A Simplified Deep-Learning-based Phase Noise Tolerant Radio-Over-Fiber Receiver

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Recently, the use of machine learning (ML) techniques in Radio-over-Fiber (RoF) systems has become an active research topic, e.g. exploring the use of ML as a nonlinear equalizer or a decoder to improve the performance of the RoF link [1]. In addition, a new receiver architecture incorporating deep learning (DL) at the receiver of an RoF link was proposed and demonstrated on an unlocked heterodyning RoF link [2] with results suggesting that the receiver has a greater tolerance against phase-induced noise and may perform better than conventional self-homodyning (SH) based receiver in certain scenarios. However, the DL-based receiver architecture has a higher complexity compared to heterodyned-based receivers [3] and conventional SH-based receiver, making it a less compelling alternative relative to aforementioned alternatives. Hence, we propose a simplified version of the DL-based phase noise tolerant RoF receiver, as shown in Fig. 1. The DL-based receiver [2] requires an additional reference tone for phase noise correction similar to SH-based receiver and heterodyned-based RoF receiver, and a part of the receiver architecture is dedicated specifically to extract the reference tone. While the SH-based receivers have a relatively simpler receiver configuration, a sufficient frequency gap between the reference tone and the main data signal is required to prevent signal-to-signal beating interference (SSBI). In contrast, heterodyned-based RoF receiver separates the reference tone and the main data signal individually through bandpass filtering avoiding SSBI. But the additional bandpass filter required limits the operating frequency of the heterodyned-based RoF receiver, and the performance of the receiver is dependent on the out-of-band suppression ratio of the bandpass filter used, especially when the frequency gap between the reference tone and the main data signal is small. The proposed simplified DL-based receiver removes the dedicated reference tone extraction portion from the receiver architecture, simplifying the overall receiver configuration. In other words, the neural network within the simplified receiver has to perform reference tone extraction in addition to phase noise correction. Hence, the performance of the simplified receiver will be dependant on the sampling rate of the received signal, and may only be used when the frequency gap between the reference tone and the main data signal is small due to sampling rate limitations.

The proposed simplified DL-based receiver reduces the overall configuration complexity of the receiver architecture, and due to having fewer components, the cost of the proposed simplified receiver may also be lower compared to the DL-based receiver demonstrated in [2], making it a more compelling option relative to the DL-based receiver in previous proposal while retaining its advantages over conventional SH-based receiver and heterodyne-based receiver.

References

