

Sigma-Delta Based Specknet Microphone Arrays for Acoustic Monitoring

Ousman Sadiq

University of Strathclyde

osadiq@eee.strath.ac.uk



Presentation

- Potential Applications
- Distributed Microphone arrays
- Localisation
- Sigma-Delta
- Distributed coding

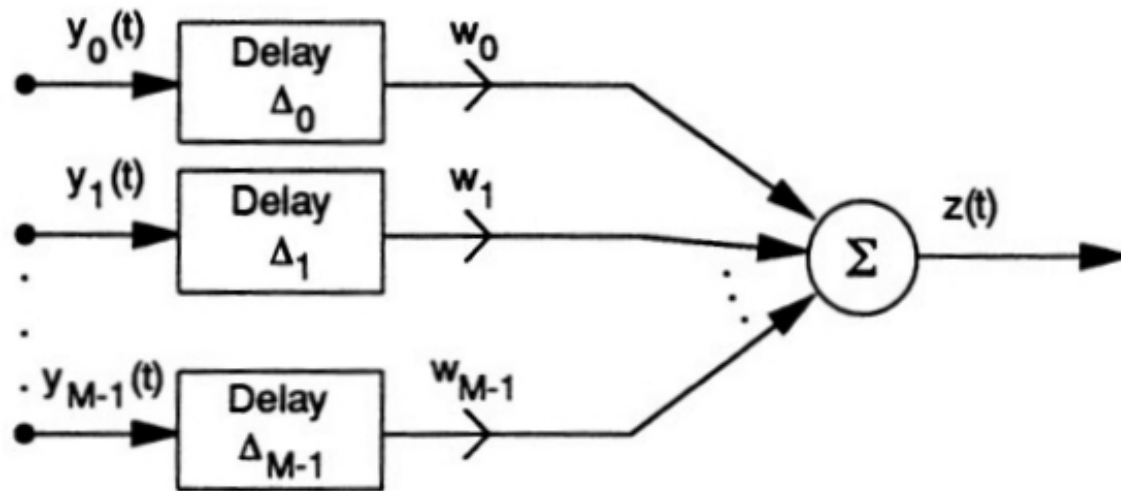
Potential Applications

- Teleconferencing
 - Users can speak without need for directing voice at single point
- Audio surveillance
 - Automatically detect and locate people when they speak in a room

Microphone arrays

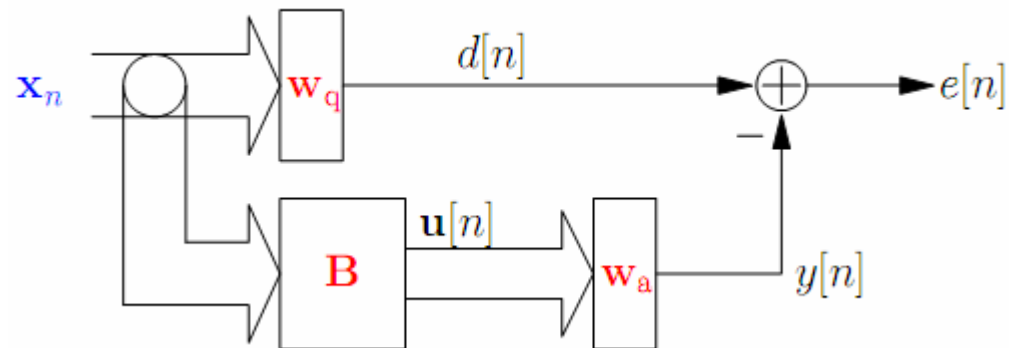
- Beamforming
 - Use of multiple microphones in a fixed configuration can improve sound from a certain direction
- Geometry
 - Spacing between microphones and the shape of the array allow different frequencies and directions to be beamformed
- Number of microphones
 - More microphones lead to an increased directionality at the expense of computation

Simple beamformer



$$z(t) = \sum_{m=0}^{M-1} y_m(t - \Delta_m) \cdot w_m$$

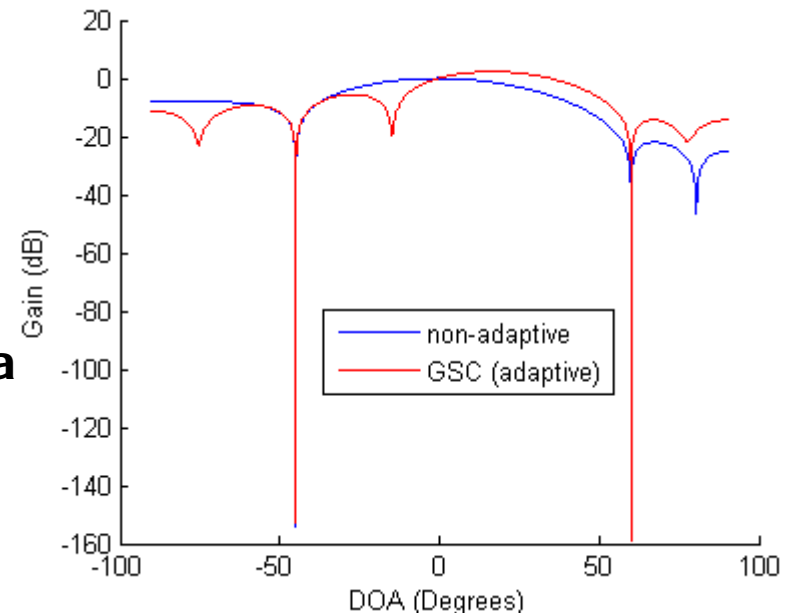
GSC Beamformer



Generalised Side-lobe Canceller

Addition of lower branch purely to deal with unspecified interferers and noise.

Use adaptive filter to find coefficients for w_a that minimise e while still maintaining constraints



Distributed microphone arrays

- Multiple Nodes
 - Multiple microphone arrays can be used to improve audio from a larger area
- Cascaded Beamforming
 - Use local beamforming at each node and inter-node beamforming over a set of nodes
- Inter-node spacing
 - Distance between nodes is large and so near field techniques must be used

Source localisation and tracking

- Localisation
 - TDOA combined with cross correlation to find DOA of sound
 - Multiple DOAs provide source position
- Tracking
 - Kalman Filters
 - Particle Filters
- Increased complexity when tracking multiple sources

Sigma-Delta

- Oversampling
 - Audio signal sampled at higher rate than Nyquist resulting in a 1 bit ADC with multi-bit resolution
- Noise shaping
 - Sigma-delta conversion reduces quantisation power in band of interest improving audio quality
- Hardware
 - Saves space, easier filter design for anti-aliasing

Distributed source coding

- Slepian-Wolf
 - Theorem showing how to perform joint decoding without loss of information
- Correlated Sources
 - Two or more correlated sources contain redundancy of information
- Encoding/Decoding
 - Relies on signals that have similar relationships no matter the input
- Bandwidth required and power usage is decreased

Looking ahead

- Investigating the techniques to be used
 - Beamforming, sigma-delta (delta-sigma), distributed source coding
- How to best combine techniques for a Specknet type environment
 - Batteries, data rates, placement of specks, complexity