n-1));
alpha = d(n) - Wz'(n-1) * xvec
Wz(n) = Wz(n-1) + alpha*g;
alpha = d(n) - (Wz(n)' * xvec)

PARTIAL SUPPRESSION METRICS

PROPOSAL 1 - Quantifies “SNR” of all frequencies other than notch frequencies of Partial suppression with respect to notch filtered clean speech

PROPOSAL 2 - Quantifies by how much the notch frequency in partial supression drops / gains with respect to noisy speech

Pros of RLS design , Notch filter (3):	Cons of the RLS design :
1) RLS filters show an improvement in convergence over the LMS algorithm (that had been chosen earlier) (2) 2) Low bandwidth, and performs well on the proposed metric Proposal_1, Proposal_2, with scalalbility to more notch frequencies.	1) RLS can be numerically unstable, which can occur when the matrix P(n) loses its property of positive definiteness (1) 2) Although RLS filters show an improvement in convergence over the LMS algorithm, RLS filters are very computationally intensive as well (1)

REFERENCES

(1) From, S. Haykins, pp 751-752, Prentice Hall, Third Edition)

(2) From Ying He,Hong He, Li Li, Yi Wu, Hongyan Pan, ” The Applications and simulation of Adaptive Filter in Noise Canceling ,”.DOI 10.1109/CSSE.2008.370

(3) From Proakis pp 339, Pearson Education, Fourth Edition

(4) From, S. Haykins, pp 569, Prentice Hall, Third Edition)