【Grant-in-Aid for Specially Promoted Research】

Science and Engineering (Engineering)

Title of Project : Proposal of multi-functional coherent Nyquist pulse and its ultrahigh-speed and highly-efficient optical transmission

Masataka Nakazawa
(Tohoku University, Research Institute of Electrical Communication, Professor)

Research Project Number : 26000009　Researcher Number : 80333889
Research Area : Engineering
Keyword : Communication systems (wireless, wired, satellite, optical, mobile)

【Purpose and Background of the Research】

Motivated by the growing demand for larger transmission capacity in optical backbone networks, it has been an important subject to increase both bit rate per wavelength and spectral efficiency (SE) simultaneously. In general, however, there exists an inevitable trade-off between the bit rate and SE. To overcome this limitation, we recently proposed a new type of optical pulse, which we call an "optical Nyquist pulse," and its overlapped time-division multiplexing ("Nyquist TDM"). The goal of this project is to achieve an ultrahigh bit rate (> Tbit/s) and SE (> 10 bit/s/Hz) simultaneously by adopting coherent Nyquist pulses and employing their TDM and multi-level quadrature amplitude modulation (QAM) techniques.

【Research Methods】

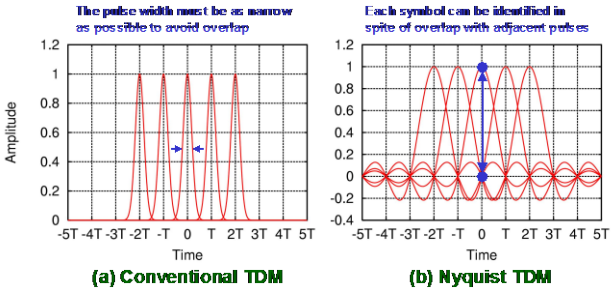

Figure 1 Comparison of conventional TDM (a) and our proposed Nyquist TDM (b).

Figure 1 shows the concept of Nyquist TDM and compares it with conventional TDM. The shape of the optical Nyquist pulse is given by the sinc-function ($\sin t / t$). It is characterized by the ringing in the tail, which crosses zero periodically. Therefore, in the TDM of optical Nyquist pulses, each symbol can be identified without being affected by intersymbol interference (ISI) despite a strong overlap with neighboring pulses, as shown by the blue dots. This is very advantageous compared with the conventional TDM of pulses shown in Fig. 1(a) in which the minimum pulse width is needed to avoid ISI as the symbol rate increases. The optical Nyquist pulse thus allows the signal bandwidth to be narrowed as much as possible without ISI.

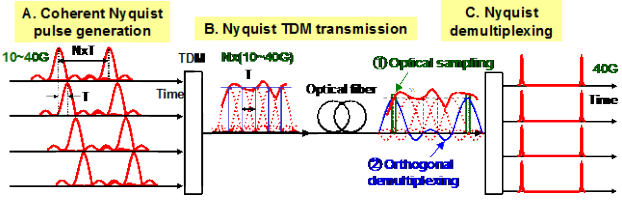

Figure 2 Basic configuration for high-speed and high-density Nyquist TDM transmission.

The basic configuration for coherent Nyquist TDM transmission is shown in Fig. 2. In this project, we establish fundamental technologies for coherent Nyquist TDM transmission by utilizing the multi-functionalities inherent in Nyquist pulses, especially their time-domain orthogonality. A key component is a coherent Nyquist pulse generator. By taking full advantage of the time-domain orthogonality of Nyquist pulses, we will develop novel demodulation and demultiplexing techniques which can provide a high SNR sufficient for ultrahigh QAM multiplicity.

【Expected Research Achievements and Scientific Significance】

We expect to realize innovative high-speed and high-density transmission with the highest possible channel bit rate and SE approaching the Shannon limit. Coherent Nyquist pulses are expected to be ideal transmission pulses that can demonstrate their excellent advantages of high speed and coherence, and find a variety of applications including signal processing and measurements.

【Publications Relevant to the Project】

M. Nakazawa, T. Hirooka, P. Ruan, and P. Guan, "Ultrahigh-speed "orthogonal" TDM transmission with an optical Nyquist pulse train," Opt. Express vol. 20, no. 2. pp. 1129-1140, Jan. (2012).

【Term of Project】 FY2014-2018

【Budget Allocation】 436, 600 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.nakazawa.riec.tohoku.ac.jp
nakazawa@riec.tohoku.ac.jp