Experimental Measurements and Analysis of In-Band Full-Duplex Interference for Underwater Acoustic Communication Systems

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The underwater acoustic (UWA) communication channel is among the most challenging channels encountered, necessitating the use of sophisticated signal processing techniques to reliably recover transmitted data. The combined effects of the channel, along with the slow propagation speed of acoustic waves in water introduce fundamental limits on the bandwidth of the channel. As a result of these challenges, UWA communication technologies have developed slowly compared to terrestrial radio communications technologies. The severe and unavoidable bandwidth constraints of the channel, in particular, motivate investigation into the suitability of the full-duplex (FD) mode of operation which has seen much interest in other communications fields, due to its potential to theoretically double the throughput of a wireless link. FD communication is the concurrent transmission and reception of signals on the same frequency band, also termed in-band full-duplex (IBFD). IBFD operation imposes significant difficulties for the communications system, given that the self-interference (SI) signal will be received with much greater power than the desired signal from the remote node. This SI problem will require both passive and active mitigation strategies to realise IBFD communications, requiring an accurate and in-depth understanding of the SI profile.

Prior work in the literature on IBFD for UWA communication is limited. An initial feasibility study on IBFD operation with multiple access schemes was presented in [1], a multi-user FD modem was proposed and evaluated in [2], and in both [3] and [4] cancellation schemes were proposed to mitigate the effects of SI based on simulation models.

This work presents empirical measurements of the SI channel for the IBFD-UWA systems.

Shallow-water scenarios are considered with soft and hard sea bottom profiles, and different probes are utilised to estimate the SI channel. These include linear frequency modulated chirps and binary phase shift keying modulated m-sequences of different durations and chips, respectively. Initial simplified modelling of the SI channel is introduced to characterise the decay of the SI reverberation. An example measurement for a linear chirp is presented in Fig. 1. In Fig. 2, the channel impulse response for the SI channel, derived from the chirp correlation, is presented.

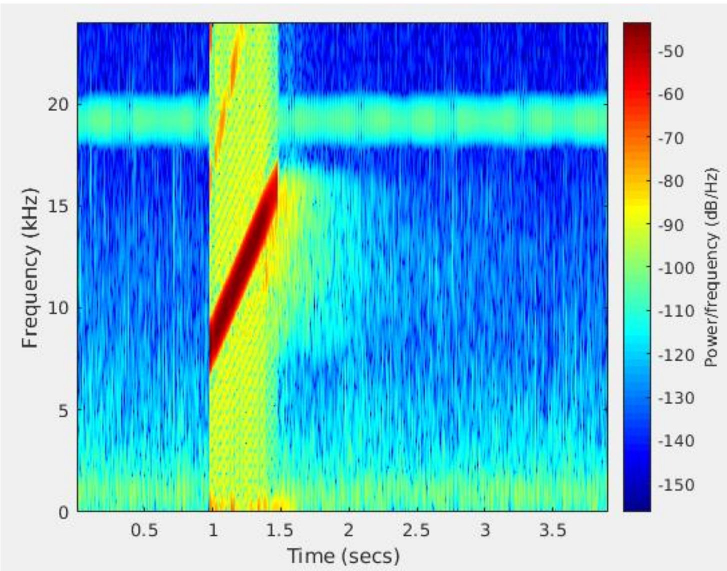

Fig 1: Spectrogram of recorded data for a linear chirp.

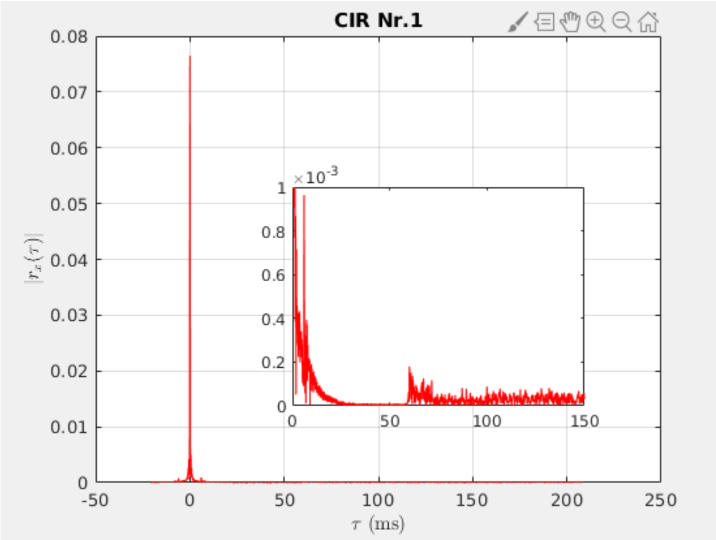

Fig. 2: Extracted channel impulse response for IBFD SI channel.

References

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