18 November, 2021

Advanced Digital Signal Processing 2021/2022
WS #2: Delay Estimation & Interference Mitigation

1 Delay Estimation

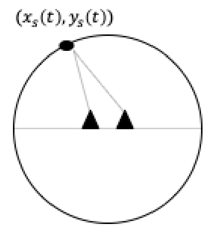

Figure 1: Example scenario

A music source (e.g., loudspeaker) generates an audio signal while moving uniformly over a circle with radius $R = 5m$, as shown in Fig. 1. At the center of the circle, two microphones are placed at $(+20cm, 0)$ and $(-20cm, 0)$. Knowing that the signal propagation speed is $v = 335m/s$, the goal is to estimate the difference time of delay (DToD) vs time using the L and R signals in **data_1.mat**. Determine the starting point P_0 and the ending point P_e.

2 Interference mitigation

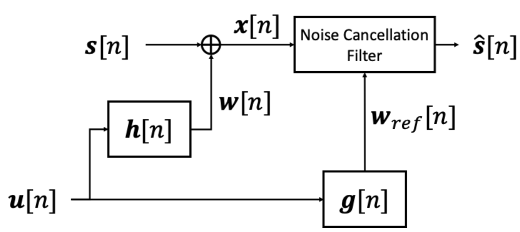

Figure 2: Reference System

Interference cancellation finds application in several practical areas. In audio related applications, an example is helicopter pilots who must be able to communicate without the interference of propellers. The system model of an interference cancellation problem is depicted in Fig. 2. The discrete-time stereo signal $\mathbf{s}[n] = [s_L[n], s_R[n]]^T$ is affected by a noise $\mathbf{w}[n] = \mathbf{h}[n] * \mathbf{u}[n]$, which depends on an external source $\mathbf{u}[n]$ through an unknown filter $\mathbf{h}[n]$, such that

$$\mathbf{x}_i[n] = \mathbf{s}[n] + \mathbf{h}_i[n] * \mathbf{u}[n] \tag{1}$$

In our example, the stereo signal is the pilot speech and the noise source are the propellers. In **data_2.mat**, you can find 3 different set of signals $\mathbf{x}_i[n] \forall i = 1, 2, 3$ with increasing difficulty.

The objective is to cancel the interference noise $\mathbf{w}[n]$, given the reference noise $\mathbf{w}_{ref}[n]$ obtained by measuring the same noise source $\mathbf{u}[n]$ through a different filter $\mathbf{g}[n]$, i.e.,

$$\mathbf{w}_i[n] = \mathbf{g}_i[n] * \mathbf{u}[n] \tag{2}$$

The quality can be evaluated by playing the restored audio.