**1. Crosstalk Canceller (CC) over a WASN**

**WASN: Wireless Acoustic Sensor Network**

**ORIGINAL SOUNDS**
- \( s_1(n) \): (e.g. Male speech)
- \( s_2(n) \): (e.g. Female speech)

**CC DESIRED RESPONSE**
- \( x_1(n) \approx s_1(n) \)
- \( x_2(n) \approx s_2(n) \)

Step 1) > Estimate the electro-acoustic channels (also called Room Impulse Responses, RIR) \( c_{ij} \) using maximum length sequences (MLS) [1].

\[ c_{ij} = [c_{ij}(0), c_{ij}(1), \ldots, c_{ij}(L_c - 1)]^T \]

Step 2) > Design the CC filters \( h_i \) [2].

Step 3) > Filter original signals \( s_1(n) \) and \( s_2(n) \) through filters \( h_i \) to obtain \( v_1(n) \) and \( v_2(n) \). Provide the desired signals \( x_1(n) \) and \( x_2(n) \) at the mic locations.

**2. Adaptiv identification of the acoustic channels**

Let us define the Global Impulse Response (GIR) \( a_{ij} \) of NODE #1 as the impulse response between \( s_j(n) \) and \( x_i(n) \):

\[ a_{ij} = c_{ij} \ast h_{11} + c_{ij} \ast h_{21} \]

We define in the same way the GIR between \( s_j(n) \) and \( x_i(n) \) as:

\[ a_{ij} = c_{ij} \ast h_{12} + c_{ij} \ast h_{22} \]

Therefore:

\[ x_1(n) = a_{11} \ast s_1(n) + a_{12} \ast s_2(n) \]

**Adaptive estimation of the GIRs**

**Step 1**

> The estimation of the GIRs related to NODE #1 is carried out minimizing the mean square of the following error signals:

\[ e_{11}(n) = |x_1(n) - \tilde{a}_{11} \ast s_1(n) - \tilde{a}_{12} \ast s_2(n)| \]

\[ e_{12}(n) = |x_1(n) - \tilde{a}_{11} \ast s_1(n) - \tilde{a}_{12} \ast s_2(n)| \]

Similar procedure to estimate the GIRs associated to NODE #2 where:

\[ a_{21} = c_{21} \ast h_{11} + c_{22} \ast h_{21} \]

\[ a_{22} = c_{21} \ast h_{12} + c_{22} \ast h_{22} \]

**Step 2**

> Once the GIRs have been estimated, the corresponding RIRs are estimated at each node through a least squares (LS) solution.

**Step 3**

> Follow steps 2) and 3) of the CC algorithm to design the new filters and provide signals \( v_1(n) \) and \( v_2(n) \) to the loudspeakers.

**3. Simulation Results**

- Real acoustic channels measured between two Bluetooth loudspeakers & two tablets (Android OS).
- Number of RIR coefficients: \( L_c = 1200 \).
- Sampling frequency \( f_s = 11025 \text{ Hz} \).
- \( s_1(n) \) and \( s_2(n) \) are uncorrelated white noise.

**Conclusions**

- GIR Estimation: MIPAPA of order \( N \) outperforms the corresponding APA of the same order.
- RIR Estimation: The MSE of MIPAPA of order \( N-1 \) is similar to that of APA of order \( N \).

**References**