# DSP Project

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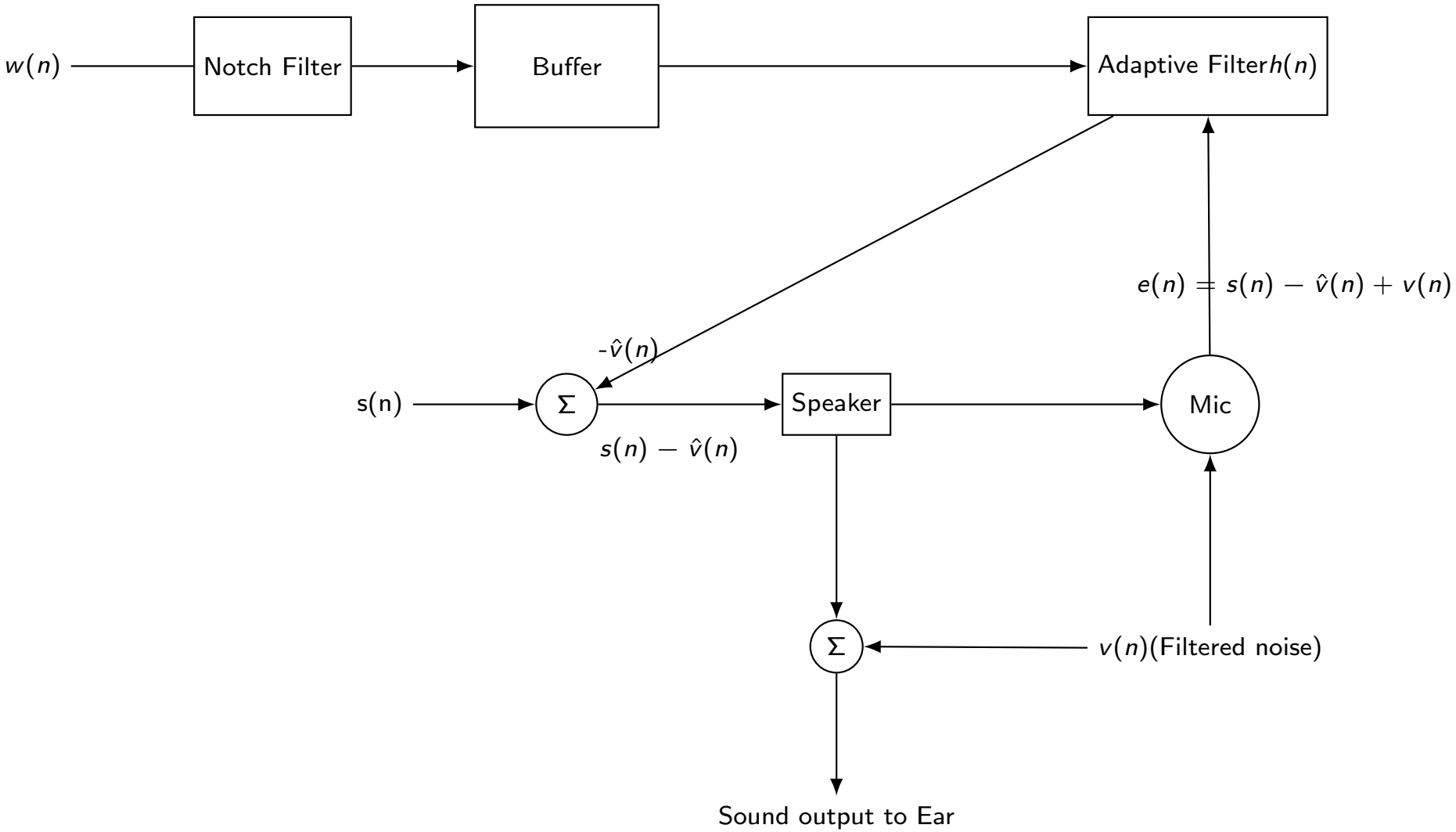
# Block Diagram



# Design, Pros and Cons

- We are estimating $\hat{v}(n)$ using the external noise $w(n)$ to v(n) using rls algorithm
- Precancelation of the estimated external noise will be sent through speaker which allows us to hear $s(n) + v(n) - \hat{v}(n)$
- We are using the RLS algorithm over the previous NLMS due to it's better noise cancellation and higher gain
- We are using second-order notch filters for partial suppression to remove tonal frequencies from external noise so that our estimated $\hat{v}$ doesn't contain those frequencies.

RLS continuously updates filter weights to minimize the total squared error using recent data . It adjusts weights using both error and past data . Uses inverse correlation matrix (P) to control learning precision .

- Pros :-
  Great for non-stationary noise that changes over time .
  Fast Convergence as compared to NLMS , so performs well in real time systems that need quick updates .
- Cons :-
  Computationally heavy as compared to NLMS .
  Requires careful Tuning of lambda and delta .

# Parameters and Tradeoffs

- Filter order(fo=8) :-
  High Filter order increases computations and may overfit to noise in early adaption .
  Low filter order may underfit the data, you are taking very less data to estimate output.
- Forgetting Factor($\lambda = 0.99999$) :-
  If $\lambda$ is high, so we have longer memory and more stable estimates .
  If $\lambda$ is low , then we are telling the filter to forget the past too quickly .
- Initialization factor ($\delta = 0.0001$) :-
  If $\delta$ is too small , so it results in very large gain, so filter will adapt quickly even if there is very slight change in noise .
  If $\delta$ is very large , so filter changes very slowly taking more time to converge .
- Radius of poles($r = 0.999$) :-
  For better notch filter, radius should tend to 1 which makes it more steeper.
  But if the poles are too close to the unit circle, it might lead to instability as we are having a finite precision.

# References


- Lecture notes
- "Adaptive Filtering: Algorithms and Practical Implementation"- Paulo S.R. Diniz
- "Statistical Digital Signal Processing and Modeling"- M.Hayes
- "Normalized LMS Algorithm - Interference Canceling"- Mohit Mewara, University of Florida Link