Fast Givens Rotation Approach to Second Order Sequential Best Rotation Algorithms

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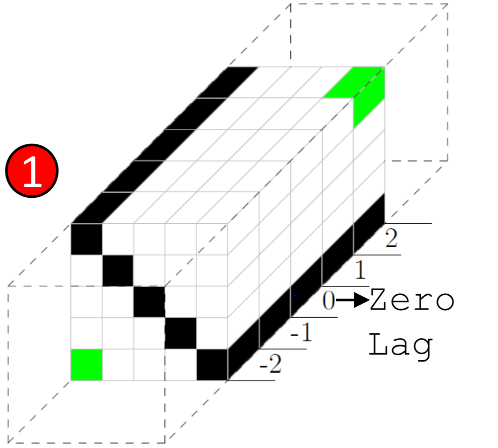
Many broadband array signal processing operations can be based on the space time covariance matrix $\boldsymbol{R}(\tau) = \mathcal{E}\{\boldsymbol{x}[n]\boldsymbol{x}^{\boldsymbol{H}}[n-\tau]\}$. *It can be diagonalised by a polynomial EVD method such as the SBR2 algorithm.*

SBR2 Algorithm

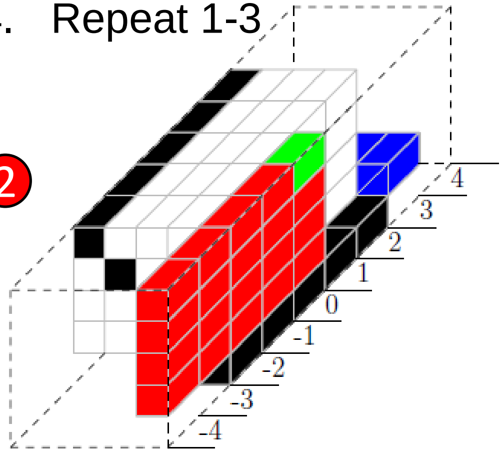
1. Maximum Element Search
2. Time Shift onto zero lag
3. Transfer energy onto diagonal using Jacobi transformation to all lags (Givens Rotations)
4. Repeat 1-3

1



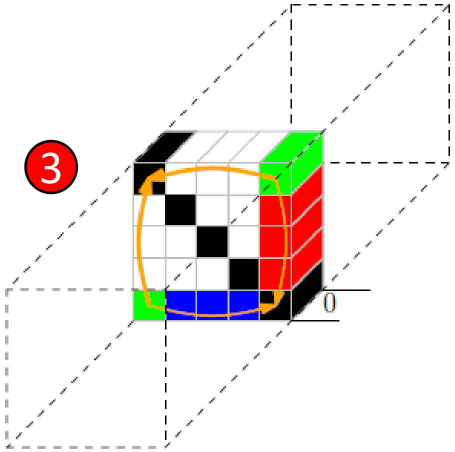
$\{k^{(i)}, \tau^{(i)}\} = \arg\max_{k,\tau} \|\hat{\mathbf{s}}_k^{(i-1)}[\tau]\|_\infty$

2



$\mathbf{S}^{(i)\prime}(z) = \tilde{\mathbf{D}}^{(i)}(z)\mathbf{S}^{(i-1)}(z)\mathbf{D}^{(i)}(z)$

3



$\mathbf{S}^{(i)}(z) = \mathbf{Q}^{(i)\mathrm{H}}\mathbf{S}^{(i)\prime}(z)\mathbf{Q}^{(i)}$

In proposed approach, step 1 & 2 are same.

Step 3 givens rotation (V) is replaced with F

$$V_i = \begin{bmatrix} I_1 & & & & \\ & c_i & & e^{j\gamma_i}s_i & \\ & & I_2 & & \\ & -e^{j\gamma_i}s_i & & c_i & \\ & & & & I_3 \end{bmatrix} \qquad F_i = \begin{bmatrix} I_1 & & & & \\ & 1 & & f_{i,1} & \\ & & I_2 & & \\ & f_{i,2} & & 1 & \\ & & & & I_3 \end{bmatrix}$$

Where $V_i = D_i F_i D_i^{-1}$, *and* $D_i \in \mathbb{R}$ *is diagonal matrix*. Matrix F_i is applied each iteration and matrices D_i are accumulated and applied at the end. Thus each for each lag, we only need 2MACs.

EXECUTION TIME COMPARISON BETWEEN STANDARD AND FAST GIVENS ROTATION-BASED SBR2 IMPLEMENTATIONS, SHOWING MEAN PLUS/MINUS ONE STANDARD DEVIATION.

	computation time / [ms]			
method	$M = 3$	$M = 5$	$M = 10$	$M = 20$
standard	1.03±0.02	2.67±0.04	5.18±0.29	14.56±0.22
FGR	0.99±0.03	2.35±0.04	4.66±0.26	13.03±0.26