SIGNAL & IMAGE PROCESSING LAB

Multi-Channel Speech Enhancement in Noisy Environments

SIPL Annual Projects Presentation

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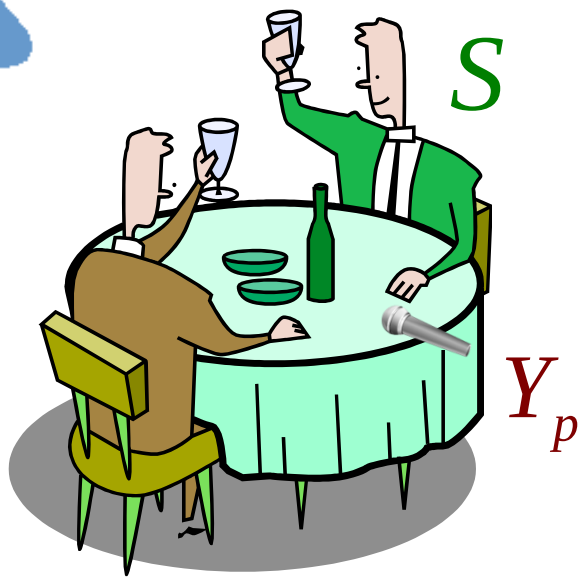
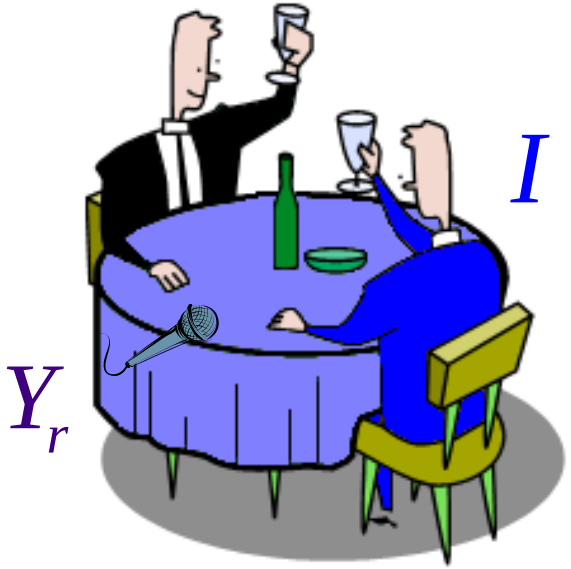
In association with: Israel Police Dept.

Outline

- Problem Description
- Optional Solutions
- Proposed Solution
- Performance Evaluation
- Conclusions

Problem Description





$$Y_p(k,\ell) = S(k,\ell) + R_{pi}(k) I(k,\ell) + R_{pn}(k) N(k,\ell)$$

$$Y_r(k,\ell) = I(k,l) + R_{rs}(k) S(k,\ell) + N(k,\ell)$$

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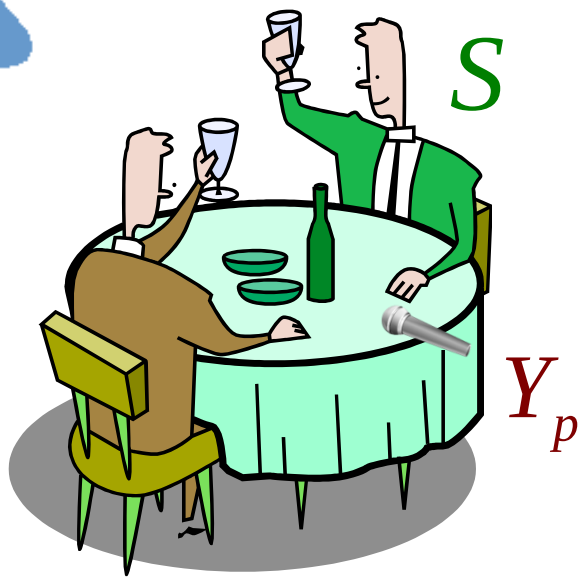
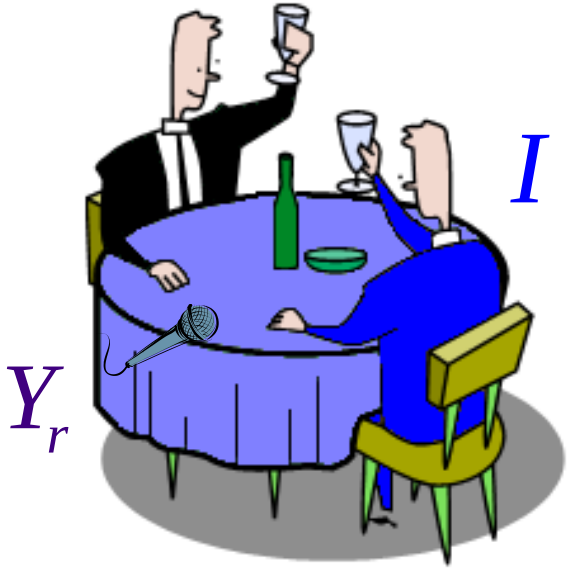
Optional Solutions

- Single-source methods
  - Spectral Subtraction [Lim & Oppenheim, 1979]
  - OM-LSA [Cohen & Berdugo, 2001]
- Multi-source methods
  - Beamforming
    - Not suitable, requires a microphone-array
- Make our own solution
  - Based on OM-LSA
  - Modification for multi-channel
    - Exploit measurements from other microphones

Optional Solutions





$$Y_p(k,\ell) = S(k,\ell) + \cancel{R_{pi}(k)\, I(k,\ell)} + R_{pn}(k)\, N(k,\ell)$$

$$Y_r(k,\ell) = \cancel{I(k,\ell)} + R_{rs}(k)\, S(k,\ell) + N(k,\ell)$$

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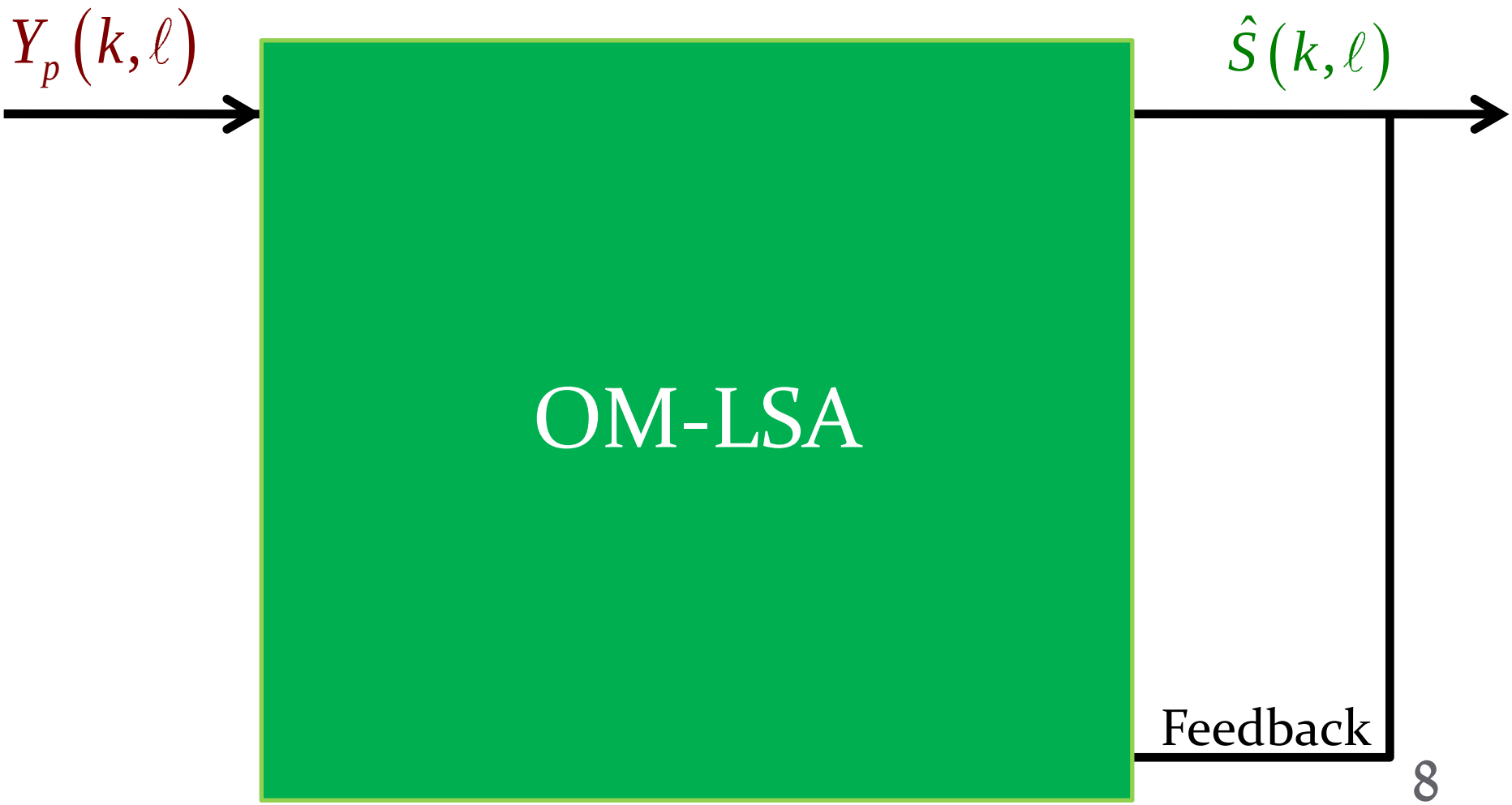
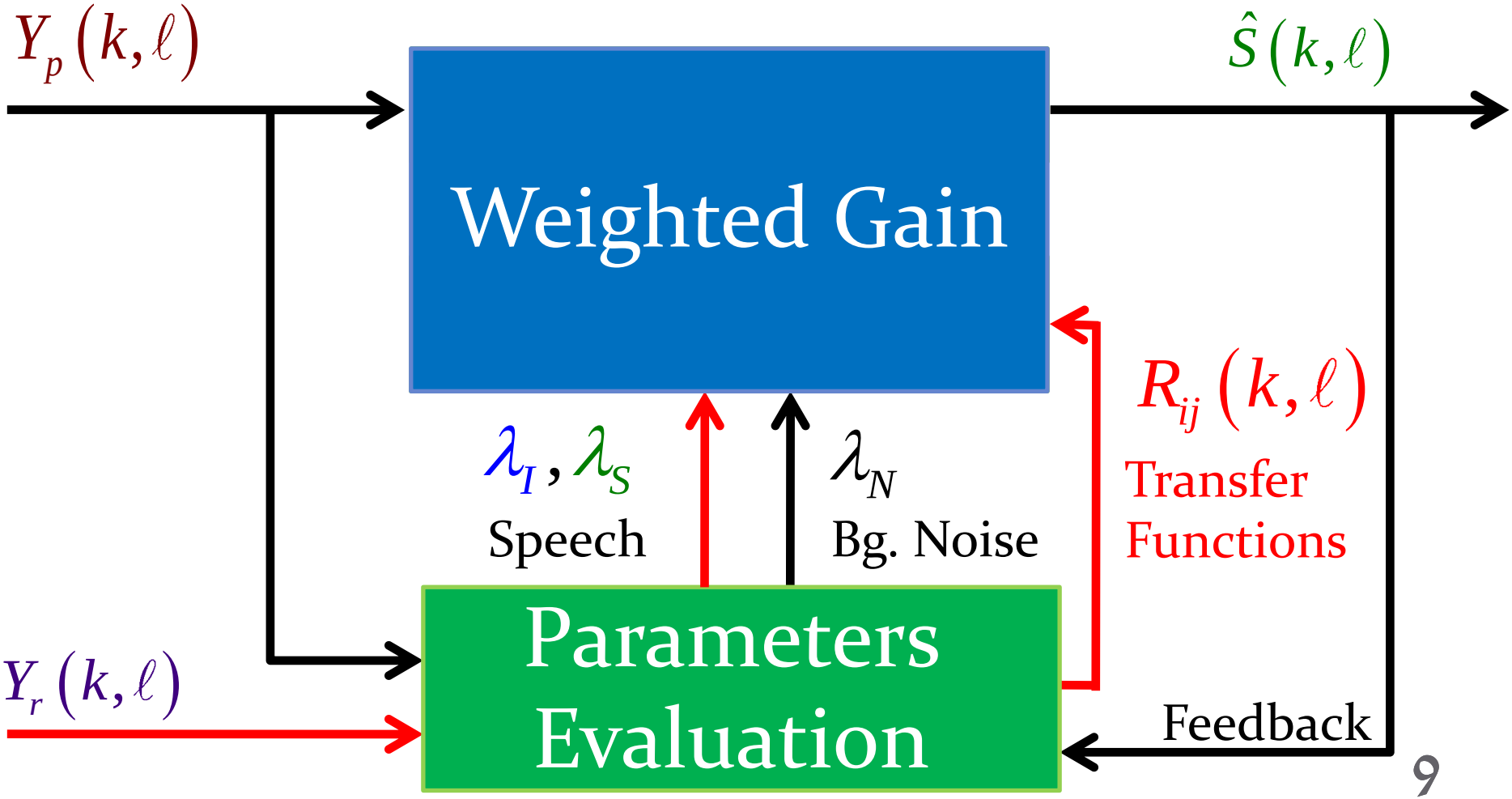
Naive Solution



Proposed Solution



Hypotheses and Gain Function

- Consider four hypotheses:

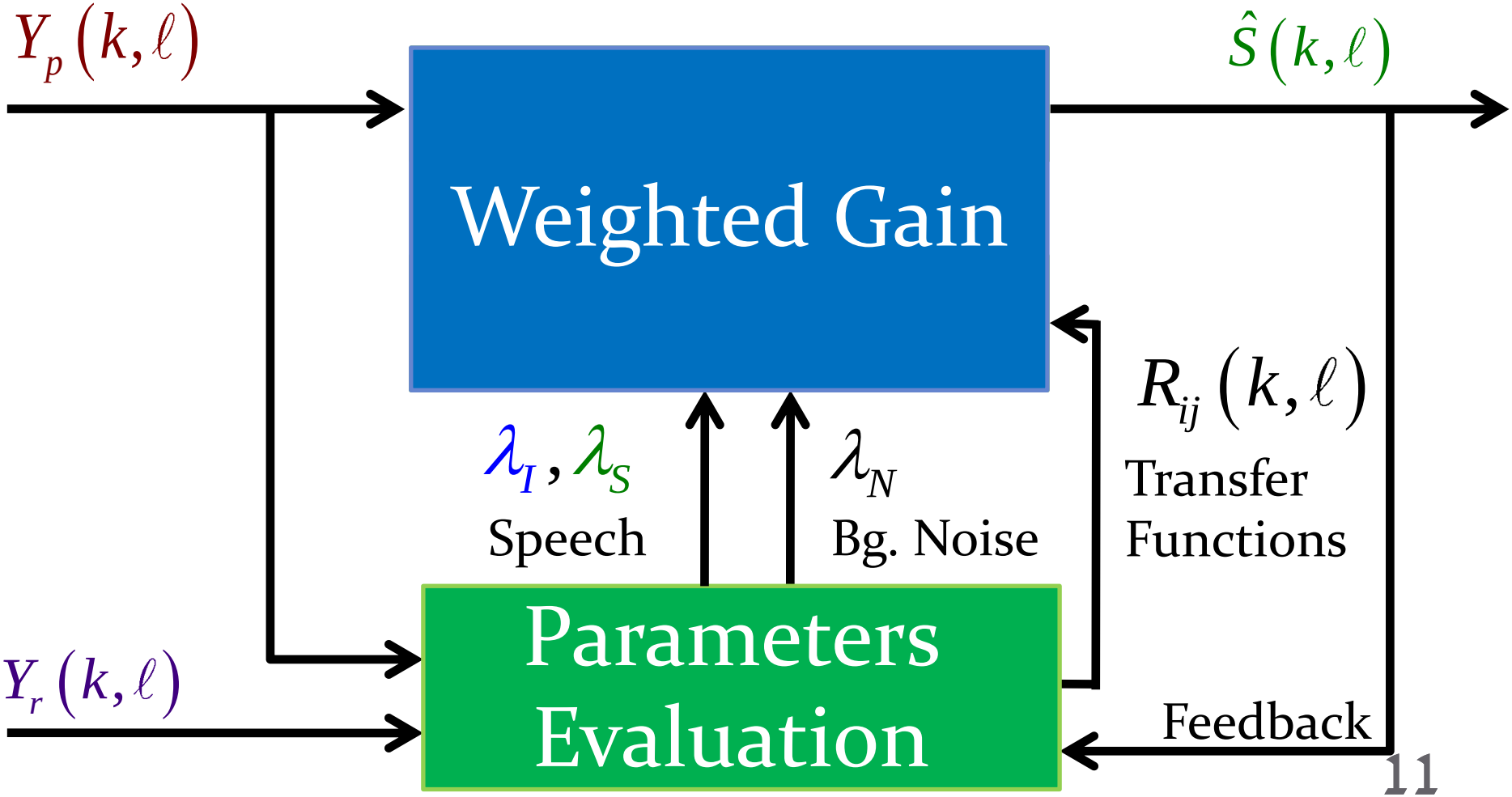
		$S(k,\ell)$ Source	
		Absent	Present
$I(k,\ell)$ Interferance	Absent	$H_1(k,\ell)$	$H_3(k,\ell)$
	Present	$H_2(k,\ell)$	$H_4(k,\ell)$

- Final estimation is given by a gain function:

$$\hat{S}(k,\ell) = G(k,\ell) Y_p(k,\ell)$$

$$\boxed{G(k,\ell) = G_{H_4}^{p_4}(k,\ell) \cdot G_{H_3}^{p_3}(k,\ell) \cdot G_{\min}^{p_2+p_1}(k,\ell)}$$

Proposed Solution



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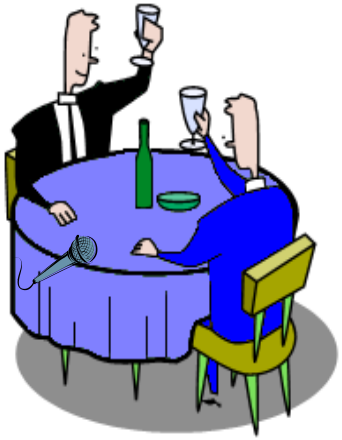
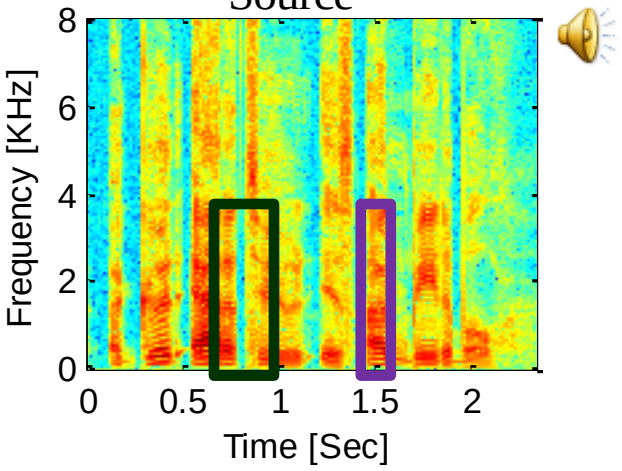
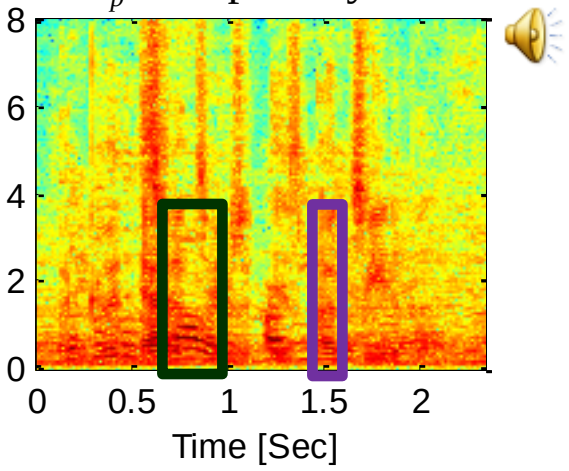


Simulated Signals

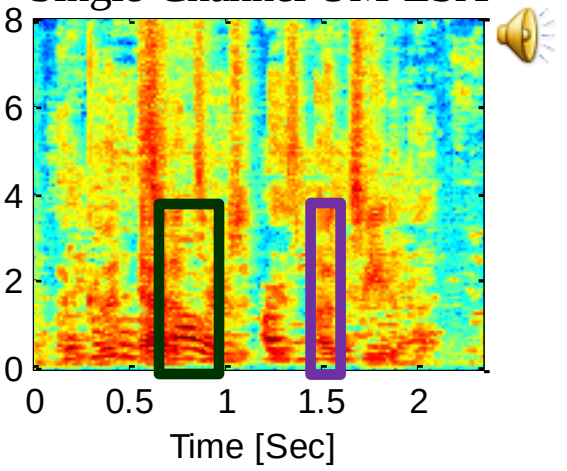
Source



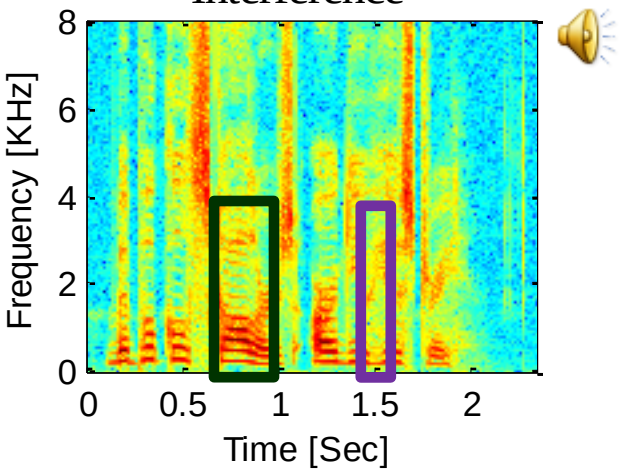
Y_p - primary mic.



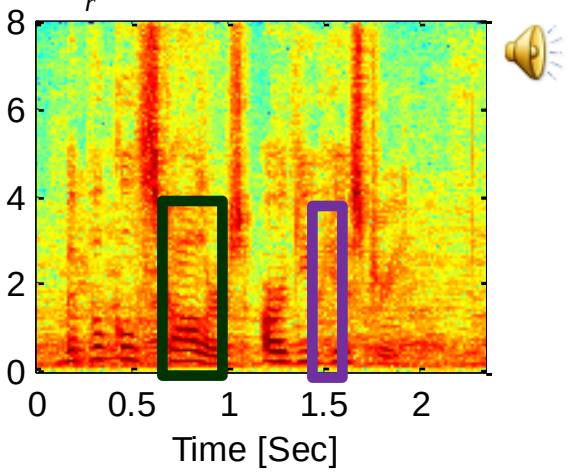
Single-Channel OM-LSA



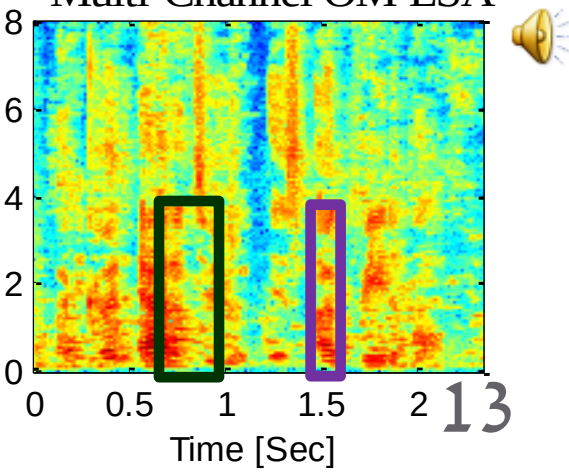
Interference



Y_r - reference mic.

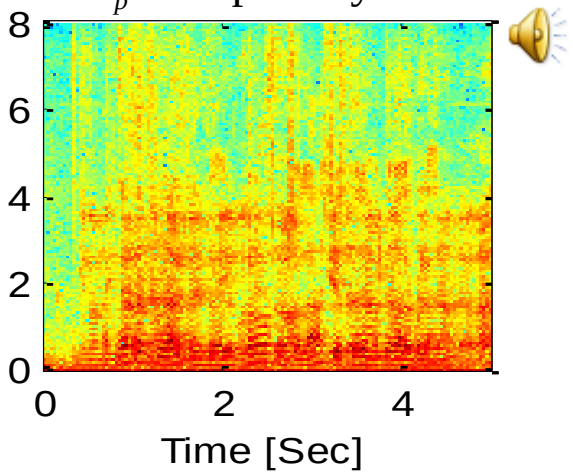


Multi-Channel OM-LSA

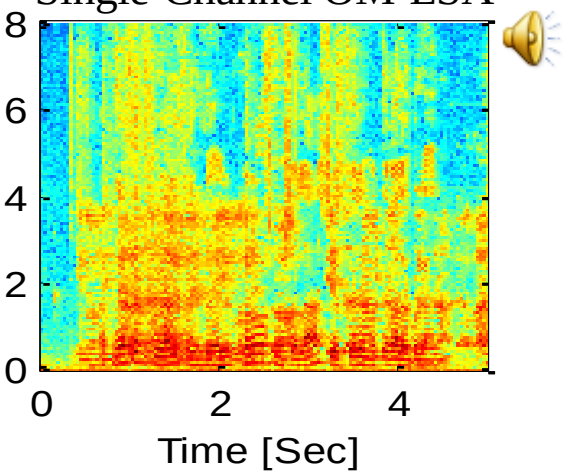


Real Signals

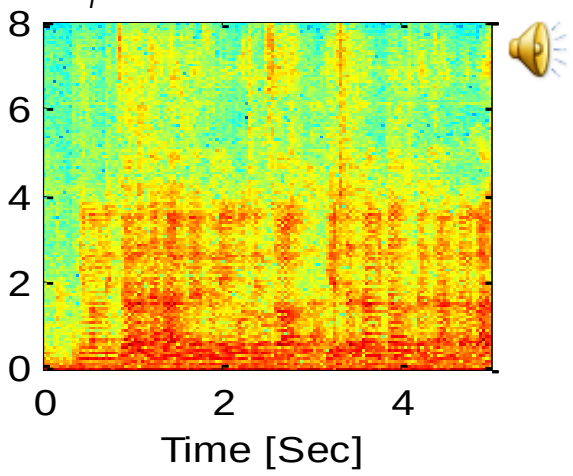
Y_p - primary mic.



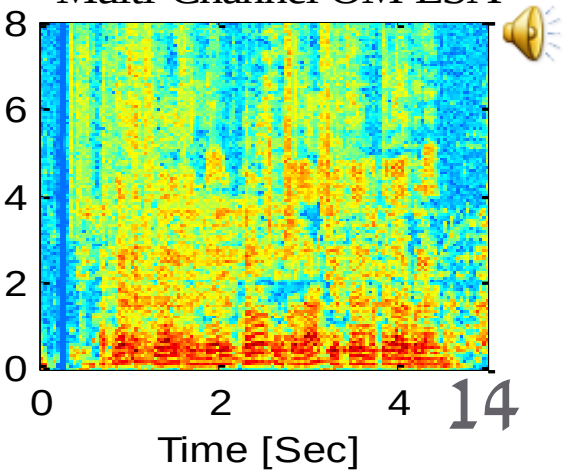
Single-Channel OM-LSA



Y_r - reference mic.

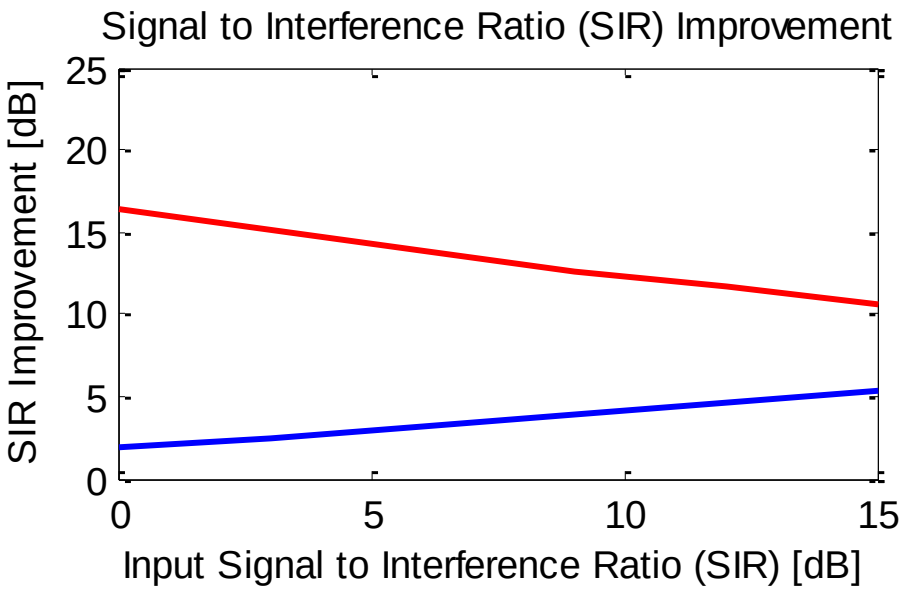


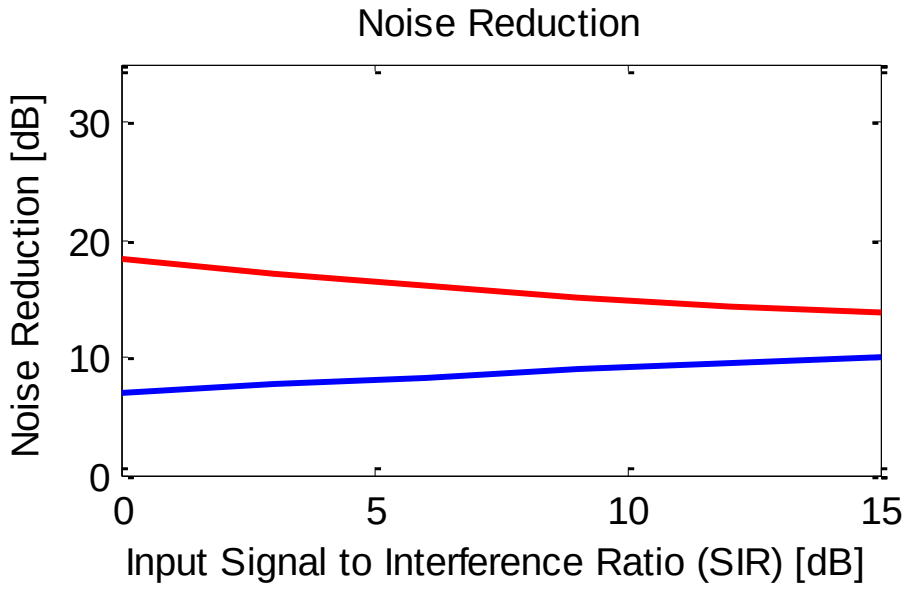
Multi-Channel OM-LSA



Performance Evaluation

- Interfering noise volume varies





Multi Channel Single Channel

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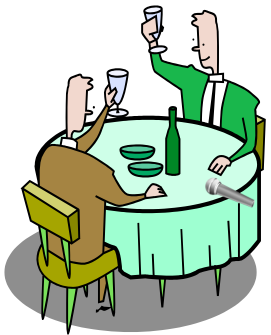
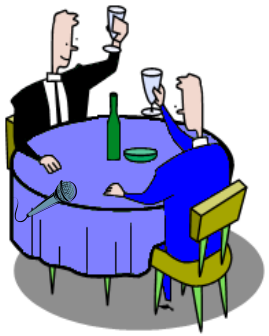
Conclusions

- Multi-channel speech enhancement in noisy environments
- Modification of the OM-LSA for multi-channel
- Good performance
- Following the same principals, the proposed algorithm can be expanded for any number of speakers and microphones





Thank you for listening!

Want to know some more?

Visit the project's website at:

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