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論　文　内　容　要　旨

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学位論文題目	Study on 8-ary Orbital-Angular-Momentum (OAM) Shift-Keying for Free-Space Optical Communication System (自由空間光通信システムのための8値OAM（軌道角運動量）シフトキーイングに関する研究)		

内容要旨

The rapid growth of technological advances requires more bandwidth, higher speed, easy installation and responsibility on the transmission network. As a new communication technique, free-space optical (FSO) communication is one of the transmission networks that meet these requirements. The free-space optics market is estimated to reach 1223.1 million USD by 2024 with a CAGR of 36.4% between 2015 and 2024. It is becoming one of the key technologies for realizing very-high-speed multi-gigabit-per-second (multi-Gb/s) large-capacity aerospace communication. Also, FSO communication can be best last-mile solution in local area network (LANs) and metropolitan area networks (MANs) where installation of fiber optic cables is impossible or complexity. When the WorldTrade Centers collapsed on September 11th, 2001, a few wireless broadband providers used FSO technologies to solve network problems for all of the corporations within a building. It gave some opportunity to get their data networks up and running in a fraction of the time until to reinstall their wire lines.

Orbital angular momentum (OAM) is used to enhance spectral efficiency and transmission capacity of the transmission network because of its feature. OAM provides a useful degree of freedom for increasing the information-carrying capacity of photon [5]. Laguerre Gaussian (LG) beam, widely used optical carrier of OAM, has an $\exp(im\phi)$ phase term, where m is a topological charge, and ϕ is azimuthal angle. Each state of OAM is orthogonal to each other, which is determined by the topological charge. Since the topological charge m is an integer and can be limitless theoretically, the transmission capacity will be improved in the FSO communication system. However, the size of the LG beam faced the limitation due to the topological charge number and all of the optical systems include finite apertures. Two kinds of applications have been reported: 1) OAM-division multiplexing (OAM-DM) and 2) OAM - shift keying (OAM-SK). For the OAM-SK, information is encoded into different OAM states to improve transmission quality. One of the advantages of OAM-SK compared to OAM-DM is the improving security of data transmission since the OAM modulation requires to receive whole angular range of 2π: a potential eavesdropping with a partial beam tapping would be corrupted.

FSO communication system has several challenges such as absorption, scattering, and atmospheric turbulence due to the weather and environment. In particular, atmospheric turbulence plays the main role that may influence in bit error rate (BER) performance of the system. Atmospheric turbulence is random fluctuation in the refractive index of air and it affects the intensity and phase of the transmitted signal.

In this study, the performance of the FSO communication system with the OAM-SK is studied. The effects of atmospheric turbulence on the OAM-SK are investigated through the numerical simulation. Our main goal is to find an effective method against atmospheric turbulence and noise. We used a model named modified von Karman phase screen model for the formulation of a transmission model to investigate our new OAM-SK method in numerical simulation. We operate the FSO link with turbulence over 1000 meters and used previously introduced 8 PSK label recognition circuit to implement the OAM-SK system for FSO.