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Role of Optical Wireless Communication Underwater

Ishita Choudhury
B. Tech.
Deptt. of Electronics & Comm. Engineering,
Gandhi Institute of Engineering & Technology,
Gunupur, Rayagada, India

Richa Sony*
B. Tech.
Deptt. of Electronics & Comm. Engineering,
Gandhi Institute of Engineering & Technology,
Gunupur, Rayagada, India

Ranjita Rout
Assistant Professor
Deptt. of Electronics & Comm. Engineering
Gandhi Institute of Engineering & Technology, Gunupur, Rayagada, India

Abstract

Wireless communication today have emerged a lot in its way. Many researchers have been looking forward to make it better and better. Recently, the importance of underwater wireless optical communication has been grown for applications of underwater observation and sea monitoring. Underwater absorption, scattering and turbulence processes will introduce attenuation and fading to light propagation and then degrade the performance of underwater wireless optical communications (UWOC). As power consumption is an important issue in underwater missions, it is fundamental to minimize the intensity loss by reducing the divergence of beam, data transmission in relatively high turbidity waters appeals for the use of energy-efficient modulations and strong channel codes at the physical and data link layers. The particular difficulty of developing such model resides in the fact that turbulence highly depends on the operational scenario and also on the condition of water, underwater wireless optical communications (UWOC), pulse modulation technique has been widely used due to the high optical power efficiency and relatively low system complexity. Compared with the simplest on-off keying (OOK) scheme, digital pulse interval modulation (DPIM) improves both power efficiency and error performance and requires no symbol synchronization. A scheme named, polarized DPIM (P-DPIM) and Po1SK, combining both to further improve the performance, and deriving its bit-error-rate (BER) expression in additive white Gaussian noise (AWGN) channel. UWOC channel suggest that P-DPIM scheme can improve both the power efficiency and error performance as well as communication distance compared with traditional DPIM system. We analysed these links in Opti System. Opti System is an innovative, rapidly evolving, and powerful software design tool that enables users to plan, test, and simulate almost every type of optical link in the transmission layer of a broad spectrum of optical networks from LAN, SAN, MAN to ultra-long-haul. It offers transmission layer optical communication system design and planning from component to system level, and visually presents analysis and scenarios.

***Keywords**: Underwater Wireless Optical Communications, Pulse Modulation Technique, Digital Pulse Interval Modulation, On-Off Keying.*

****Author for correspondence*** rsony.jsr19@gmail.com

1. Introduction

An optical fiber is a flexible, transparent fiber made by drawing glass (silica) or plastic to a diameter slightly thicker than that of a human hair. Optical fibers are used most often as a means to transmit light between the two ends of the fiber and find wide usage in fiber-optic communications, where they permit transmission over longer distances and at higher bandwidths (data rates) than wire cables. Fibers are used instead of metal wires because signals travel along them with lesser amounts of loss; in addition, fibers are also immune to electromagnetic interference, a problem from which metal wires suffer excessively. Fibers are also used for illumination, and are wrapped in bundles so that they may be used to carry images, thus allowing viewing in confined spaces, as in the case of a fiberscope. Specially designed fibers are also used for a variety of other applications, some of them being fiber optic sensors and fiber lasers.

Optical fibers typically include a transparent core surrounded by a transparent cladding material with a lower index of refraction. Light is kept in the core by the phenomenon of total internal reflection which causes the fiber to act as a wave-guide. Fibers that support many propagation paths or transverse modes are called multi-mode fibers (MMF), while those that support a single mode are called single-mode fibers (SMF). Multi-mode fibers generally have a wider core diameter and are used for short-distance communication links and for applications where high power must be transmitted. Single-mode fibers are used for most communication links longer than 1,000 meters (3,300 ft.). An optical fiber transmission link comprises of element which are transmitter consisting of a light source and its associated drive circuitry, a cable offering mechanical and environmental protection to the optical fibers contained inside, and a receiver consisting of a photo detector plus Amplification and signal-restoring circuitry. Additional components include optical connectors, splices, couplers or beam splitters, and repeaters. The cabled optical fiber is one of the most important elements in an optical fiber link.

2. Optical Wireless Communication

Optical wireless communications (OWC) is a form of optical communication in which unguided visible, infrared (IR), or ultraviolet (UV) light is used to carry a signal. OWC systems operating in the visible band (390–750nm) are commonly referred to as visible light communication (VLC). VLC systems take advantage of light emitting diodes (LEDs) which can be pulsed at very high speeds without noticeable effect on the lighting output and human eye. VLC can be possibly used in a wide range of applications including wireless local area networks, wireless personal area networks and vehicular networks among others. On the other hand, terrestrial point-to-point OWC systems, also known as the free space optical (FSO) systems, operate at the near IR frequencies (750–1600nm). These systems typically use laser transmitters and offer a cost-effective protocol-transparent link with high data rates, i.e., 10Gbit/s per wavelength, and provide a potential solution for the backhaul bottleneck. There has also been a growing interest on ultraviolet communication (UVC) as a result of recent progress in solid state optical sources/detectors operating within solar-blind UV spectrum (200–280nm). In this so-called deep

UV band, solar radiation is negligible at the ground level and this makes possible the design of photon-counting detectors with wide field-of-view receivers that increase the received energy with little additional background noise. Such designs are particularly useful for outdoor non-line-of-sight configurations to support low power short-range UVC such as in wireless sensor and ad-hoc networks.

3. Simulation Set-Up

The simulation is done using OptiSystem Simulation Software. OptiSystem is a thorough programming outline suite that allows us to arrange, test, and simulate optical connections in cutting edge optical systems. Propose algorithm comprises of a transmitter with NRZ signals, wireless optical channel, and optical receiver consisting of PIN photo-detector, Bessel filter and BER analyzer to visualize the yield result. The biggest challenge for underwater wireless communication originates from the fundamental characteristics of ocean or sea water; addressing these challenges requires a thorough understanding of complex physio-chemical biological systems. So as to investigate the effect of nonlinearities on the optical communication system, the transmission distance of the optical system is differed.

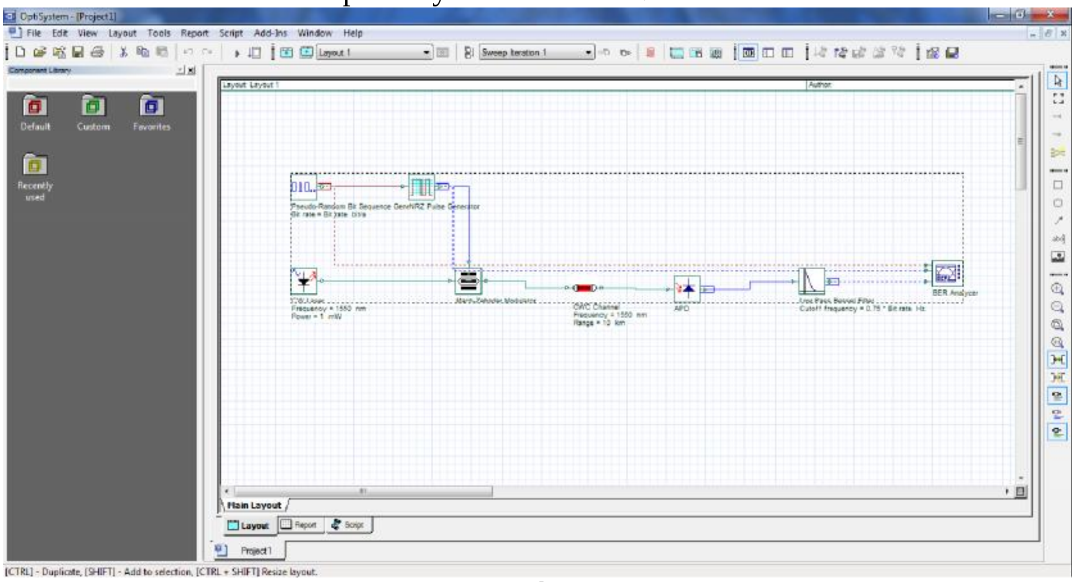

Fig. 1: Simulation setup

Table 1

Parameters	Values
Bit rate	20 bps
Modulation	NRZ
Distance	20,40,60,80
Power	1mW

4. Results and Discussion

We have simulated the optical link working at 20Gbps. The nonlinear effects are analyzed in terms Q Factor, BER with the use of Eye Diagrams. Following table shows the impact of nonlinear effects on the Q-factor in accordance to the increase in transmission distance for NRZ modulation.

Table 2: Project Tabulation

Distance (Km)	Q	BER	Eye Height	Threshold
20	6.9976	$1.301e^{-012}$	0.000465	0.000489
40	6.9952	$1.31852e^{012}$	0.000116422	0.000121764
60	6.92164	$2.2319e^{012}$	$5.1396e^{-005}$	$5.35437e^{-0.005}$
80	6.70179	$1.028e^{-01}$	$2.18922e^{-.005}$	$2.96946e^{-00}$

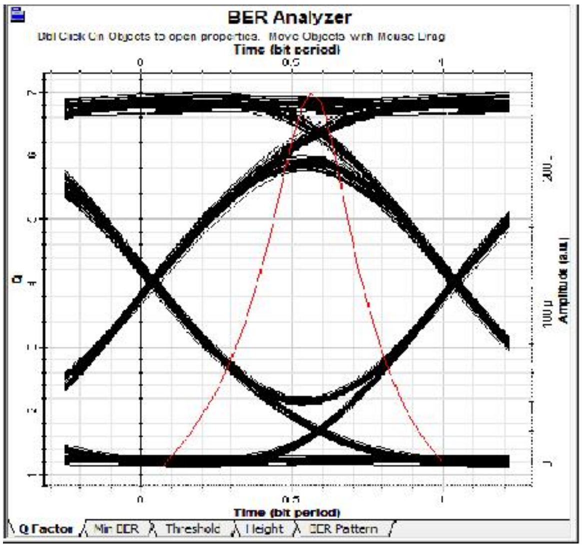

Fig. 2: Eye diagram at 40 KM

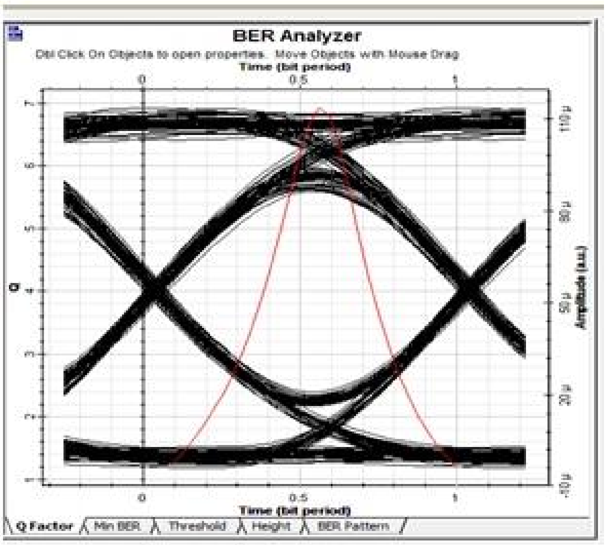

Fig. 3: Eye diagram at 60 KM

5. Conclusion

As wireless frequency penetrates the wall, wireless communication is faster. Optisystem software was used to generate under water wireless optical link in this paper. The link is between 20-80 km. It is found that the best is at 40 km which then goes to degrade. The output is better at 40 km in terms of Q-factors, Bit Error Rate and eye diagram.

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