ABSTRACT

Optical code-division multiple-access (OCDMA) is a novel kind of spread-spectrum technology in the field of optical communication research. It combines the large bandwidth capacity of the fiber medium with the features of a CDMA technique to achieve high-speed connectivity. It has become attractive due to major advantages like asynchronous access capability, security against eavesdropping, protection against jamming, provision for adding more users, simplified network control and management and the possibility of multimedia traffic. However, theoretical analysis of OCDMA systems has shown that multi-user interference (MUI) is the main reason for performance degradation, especially when large number of users is involved.

One of the coding scheme called spectral-amplitude-coding optical CDMA (SAC-OCDMA) systems is now receiving much attention because MUI can be eliminated when codes with fixed in-phase cross-correlation (IPCC) are used as address sequences. Nevertheless, such systems exhibit inherent phase-induced intensity noise (PIIN) due to spontaneous emission of the broadband source that severally affects the overall system performance. To suppress it, the value of IPCC should be kept as small as possible. Therefore, the codes with ideal IPCC become attractive. In the literature, a number of codes were proposed for SAC-OCDMA communication systems so far. The proposed codes have their own advantages and limitations and no one code family has all the merits like
increased code cardinality, simplified encoding / decoding technique, shorter code length, single code weight and the possibility of supporting multi rate multimedia SAC-OCDMA communication systems.

This thesis aims to present some novel code families for SAC-OCDMA systems. The main objective of these codes is to increase the code cardinality of the code family, to increase the number of simultaneous users for the given bit error rate, to completely eliminate the phase induced intensity noise and the multiuser interference, to simplify the encoder / decoder architectures and to support multi rate multimedia SAC-OCDMA communication system.

Four novel code families namely, split-expand modified prime (SEMP) codes, single weight zero cross correlation (SWZCC) codes, modulo-p addition based constant weight variable length (CWVL) prime codes and variable length variable weight (VLVW) prime codes are proposed.

SEMP codes are designed based on modulo-p multiplication method. These codes are the divided and expanded version of the modified prime codes. SEMP codes are proposed mainly to increase the code cardinality, to lower the cross correlation, to minimize the effect of the PIIN and MUI and thus to improve the performance of the SAC-OCDMA system. The bit error rate of SAC-OCDMA system is analyzed by using the proposed SEMP codes and compared with that of other commonly used codes. The performance of the proposed code family is better than the MQC and PMP codes.
The SWZCC codes are proposed with weight equal to one, independent of the code size and with zero cross correlation value. These codes are designed by using the simple mathematical rules and are developed using diagonal matrix representation. Since the code weight of the SWZCC code is one, the number of fiber Bragg gratings required to construct the encoder/decoder structure is less in number. Further, its zero cross-correlation property has an ability to eliminate completely the PIIN noise. The performance of the SAC-OCDMA system is analyzed with SWZCC codes. The analysis results obtained show better performance in comparison with the MQC and PMP codes.

CWVL prime codes are developed for the first time to the best of the author’s knowledge based on modulo-p addition method. These codes are proposed with weight equal to one and with zero IPCC value to support variable bit rate services, for the given prime number p. Since PIIN is completely not present in this case, the effect of shot noise and thermal noise is analyzed for the system with CWVL prime codes. The performance is found to be superior over the other codes.

Finally, the VLVW prime codes are constructed with an ability to support different weight, length and to satisfy the different qualities of service requirements. Modulo-p multiplication is used to develop the code family. The diagonal elements of the resultant modulo-p method are considered as the basic sequences for the development of the VLVW prime codes. These codes will be able to support p number of code sets with variable length for the given prime number p. Also, the IPCC value of the proposed code is always
zero irrespective of the prime number p, code weight, code length and code size. Further, the obtained analysis results show a satisfactory performance.

The conclusions and the possible scope for future work are also presented at the end of thesis.