Blind Channel Estimation for DCO-OFDM based Vehicular Visible Light Communication

Gokhan Gurbilek, *Student Member, IEEE,* Mertkan Koca, *Student Member, IEEE*

and Sinem Coleri, *Senior Member, IEEE*

ABSTRACT

Visible light communication (VLC) is considered as a complementary technology to radio frequency (RF) based solutions in vehicular communication due to its relatively high and licence-free bandwidth, high security and low cost. Direct Current-Biased Optical Orthogonal Frequency Division Multiplexing (DCO-OFDM) is a strong candidate for vehicular VLC (V2LC), meeting the high rate data sharing requirements of autonomous and connected vehicle applications, due to its robustness, high spectral efficiency and capability of dealing with inter-symbol interference (ISI). Blind channel estimation (CE) methods for OFDM systems in the RF literature, which are also applicable to VLC systems, provide high rate communication by eliminating pilot overhead in conventional pilot based CE methods, at the cost of higher complexity and lower CE accuracy. On the other hand, in the VLC literature, there is no work regarding blind CE for OFDM systems. In this paper, we propose a novel blind CE method for V2LC with the goal of improving the CE accuracy based on the exploitation of the real data based channel characteristics. First, the normalized channel frequency response (CFR) of the V2LC channel is demonstrated to be invariant of inter-vehicular distance, relative transmitter (TX)/receiver (RX) zenith angle and ambient light based on the real vehicle-to-vehicle (V2V) communication data. This channel characteristic is then exploited in the blind CE to estimate the value of only the normalization factor instead of the separate estimation of channel state information (CSI) at each subcarrier. Extensive simulations at different vehicle speeds show that the proposed method outperforms the pilot based CE methods in both the average throughput and bit error rate (BER) for all modulation schemes, excluding 64-QAM DCO-OFDM due to the unavailability of an optimal estimator for practical reasons. Moreover, the real-time performance of the proposed blind CE is demonstrated to be very close to the maximum throughput of each modulation scheme at high signal-to-noise ratio (SNR) levels, for the realistic vehicle mobility scenario extracted from Simulation of Urban Mobility (SUMO).

*Index Terms*—Vehicular communication, visible light communication, blind channel estimation, OFDM