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CODING TO ENHANCE PERFORMANCE OF AMPLIFIED OPTICAL COMMUNICATION SYSTEMS IN THE PRESENCE OF NOISE COMPONENTS OF OPTICAL DEVICES AND CHANNEL INTERFERENCE

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Abstract

In this paper, performance of amplified light wave systems employing both conventional M-aty Quadrature Amplitude Modulation Subcarriers Multiple Intensity Modulation / Direct Detection (M-ary QAM-SCM-IM/ DD) and OCDMA/DD schemes have been analyzed. The analysis also incorporates the influence of code rates (weights) on the system performance. It is observed front analysis that for a given number of users, performance of OCDMA networks improves with the increase in the code weight. Fourteener, use of large code weight will give rise to better performance, but a smaller number of simultaneous supportable users. On the other hand, use of small code weight leads to a poor performance, but in this case the number of supportable users is large. Also, it is found that coding can increase the total channel number and eliminate error floor under a given bit error rate and receiver sensitivity.

These systems employ-ng optical amplifier have been studied and investigated. It is found that coding can increase the total channel number and eliminate error floor under a given hit error rate and receiver sensitivity. A performance comparison of QAM and OCDMA systems reveals that OCDMA can accommodate a larger number of subscribers and more simultaneous users than QAM.

Keyword: CODING, ENHANCE PERFORMANCE, OPTICAL COMMUNICATION SYSTEMS, NOISE COMPONENTS, OPTICAL DEVICES, CHANNEL INTERFERENCE.

*** Introduction**

Since the start of the communications revolution with the invention of low-loss optical fibers in 1970, Corning has been constantly innovating to increase the speed and capacity of optical networks while reducing installation costs. Today, optical communications solutions have been provided to growing sectors such as fiber to the home, wireless technology and large-scale data centers (Behringer, 2006).

The ultimate goal of the future transmission network is to create a complete optical network which is to achieve optical fiber transmission instead of copper wire transmission in the access network and backbone network. Eye contact will inevitably facilitate further progress of the network (Bloomfield, 1994).

Optical Communication is a type of communication in which light is used to transmit the signal to the far end instead of the electric current. Optical communication depends on optical fibers to transmit signals to their destinations. The modulator or demodulator, the transmitter and receiver, the optical signal and the transparent channel are the basic building blocks of the optical communication system, and because of its many advantages over transmission Electricity Optical fibers have largely replaced copper wire communications in core networks in the developed world (Ho, 2005).

Since the development of low-loss fiber optic cables in the 1970s, optical communications have become one of the most common methods of communication. Optical communications systems consist of the following components:- (Antony, 2010)

1- Transmitter, converts and transmits an electronic signal into an optical signal. The most common transmitters are semiconductor devices such as light-emitting diodes (LEDs) and laser diodes.

2- Receivers: They usually consist of a photodetector which converts light into electricity using the photoelectric effect. The photodetector is usually a semiconductor-based photodiode.

3- Optical fiber: It consists of a core, cladding, and insulator through which light is directed along the core using total internal reflection. Additional elements such as wrenches, cables, generators, beam splitters and optical amplifiers are used to improve the performance of the communication system.

The main benefits of optical communication: High bandwidth. Exceptionally low loss. large transmission range. No electromagnetic interference. Disadvantages of optical communication: the high cost of cables. Transceiver and other high-cost support equipment. High skill and experience are required during cabling installation and interconnection.

Advantages of optical communication are long transmission distance and energy saving, which Suppose you want to send 10 gigabits of information in one second, which is 10 billion signals, if you use electrical communication, you need to adjust the signal every 100 meters, in contrast, using optical communication requires an interval of more than 100 km and the fewer times the signal is tuned, the fewer devices will be used, thus saving energy (Strand & Chiu, 2003). In addition, when you call or chat online now with your distant friends you will feel that there is no difference with local conversation without voice delay and in the age of electrical communication one can send at short distance and transmit less information International communication is mainly transmitted via satellite as a relay, and with optical communication one can travel long distances and transmit more information, so using fiber-optic cables laid on the sea floor can communicate with the outside and electric waves have the same speed as light waves and because the transmission path is longer by satellite, the signal arrives slower, and the submarine cable is much shorter so it will be Signal is faster (Shimizu et al., 2002).

Transmission of a huge amount of information simultaneously using optical communication: a large number of users can simultaneously receive the required information as movies or news in one second, electrical communications can transmit at a speed of (10 gigabit only) of information, that is, 10 billion signals in the binary system, on the other hand, optical communication can transmit information up to 1 terabyte, or 1 trillion signals in the binary system (Mukherjee, 2000).

Fast communication speed: Electrical communication can cause electrical noise errors and lead to low communication speed, however optical communication is not affected by noise so it can transmit signals quickly (Gangwar& Sharma, 2012).

In this regard, this study aims to shows the coding to enhance performance of amplified optical communication systems in the presence of noise components of optical devices and channel interference.

*** Literature Review**

Although the history of optical communication dates back to the 1880s, transmission problems were experienced in those years according to the communication techniques of the period. Over time, transmission problems in optical communication were solved, but it took a long time to adapt to communication systems. This is because the concept of the sheath surrounding the core region was formed later.

In 1880, A. Graham Bell patented the optical telephone system he named "Photophone". In the same years, W. Wheleer conducted experiments that directed the light using the coated light tube. By the 1920s, J. L. Baird in England and W. Hansell in the United States patented the idea of transmitting image or fax information through hollow pipes or transparent rods. After these years, optical communication showed a rapid development, but the loss factor, which was the biggest problem of optical communication in those years, still has not been solved (Keiser, 1983).

In 1954, A. Heel determined that coating glass with a low refractive index on a fiber cable would reduce its exposure to external agents and other fiber cables. Thus, the biggest problem with fibers, which is the signal reduction during the transmission of light through the fiber tube, was solved by Heel and with the support of the American optical physicist B. O'Brien. This phenomenon protects the overall reflection surface from noise and significantly reduces crosstalk between the fibers. Later, optical fibers were also used in laser therapy. A.L Schawlow and C.H Townes have studied the function of lasers in the infrared and visible spectrum. The first laser in the visible spectrum made of sapphire material (Sharma, 1987).

The first successful optical laser was made by A. Maiman. The discovery of the laser, which provided the optical equivalent of a radio frequency (RF) generator in the late 1950s and early 1960s, led to the technology for optical communication. In 1961, E. Snitzer carried light from fibers in the form of a single-mode waveguide. However, due to the loss of 1 dB per meter, it can only be used for medical research on the human body. However, a loss of more than 10 or 20 dB per kilometer could not be tolerated in long-range communication systems, so this was not enough. In the standard communications lab, C.K Kao found that fiber losses are related to additions to the glass, not the silica glass itself (Sharma, 1987).

Using light to transmit information from one place to another is a very old technology. In 800 BC, the Greeks used fire and smoke signals to send information such as victory in war, alerting against the enemy, and asking for help. Often only one type of signal was transmitted during the second. In the first century BC, the optical signals were encoded using signals so that any message could be sent, and there was no significant development in optical communication until the end of the eighteenth century, and the speed of the optical communication link was limited due to the requirements of line-of-sight transmission paths, the human eye as a receiver and unreliable nature for transmission Sion tracks are affected by atmospheric influences such as fog and rain (Latimer, 2003).

In 1835, Samuel Morse invented the telegraph and began the era of electrical communications around the world. The use of wired cables to transmit Morse coded signals was implemented in 1844 AD, and in 1872 AD, Alexander Graham Bell proposed a photographic telephone with a membrane that gives speech transmission at a distance of 200 m; But within four years, Graham Bell converted the photo phone into an electric current telephone for transmitting speech signals, and in 1878 the first telephone exchange was installed in New Haven. Meanwhile, Hertz discovered radio waves in 1887

AD, Marco demonstrated wireless communication without using wires in 1895 AD, using modulation techniques. The signals were converted and imitated over a long-distance using radio and microwave waves as a carrier (Arumugam, 2001).

As visual communication systems become more complex, they are vulnerable to denial of service and eavesdropping in new and unique ways Measurement and monitoring can provide enhanced security to identify suspicious activity and initiate preventive measures against denial of service and eavesdropping caused by human error or malicious attack an effective scheme depends on an understanding of physics Underlying data transmission in an optical (WDM) network. Erbium-doped fiber amplifiers (EDFA) boost wavelengths in the range (1,550 nm) and typically pump light (1,480) and when an undesirable high-energy wavelength is added, severely humiliating effects can occur as a measure to achieve a denial-of-service attack, and the length can also saturate the unwanted waveform is intensely intense and reduces the gain of an optical amplifier and simple crosstalk can destroy the data on the channels.

If that wavelength disappears, the network returns to normal without any permanent trace of the offender. Pump light is used to excite the erbium atoms into higher orbits and stimulate them. The input signal releases the excess energy as photons in phase and of the same wavelength (Matusitz, 2005).

Optical components and media for data transmission have some significant advantages over their electrical counterparts compared to copper cables, the use of fiber optic cables is easier and more flexible and needs less space while reducing fire risk due to lower heat generation, and unlimited bandwidth for fiber optic applications (80 TB) / s) outperforms electrical transmission (50 Mbit / s) many times, and in addition many independent data channels can be transmitted over vast distances with low losses (Elliott, 2002).

The first step in designing an optical communication system is to determine how to convert electrical binary data into an optical bit stream. An opt electric modulator is used for this purpose. The simplest optical pulse technology is used so that the presence of a pulse in the 1-bit time period and its absence corresponds to 0 bits, this is indicated on It is the on and off switch because the light is either off or on depending on whether (0 or 1 bit) is being transmitted (Zoiros et al., 2004).

*** Global Fiber Optic Communication Network**

The advent of the Internet in the early 1990s made it necessary to develop a global network capable of connecting all computers including mobile phones in a transparent manner, such a network required the deployment of fiber-based submarine cables across all oceans and the first cable of this Tribe was established in 1988 AD across the Atlantic Ocean (TAT-8), but it was designed to operate at a speed (280 Mbit / s only) using second generation technology, and the same technology was used for the first trans-Pacific fiber optic cable (TPC-3), which began operation in 1989 AD (Palais, 1988).

By 1990, third-generation optical wave systems were developed and the TAT-9 submarine system used this technology in 1991; Designed to operate close to (1.55 µm at a bit rate of 560 Mbps) with a repeater spacing of about 80 km, increased transatlantic traffic led to the deployment of cables (TAT-10 and TAT-11) by 1993 with the same technology. The submarine cable is strong and the inner structure of a submarine cable contains several fibers to carry bidirectional movement. The optical fibers are immersed in a waterproof gel surrounded by several steel bars to provide strength and the steel bars are kept inside a copper tube covered with polyethylene insulation (Umeda et al., 2007).

The study of the applicability of single-mode fibers from the point of view of the limited optical power transmitted due to scattering and noise processes. To deal with the applicability of the fibers and thus with the performance of light wave systems (Bao& Chen, 2012). The most important parameters affecting the performance of amplified optical networks are the maximum transmission length, the maximum permissible signal power, channel frequency separation, as well as the deterioration of receiver sensitivity and the total number of channels.The effects of APD, thermal noise, ASE, and interference (crosstalk) are examined by OCDMA/DD. Moreover, one such scheme is Optical Orthogonal Code Division Multiple Access (OOCDMA).

*** Modal Analysis in Optical Waveguides**

Fibers used in optical communication are waveguides made of transparent insulator, which are responsible for transmitting visible and infrared light over long distances (Di et al., 2010). To perform optical waveguide analysis, Maxwell's equations, electrical properties of matter, and the laws of reflection and refraction of light are taken into account. For the light to stay inside a fiber, the refractive index of the sheath region must be less than the refractive index of the core region (Kiyat, 2000).

*** Optical Modifiers**

Optical modulators are elements that perform various functions such as modulating phase, amplitude, frequency and polarization in optical fiber systems, and most of them act as solid-state elements (Jia et al., 2008). The light source is modulated by the electrical control signal by changing the optical properties of the modulator material (Liu et al., 2011).

The control signal is related to the properties of the material through photoelectric, acoustic and magnetic mechanisms. Optical modulators are also divided into analog or digital modulators according to the type of information signal used. In analog modulation, the change in the light emitted by the optical source is continuous, while in digital modulation there are discrete changes in light intensity. Digital modulated systems have a lower signal-to-noise ratio than analog modulated systems. The analog quantities used in modulation are those of quantity, intensity, optical phase, polarization, and color. In digital modulation, frequency modulation, on-off intensity modulation, Doppler shift, pulse width or time-delay modulation, and hybrid systems techniques are used.

A beam of light is modulated using five basic properties of light: optical density, phase, polarization, wavelength, and spectral distribution. Fiber sensors that use the first three characteristics are dense. These sensors are divided into two different groups as phase modulated and density modulated sensors. Apart from these, optical modulators are divided into three like phase modulator, amplitude modulator and frequency modulator according to the modulation of phase, amplitude or frequency of the electrical source signal. These modulator types are presented in detail in the following sections.

*** Modulation Techniques**

Optical signals are modulated by two alternative methods, direct modulation and external modulation.

*** Direct Modification**

By modulating the electric signal current applied to the laser, the laser is turned on/off; However, for many light sources, the modulation modifies not only the amplitude of the light, but also its phase and frequency. Unwanted frequency modulation is called the chirp factor. Direct modification is a very simple and cost-effective method and is not as effective as external modification due to the high chirping factor (Sackinger, 2005).

*** External Modulation**

The input signal is given by a continuous signal laser (CW, continuous wave) and the laser is constantly on. The optical signal is modulated by an external optoelectronic modem. External modification is more complex and more expensive than direct modification technology. In external modulation, the quality of the modulated signal is high because the bandwidth is narrow and the noise signal is minimally modulated, in other words, the chirping factor is low.

*** Main Features of Optical Modifiers - Spectral Width**

Kaur et al. (2012) given that the amplitude of the optical signal is modulated in an arrangement consisting of an ideal light source and an ideal modulator, the mode of the modulator output signal on the frequency spectrum, with frequency f and bandwidth B, being as much as B/2 to the right and left of the signal, the bandwidth in a position that allows It happens and it only expands. If this bandwidth is expressed as the wavelength width as it is often used, then the wavelength is the speed of light in a vacuum and B is the bandwidth.

However, in practice, these ideal conditions are not completely satisfied, and only certain types of exogenous modifiers approximate this model. In this way, a narrow-spectrum optical signal over a frequency band is called a finite shunt pulse. In practice, while the amplitude of the signal is modified, its phase and frequency also change to a certain extent. Unwanted frequency modulation is called the chirp factor. Direct modulators are good examples of chirp operator formation, the signal width on the frequency band is greater than the bandwidth of B.

* The widespread use of optical communication networks has increased the importance of optical circuit elements and detailed studies are needed on this topic. Optical modulators, which are among the elements of the optical circuit, their working principle and performance parameters are examined theoretically, and the effects of these performance parameters are observed in applications made using the OptiSystem 7.0 simulator (Wooten et al., 2000; Hunsperger, 1995; Grattan & Ning, 1999).

The effect of the chirp factor, which is one of the most important factors in maintaining the original signal in optical modulators, has been comparatively studied on EML and Mach-Zender modulators, which are widely used in industry (Galindez&Thévenaz, 2008). While the signal location on the bandwidth of the Mach-Zender modulator is 0.52 THz, it is far from the ideal modulator characteristic of the EML modulator of 0.72 THz. However, no significant change in the output power of both modulators was observed, and it was concluded that both modulators could be used in cases where the chirping factor was not a priority.

The effect of ER damping factor and average power of optical modulator coefficients were also studied. The ER factor is ideally infinite, and it has been observed that the modulator output signal approaches the original signal as the ER value increases. In order to measure the effect of the ER boost rate on the modulator output signal, two different modulator settings with an ER value of 5 dB and 30 dB and an increase in the ER factor of 30 dB were set up which provided a gain of up to 60% over the frequency band. In order to analyze the effect of the average power on the original signal oscillation, two different settings with average power of 10 dBm and 200 dBm were generated by keeping the ER factor constant. While the signal amplitude was 113.85 dBm in the setup with an input power of 10 dBm, it was observed that the amplitude increased to 137.86 dBm in the setup with an input power of 200 dBm, and it was observed that the original signal fluctuation was better preserved in the setup where the power was The input is 200 dBm. Another parameter that affects the performance of optical modulators is the bias voltage. It has been determined that the effect of the chirping factor, one of the factors that reduces the contact quality of modulators, decreases by 50% with the 1V negative bias voltage applied to the modulator.

The placement of modifiers in the optical network and their use in industry are analyzed. In a two-channel optical network, the source signal was applied to the optical modulator by passing through a 50 dBm optical amplifier after a 50 km optical fiber. In the other channel, the source signal is passed directly through the modulator and given to the output. In this application, loss analysis was performed by comparing the use of modulator in the ideal environment and in the industry. While the OSNR (Optical Signal to Noise Ratio) in a lossless environment was 79.98 dB, it was found to be 33.7 dB in a lossless environment (Ramaswami et al., 2009; Chen & Murphy, 2011).

Abu-Gazleh (2012) analyzed the performance of optical wave amplified systems using both conventional M-ary quadrupole amplitude modulation/direct detection (M-ary QAM-SCM-IM/DD) subcarriers and OCDMA/DD schemes. The analysis also includes the effect of code rates (weights) on system performance.It is observed from the analysis that for a certain number of users, the performance of OCDMA networks improves with increasing code weight. Moreover, using a large weight of the blade will result in better performance, but fewer users that can be supported simultaneously.

On the other hand, using a small blade weight leads to poor performance, but in this case the number of supporting users is large. It was also found that the encoder can increase the total number of the channel and remove the error ground under a certain bit error rate and receiver sensitivity. These optical amplifier systems have been studied and examined. It has been found that the encoder can increase the total number of the channel and remove the error ground under a certain bit error rate and receiver sensitivity. A performance comparison of QAM and OCDMA systems reveals that OCDMA can accommodate more subscribers and concurrent users than QAM.

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