An HMM Decomposition Approach applied to AURORA 2

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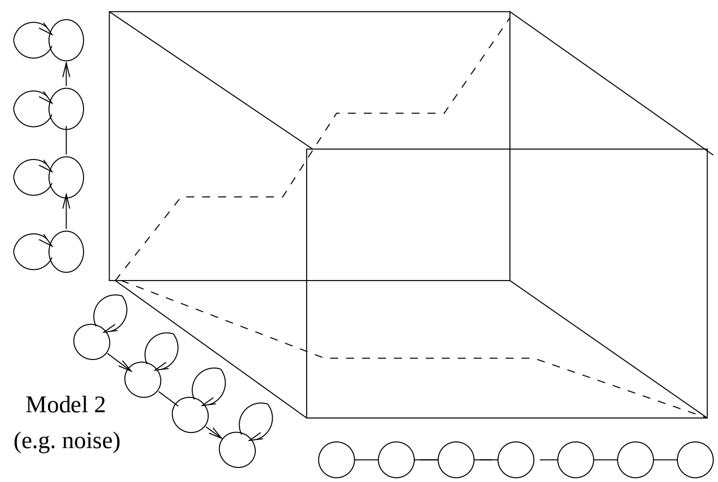
January 8, 2002

Overview

- HMM Decomposition
- Constructing a Noise Model
- Employing Delta Features
- Employing Harmonicity Information
- Results + Conclusions

HMM Decomposition



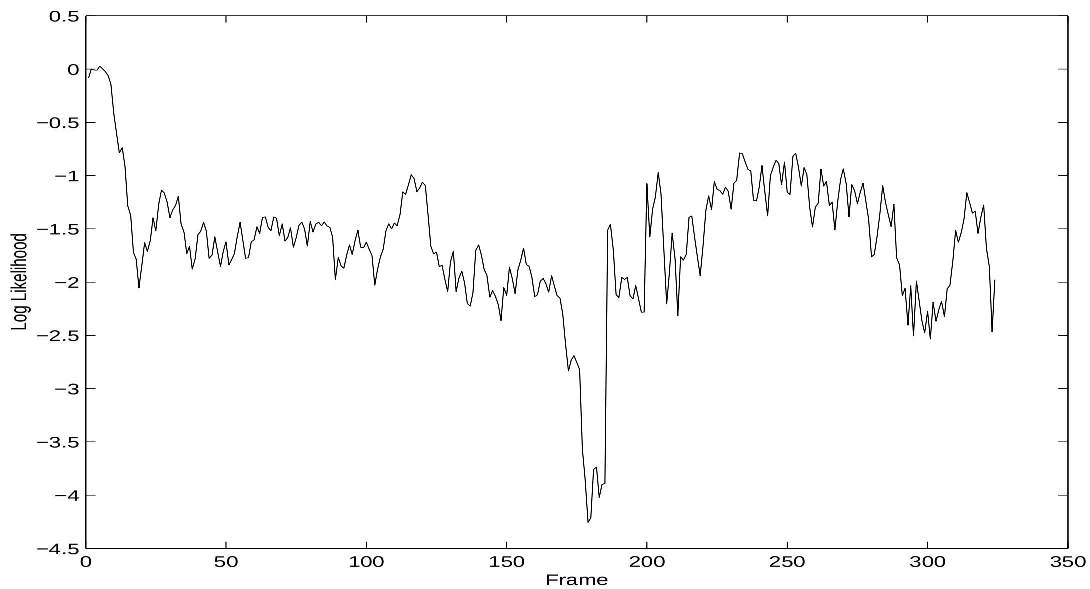
$$X_t = \log(\exp(X1_t) + \exp(X2_t)) \approx max(X1_t, X2_t)$$

$$P(X_t|i, j) =$$
$$C(X_t, \mu1_i, \sigma1_i)N(X_t, \mu2_j, \sigma2_j) + C(X_t, \mu2_i, \sigma2_i)N(X_t, \mu1_j, \sigma1_j)$$

Estimating the Noise Model

Stationary Noise Model:

Assume Gaussian distribution and use first N frames to estimate noise μ and σ for each frequency channel.

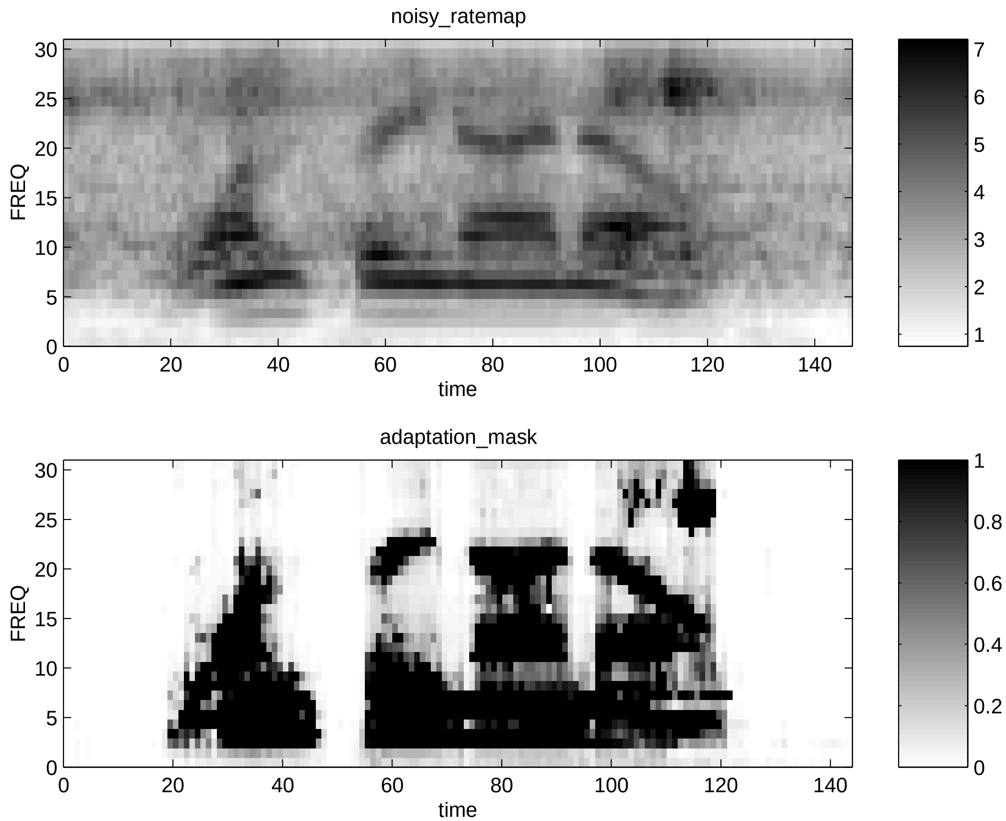


Adaptive Noise Models

“1390” +

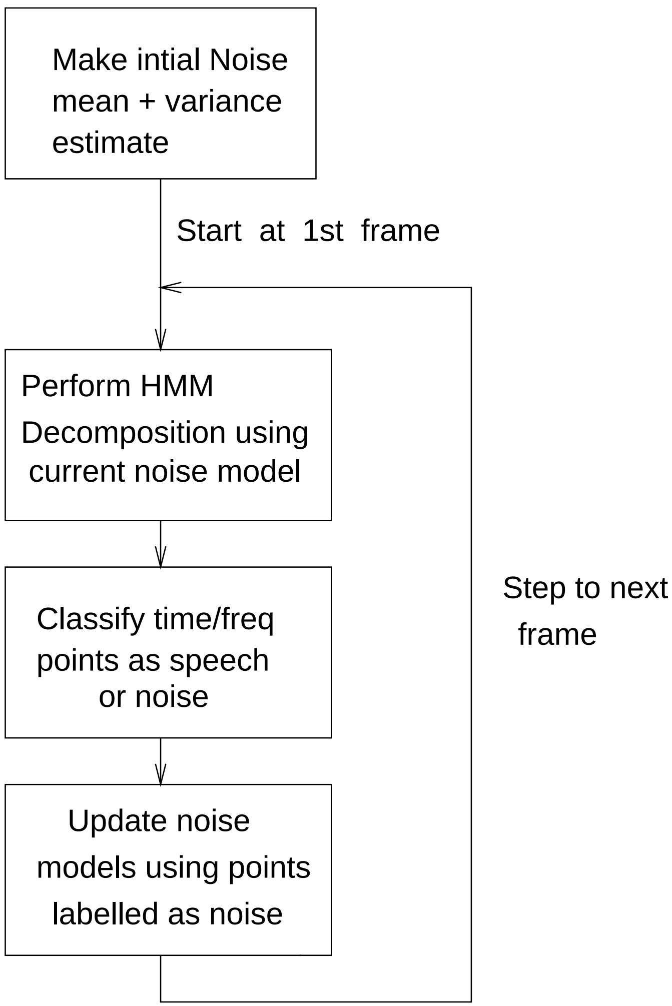
5dB Subway

P(Speech)



Adapt noise models using data in the low P(Speech) regions.

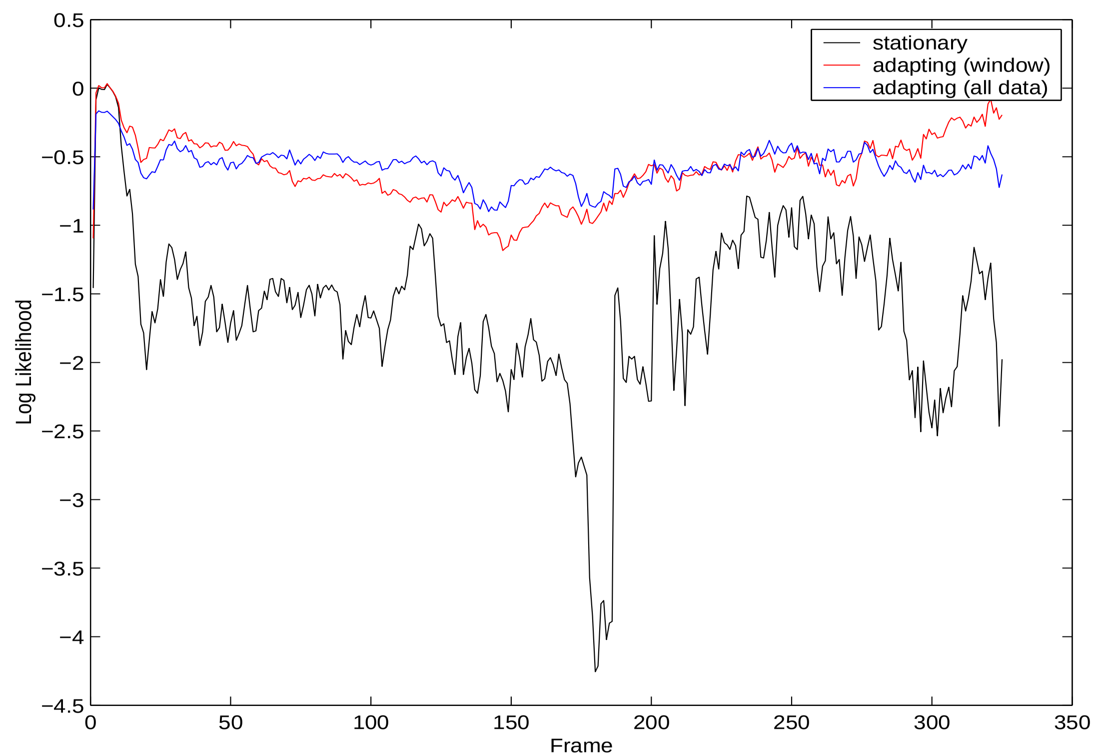
Adaptive Noise Models



Noise mean and variance adaptation strategies:

- employ all points classified as noise,
- employ previous N points classified as noise.

Comparison of Adaptive and Stationary Noise Models



Model	Stationary	Windowed	All Data
Mean Log Lik	-1.62	-0.60	-0.57

Adaptation Example

“1390” +

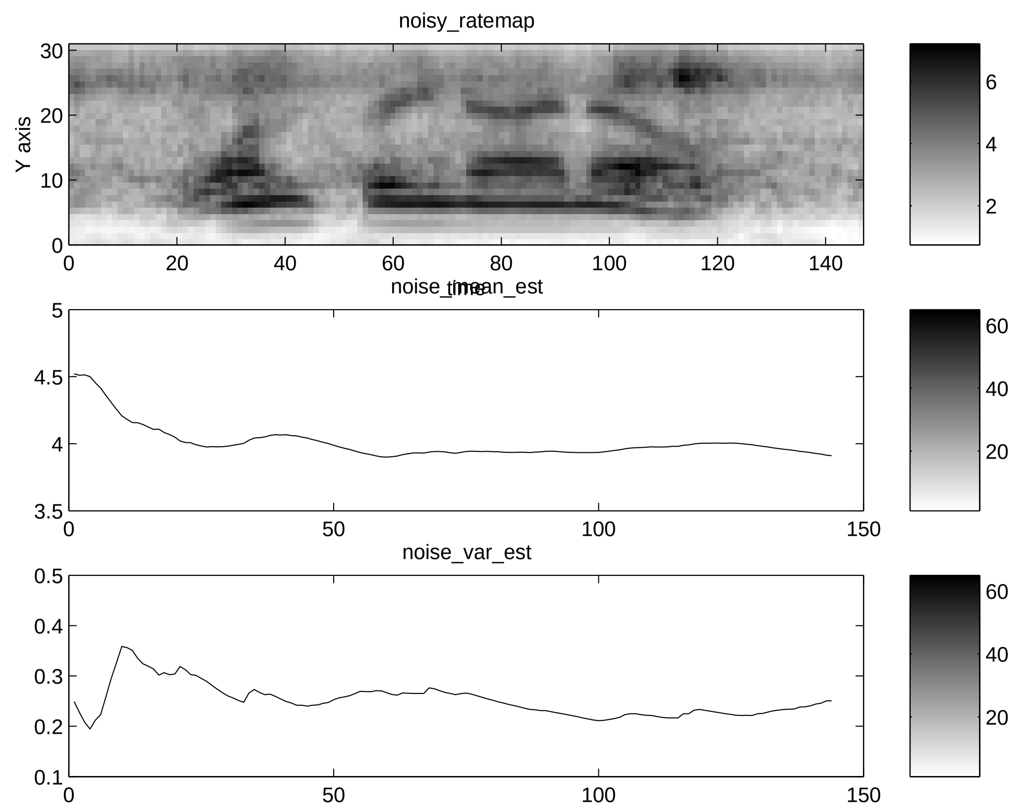
5dB Subway

Noise Mean

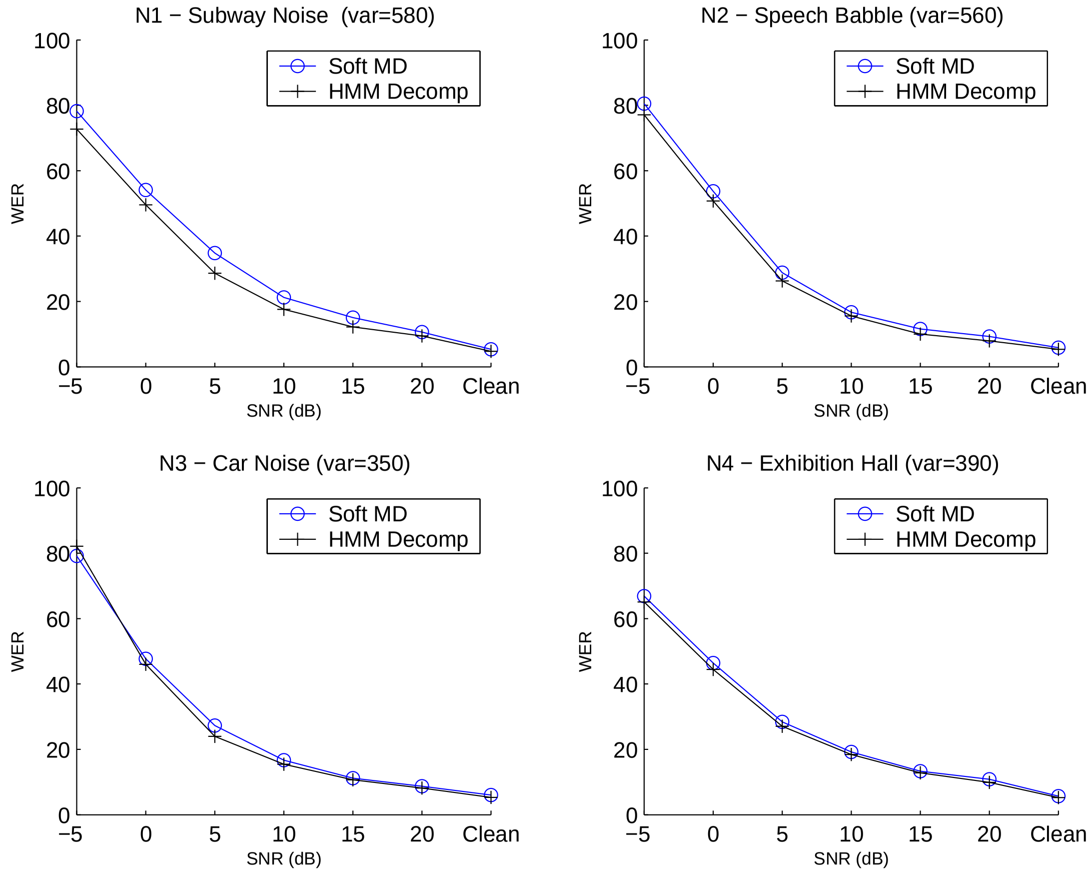
(channel 25)

Noise Var

(channel 25)



Initial Results for AURORA 2



	0dB	5dB	10dB	15dB	20dB
MD Soft	49.5	70.2	81.5	87.2	87.2
HMM Decomp	52.3	73.5	83.2	88.5	91.1

Employing Delta Features

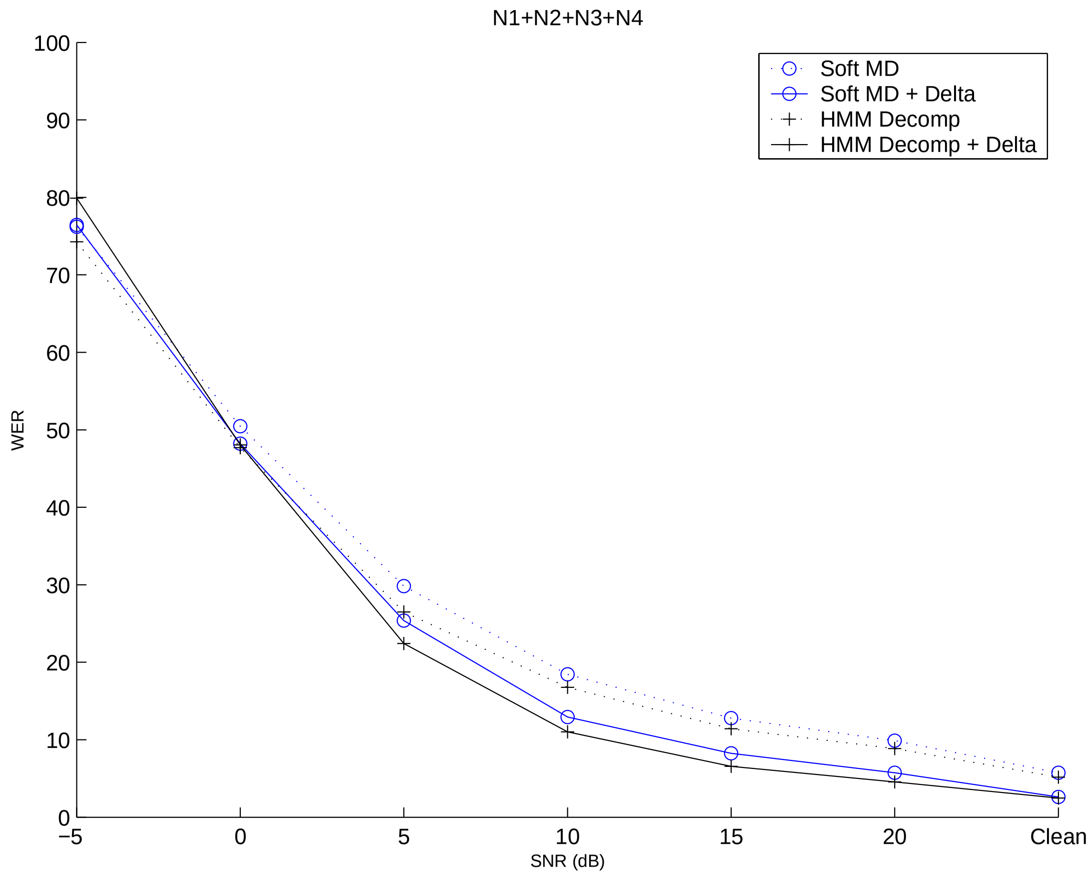
- Without delta features:

$$P(X) =$$
$$C(X, \mu_S, \sigma_S)N(X, \mu_N, \sigma_N) + C(X, \mu_N, \sigma_N)N(X, \mu_S, \sigma_S)$$

- With delta features:

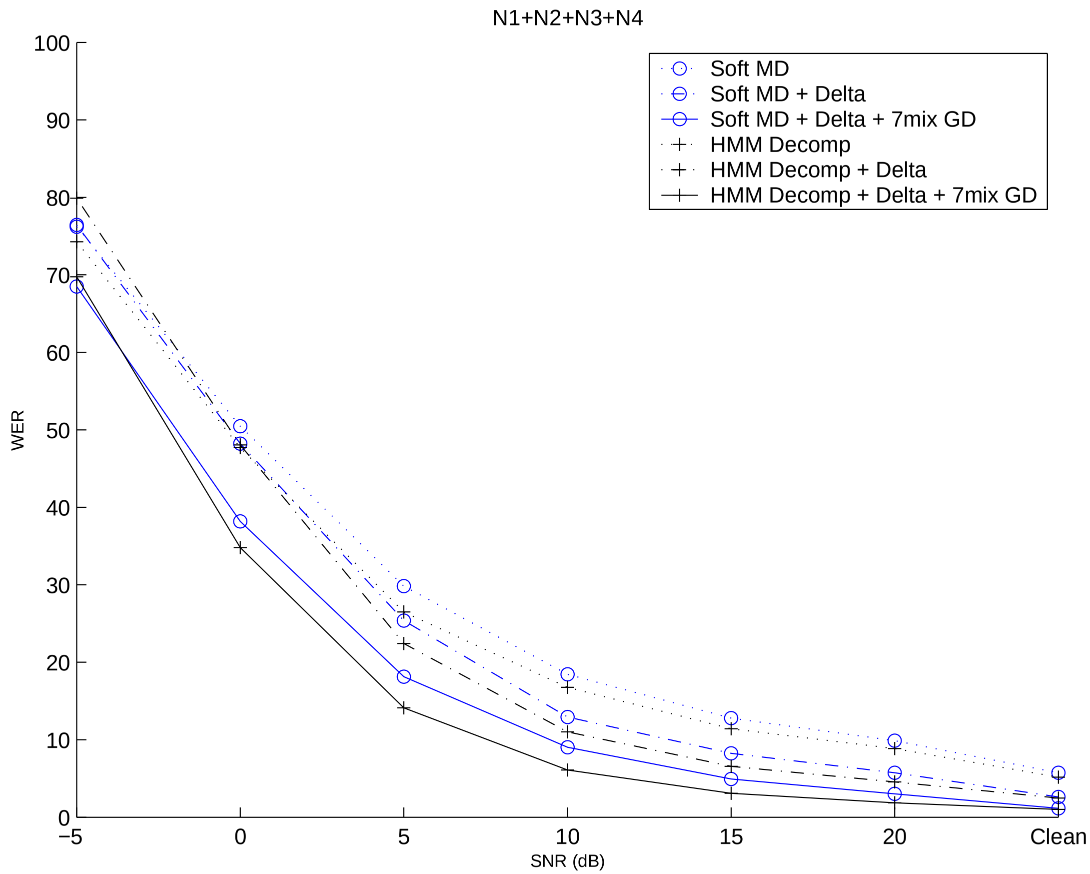
$$C(X, \mu_S, \sigma_S)(N(X, \mu_N, \sigma_N) + N(X', \mu_{N'}, \sigma_{N'}))$$
$$+ C(X, \mu_N, \sigma_N)(N(X, \mu_S, \sigma_S) + N(X', \mu_{S'}, \sigma_{S'}))$$

Results with Delta Features (3mix)



	0dB	5dB	10dB	15dB	20dB
MD Soft	51.8	74.6	87.1	91.8	94.3
HMM Decomp	52.0	77.6	89.0	93.4	95.4

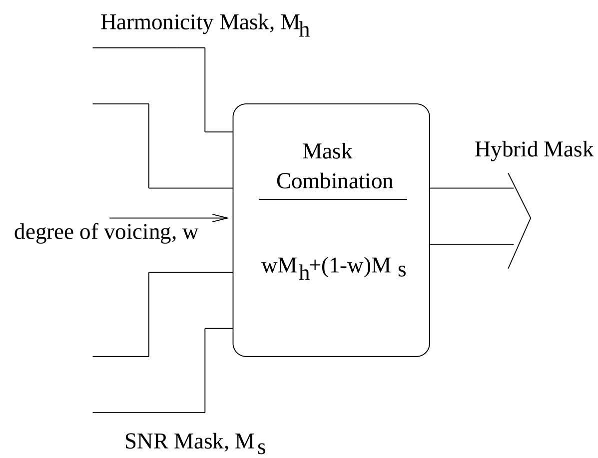
Results with Delta Features (7mix GD)



	0dB	5dB	10dB	15dB	20dB
MD Soft	61.8	81.9	91.0	95.1	97.0
HMM Decomp	65.2	85.9	93.9	96.9	98.2

Employing Harmonicity Information

- Soft MD

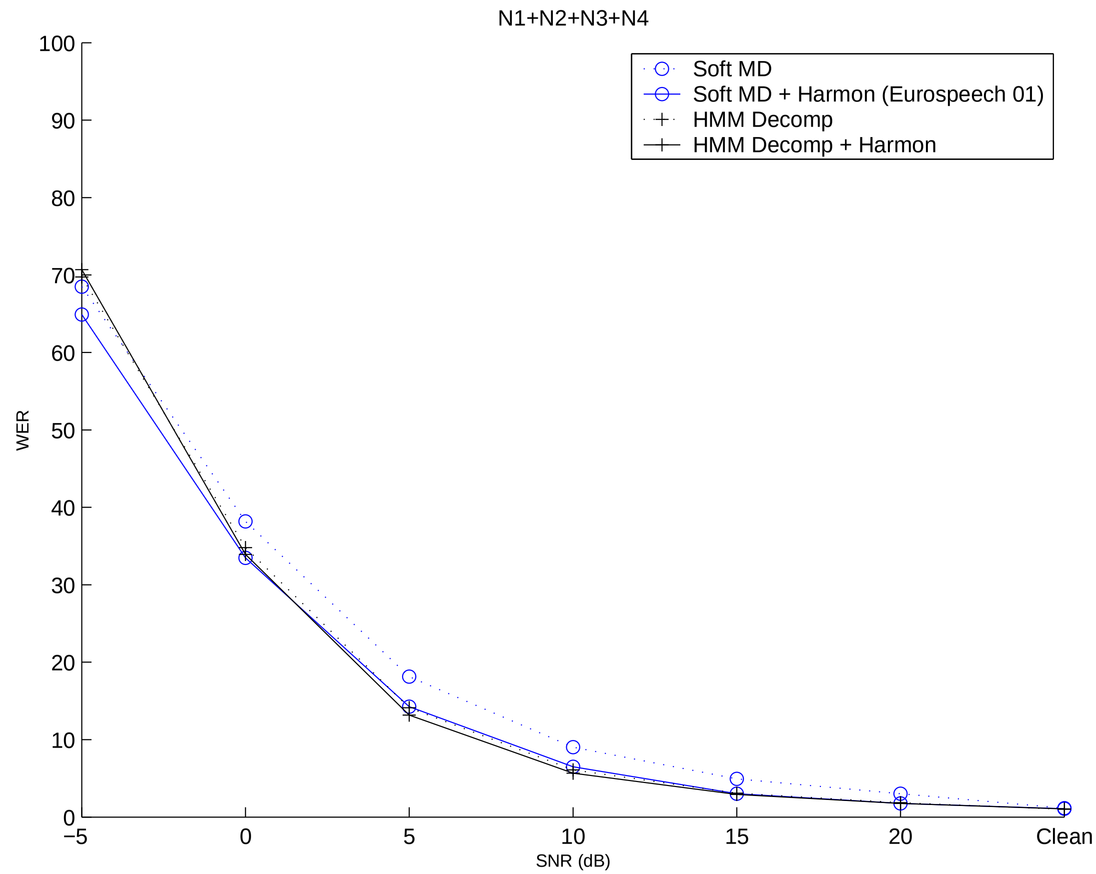


- HMM Decomposition

$$P_h(Speech) = wM_h + (1-w)0.5$$

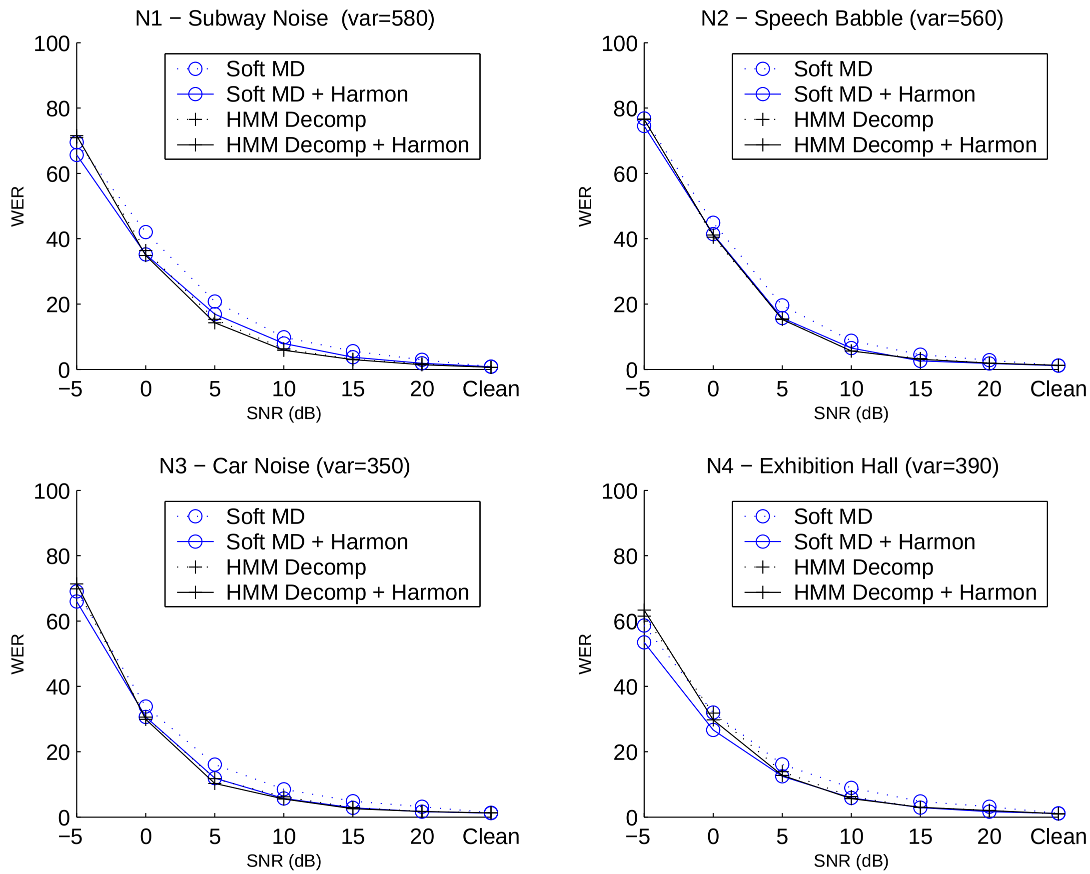
$$P(X) = C(X,\mu_S,\sigma_S)N(X,\mu_N,\sigma_N)(1-P_h) + C(X,\mu_N,\sigma_N)N(X,\mu_S,\sigma_S)P_h$$

Results for Full System



	0dB	5dB	10dB	15dB	20dB
MD Soft	66.5	85.8	93.5	97.0	98.2
HMM Decomp	66.1	86.8	94.3	97.1	98.2

Results for Full System



	0dB	5dB	10dB	15dB	20dB
MD Soft	66.5	85.8	93.5	97.0	98.2
HMM Decomp	66.1	86.8	94.3	97.1	98.2

Model Decomposition vs Soft Missing Data

- **Missing Data with Soft Masks**

  P(x)= w P(Speech=x) + $\frac{1-w}{x}$ P(Speech<x)

  Where w = P(Observation is dominated by Speech)

- **Speech/Noise Model Decomposition**

  P(x)= P(Noise<x) P(Speech=x) + P(Noise=x) P(Speech<x)

where x is the observed data.