RESEARCH ARTICLE

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Long Distance Transmission in Optical-IDMA System

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Abstract

In optical fiber communication system the transmission of signal through optical fiber in long distance with less repeaters can reduce the system's cost and maintain the signal quality. For long-distance transmission Nonlinear effect and dispersion increases with distance and degrade the signal quality of the optical-interleave Division multiple Access (O-IDMA) system. To reduce Nonlinear effect and dispersion Gaussian pulse has been replaced by Solitons and evaluate the performance. MATLAB has been opted to simulate the Optical fiber channel based IDMA system. Simulation outcomes shows that Solitons may be better option in place of Gaussian pulse for long distance transmission.

Keywords: IDMA scheme, O-IDMA scheme, BER, Gaussian pulse, Solitons.

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Introduction

In wired communication, optical fiber is the used more frequently in present time due to large bandwidth and very low noise.[1-3] Proper bandwidth utilization is important for optical fiber sysem because it increases the number of users as well as data transmission rate. Multiple access schemes are used for efficient utilization of bandwidth. Latest multiple access scheme IDMA which is being implemented.[4] A detailed discussion of the optical IDMA system has been presented in the next section. In the IDMA system, the signal form is generally Gaussian, and the transmissited signal gets distorted due to a non-linear effect.

The optical transmitting pulse in the form of Gaussian pulse broadens with increasing the length of the an optical fibre because group velocity dispersion (GVD) phenomena come during the traveling of the pulse and the GVD effect distort the transmitting signal. To counteract the pulse-widening effects of GVD events, a particular type of pulse formation familiar as a soliton offers the benefit of nonlinear processes in silica, specially self-phase modulation (SPM) extracted from the Kerr non-linearity.

Solitons are actually very narrow pulses and have high peak powers. Soliton pulses are created by using self-phase modulation to counterbalance the effect of dispersion in an optical fibre. Due to its extreme stability, the soliton can maintain its shape and speed while transmitting over the fiber. Solitons do not widen during the transmission through optical fibre over thousands of kilometers because it is not affected due to dispersion and non linear effect.

In this research paper, Solitons and Gaussian pulse have been used as the input transmitting signal. It is also examined that Solitons have superior performance than Gaussian pulse.

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In section 2, O-IDMA scheme has been presented wlile in section 3 Solitons and nonlinear effet have been presented. In section 4 results and dission while in lsat section 5, conclusion have been presented.

Optical-IDMA Scheme

The optical fiber channel which is constructed communication system with interleave division mulptiple access scheme has been shown in Figure 1. In Figure 1 the O-IDMA transmitter is shown in upper portion while O-IDMA receiver structure is shown in down portion. In O-IDMA transmission section, the signals first encoded by encoder and next interleaved by the interleaves, next the signals are converted into optical form and last the signals are combined to transmit through single optical fiber. Moreover, in O-IDMA transmission seprate interleaver is used for each user and all the interleaves are orthogonal to each other. Here interleaver are used for user sepration in O-IDMA system while in O-CDMA spreading is used for user sepration due to this the difficulty of Multiple access interference (MAI) in Optical-CDMA has been resolved

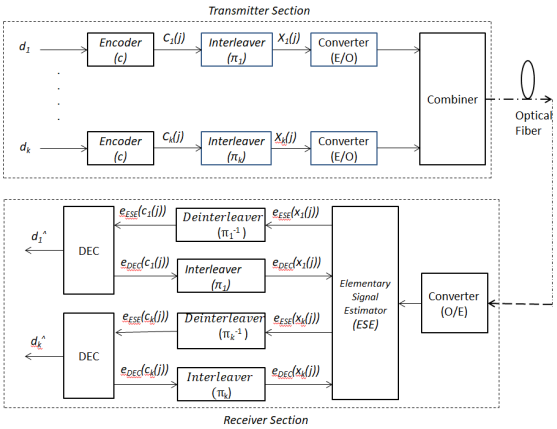

Figure 1: Block diagram of optical-IDMA system

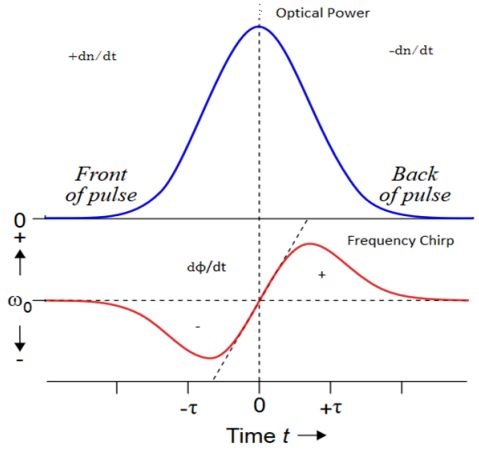

Figure 2: Spectral broadening of gaussian pulse caused by self-phase modulation.

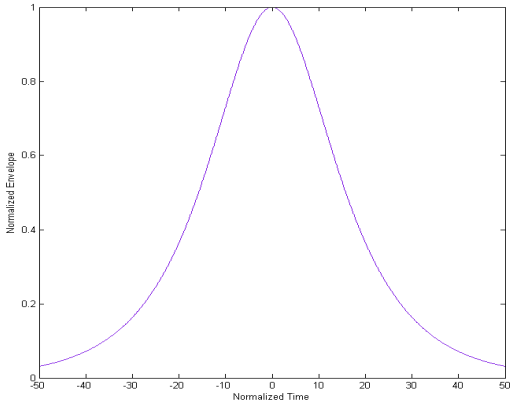

Figure 3: Hyperbolic secant pulse (solitons pulse).

in O-IDMA.[5-8] In the O-IDMA receiver section, the optical signals are converted into electrical form. The next step is that the signals pass through Elementry signal estimator, deinterleavers and decoders to get the signals into original form. For high spectrum efficiency, less receiver difficulty and better performance, the new evolved multiple-access strategy based on interleaving mechanism is used in the advanced optical fiber channel based IDMA transmiting system. The IDMA technique uses interleavers to disperse user data in order to distinguish between different users.

Figure 1 introduces the block diagram of the O-IDMA transmitter as well as receiver system. There are numerous uses for O-IDMA. The basic mechanism and formulation of IDMA may be reviewed in.[9-10]

Solitons to Reduce Nonlinear Effects in Channel of O-IDMA System

Non-linear distortion and dispersion are the main parameters that distort the transmitting optical signal in Gaussian pulse in long distance transmission. The optical signal travels along the fiber and as the distance increases, its shape distorts because it broadens with distance.[11] Hence it is very difficult to transmit the signal in the form of Gaussian pulse for long distance. Therefore, the fiber-based transmitting system's capacity is limited due to these distortion effects. Spectral broadening of Gaussian shape pulse caused by self-phase Modulation is shown in Figure 2.

Solitons is the another pulse that does not broaden due to non-linear distortion and dispersion as the distance increases even upto 500 km. in Figure 3 the shape of the Solitons is shown and it is alike to Gaussian pulse, therefore, the compatibility of the system is also very good with Solitons. Here it is clear that Solitons may be used to improve the O-IDMA system performance.

The fundamental form of Sloitons can be represented mathematically as[12]

$$u(z,t) = \text{sech}(t) \times e^{\frac{jz}{2}}\ (1) \qquad (1)$$

Here, *u(z, t)*is the important function which is pulse envelope function.

The phase shifts of a Solitons with nonlinear effect may be represented as

$$d\Phi_{nonlin} = |u(t)|^2 dz = sech^2(t)dz\ (2) \qquad (2)$$

And phase shifts of a Solitons with dispersion effect may be represented as:

$$d\Phi_{disp} = \left(\frac{1}{2}\frac{\partial^2 u}{\partial t^2}\right)dz = \left[\frac{1}{2} - sech^2(t)\right]dz \qquad (3)$$

The summation of these two terms i.e., the phase shifts of a solitons pulse with nonlinear effect and phase shifts of a Solitons with dispersion effect is a constant. After integration, the phase shift will be z/2, which will be common to the entire pulse. Therefore solitons remain entirely non-dispersive in both cases i.e., temporal and frequency domains, because such a phase shift does not alter either the temporal or spectral structure of a pulse.

Results and Conference

The performance of the O-IDMA syatem may be evaluated on the basis of the parameter BER (bit error rate).[13] The

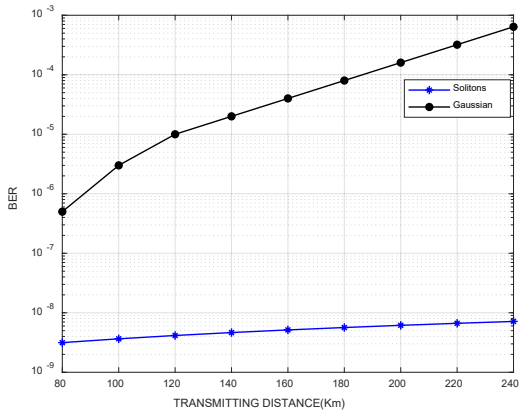

Figure 4: BER (bit error rate) performance of O-IDMA System with varying the transmitting distance of Optical fiber for gaussian and solitons.

Optocal-IDMA (O-IDMA) system has been simulated using MATLAB using input signal shape Gaussian pulse as well as Solitons with varying transmitting distance. Figure 4 shows the simulated result of the O-IDMA using the input signal as Gaussian pulse and Solitons with varying distance.

During simulation, a random interleaving process is opted for O-IDMA system.[14-16] The other parameters, used for the simulationof the O-IDMA system for better results are spreading length = 16, number of iteration = 15, efficiency =0.80, the common data length for every user = 4096 bits, detectors responsivity = 0.65, optical fiber operating wavelength = 155 nm, maximum bit rate capacity in Gbps, transmitted signal power = 1 mW, number of users = 40, refractive index = $2.35*10^{-20}$ and OOK modulation has been used.

Figure 4 shows the BER versus transmitting distance performance of the O-IDMA system employing input transmitting pulse as solitons and a Gaussian pulse. While the BER of input pulse as solitons is practically constant, the BER of input pulse as Gaussian pulses is seen to disperse linearly with distance. The reason of better performance by solitons is that solitons does not disperse due to dispersion and non-linear effect while Gaussian pulse disperses due to these effect as distance increases.

Conclusion

In this article, the O-IDMA transmitting system has been analyzed on the basis of input shape of pulse i.e., Gaussian pulse as well as Solitons. It is clear from the result analysis that Solitons may be used in place of Gausian pulse and the performance of the Optical-IDMA transmitting system may be increased. It is also clear that Solitons is compatible like the Gaussian pulse in O-IDMA system.

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