https://dx.doi.org/10.22161/ijaers.4.5.28 *ISSN: 2349-6495(P) | 2456-1908(O)*

A Review on Advancements in Optical Communication System

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Abstract--- *Communication systems are revolutionized by the tremendous research being done in this direction. The need is the mother of the invention. The need of data transfer in increasing every day. There is the big demand for the fast optical communication systems. The optical fibers have the big potential of carrying the different channels which can transmit the data at amazing speed. In this work we have studied the research done in the field of technological development taking place in fiber communication system. The focus is on the use of fiber link as a modern medium of communication in the optical range.*
Keywords---Communication system, Optical data transfer, Channel, Fiber link, Optical range.

I. INTRODUCTION

There are certain inherent flaws with the optical transmission system like intersymbol interference and noise. This distortion is introduced by the narrow bandwidth and some distortions due to the media through the optical signals travel. The linear transversal filter is used to reduce symbol interference. The system designed to remove unknown distortion is called an adaptive equalizer. The corrective measure is to identify the distortion and adjust accordingly with the objective to remove it. The equalizer can be the supervised or unsupervised type. In the TV or radio Transmission, blind equalizers are used.

Xuen He and et.al have employed step size controller method to achieve an efficient solution in fiber communication system is to the communication system. This work makes the use of PSD directed adaptive FD-LMS algorithm. This algorithm nullifies the posterior derivation of each frequency being in the FMI system with AWGN channels. The proposed algorithm has been verified by simulation results. The three algorithms namely conventional adaptive FD-LMS, signal PSD dependent noise PSD directed FD-LMS is found to be minimum. The convergence speed is improved by 48-39%.

It has also been established that the convergence is faster in longer transmission distance or larger differential mode group delay. The proposed algorithms are evaluated at different system MDL. The complexity comparison for three algorithms is done in terms of needed complex multiplication. The check is formed over long distance thus simulating transmission length varying between 1000and 3000 km. The power spectral density methodology requires in complex and needs of higher order. The hardware complexity of noise PSD directed method slowly decreases with the increase in the transmission distance. It has been found practically when the step size increased from 0.001 to 0.002 frequency domain least mean square algorithm needs simple hardware and this tends to converge efficiently. The equalizer converges to higher MSE. The noise PSD directed method iterated over 3000 km transmission on all six modes and it tends to convergence at same MSE to get the standard -10 dB normalized MSE (NMSE).The noise PSD directed algorithms require 47 blocks and the conventional algorithm needs 48 blocks [1].

Sean O¨Arık and et.al have proposed Long-haul mode-division multiplexing (MDM) for adaptive multi-input-multi-output (MIMO) equalization to reduce for modal crosstalk and modal dispersion. To minimize computational complexity, use MIMO frequency-domain equalization (FDE).Polarization division multiplexing (PDM) system use single mode fiber but its transmission effected by noise, fiber nonlinearity and dispersion. In multi-mode fiber (MMF) with multi-input-multi-output (MIMO) transmission Increasing per-fiber capacity can be achieved more readily by increasing spatial dimensionality the total number of dimensions available for multiplexing, including spatial and polarization degrees of freedom denoted by D. In first case two polarization modes of single mode fiber using D=2. This is made possible by equalization techniques goes on going up with the upward drift of D and higher group delay. In second case systems using modedivision multiplexing (MDM) in MMFs (D>2) receiver, computational complexity increases because of an increase in *D* and because of the large group delay (GD) spread from the modal dispersion (MD). Two approaches for minimizing GD spread and controlling receiver complexity are optimization of the fiber index profile and

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the introduction of strong mode coupling. High group delay has been obtained in step index fiber and low group delay obtained in graded index fibers with large cores (D).LMS algorithm and recursive version are used for MIMO FDE. It has been observed that RLS achieves faster convergence, higher throughput efficiency, lower output SER, and greater tolerance to mode-dependent loss, but gives higher complexity per FFT block. Therefore, RLS preferable for adapting to an unknown channel but LMS continuously might be preferable, depending on channel dynamics and system requirements [2].

Md. Saifuddin Faruk and et.al have been proposed a novel adaptive frequency-domain equalization (FDE) scheme in digital coherent optical receivers, which can work with rationally-oversampled input sequences using the constant modulus algorithm (*CMA).* Adaptive filters play an important role in digital coherent optical receivers because they can perform signal-processing functions such as equalization, polarization demultiplexing, and clock recovery all at once. the frequency-domain based equalization algorithm needs simple logic and computational expression. This requires lesser time the logic is to apply the processing in the blocks and fast implementation of the discrete Fourier transform (DFT) with the FFT algorithm. The proposed scheme is based on frequency-domain up sampling and down sampling the symbol-spaced error signal is obtained by the constantmodulus algorithm (CMA).It has been obtained that comparison of previous scheme and proposed scheme. The equalization is done without dividing into groups. Thus, the required number of adaptive filters for dual-polarization (DP) systems is reduced from eight to four .The filter designed for the purpose is to initialize in such a way that the problem of singularity does not come on the way.The effectiveness of the proposed scheme is verified with 10-Gbaud dual-polarization QPSK transmission experiments [3].

Neng and et.al have propounded the normalized FDE over a thousand km. distance experiment. This work makes the use of master-slave phase estimation (MS-PE) which can be used to reduce the complexity of carrier recovery with minimal Q2-penalty.To provide multiplicative capacity growth on a single fiber mode-division multiplexing (MDM) has been proposed. MDM transmission using few-mode fiber (FMF) in a long haul because of mode coupling it is difficult to reduce multimode interferences multiple-input-multiple-output (MIMO) equalization is required. Differential mode group delay (DMGD) is responsible for increase thealgorithmic complexity of MIMO equalization. The collected DMGD grows the TDE becomes more complex,while FDE may be more feasible. The channel out consist of sharp spikes between the LP01 and LP11 modes. The MDM transmission for the first timebased on NA-FDE to increase the speed of convergence. The step size μ is responsible for the convergence speed for the specified frequency range. Different frequencies have different rates of convergence. In NA-FDE, a normalized step size $\mu(k) = \alpha / P(k)$ is used for FDE. In both cases, an equalizer length of 1024 taps was used and same step size was used for fair Comparison. It has been observed that NA-FDE converges six times faster compared with CA-FDE at a mean square error (MSE) of 10-5.The application of NA –FDE for FMI transmission has been checked over loop over 1000 cm. In master-slave phase estimation (MS-PS) the LP01,X mode selected as master mode and LP01,X selected as phase noise. NA-FDE was found to give similar performance as a TDE but has 16.2 times reduced complexity [4].

An Li and et.al have demonstrated the use of mechanical grating based mode converters to achieve two forms of dual-spatial-mode transmission LP01and LP11 and dual LP11 modes .It has demonstrated mode- division multiplexing (MDM) of LP01 and LP11 modes to generate LP11 modes (LP11a+LP11b) and even all three modes (LP01+LP11a+LP11b)over few-mode fiber (FMF)The transmission system with mode multiplexing are a very crucial problem. The mode selective devices proposed in divided into two major categories: free-space based (FSB) and fiber based(FB).Free space components are bulky in size ex liquid-crystal-on-silicon (Lcos) spatial light modulator (SLM). But fiber based mode selective device have compact and easiness of integration. .Firstly proposed 107-Gb/s coherent optical OFDM (CO-OFDM) transmission over a 4.5-km two-mode fiber using LP01 and LP11 modes. Secondly proposed 58.8-Gb/s CO-OFDM transmission using dual modes where the mode separation is achieved via 4× 4 electronic MIMO processing [5].

Sebastian Randel and et.al have been demonstrated the impulse response matrix of few-mode fiber links that support the propagation of LP01 and LP11 modes over up to 1,200-*km.*Results are obtained by by multiple-input multiple- output (MIMO) digital signal processing (DSP)in combination with differential group delay (DGD) compensated fiber spans. Equalizer is used to remove complexity in long haul transmission so two scheme must be remembered. first optical means to minimize the modal delay spread (MDS), i.e. the width of the impulse response, must be analyzed .second In a second step, the performance-complexity of efficient equalizer structures such as the frequency-domain equalizer (FDE) must be studied. it has been observed that MDS can be reduced to

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about 10 ns using a DGD compensated fiber span. Also observed that the system MDL is below 5 dB after 1,200 km. characterize the channel's model delay spread and mode-dependent loss [6].

Joseph M. Kahn and et.al have proposed a mode coupling scheme for overcoming major challenges incoherent mode-division-multiplexed systems. SMC (strong mode coupling) helps to bring down the delay done to the group and helps to optimize the complexity of MI (multiple inputs)multi-output signal processing. Strong mode coupling is responsible for creating frequency diversity dramatically reducing out stage probability. Transfer of energy from one ideal mode to another during propagation only due to mode coupling. It has been observed that practically strong couple modes having equal or nearly equal propagation constant but weakly coupled modes having a highly unequal propagation constant. The separation between two modes results in modal dispersion increasing capacity through mode division multiplexing (MDM). SMF (single-mode fiber helps in the wave movement in two polarization conditions. Polarization-mode dispersion (PMD) and polarization-dependent loss (PDL) have long been described by field coupling models. It has been observed that strongly coupled modal group delay or gain depend only no. of modes and variance of accumulated delay or gain and can be derived from the eigenvalue distributions of certain random variables[7].

SDM (space division multiplexing) has been putforth by Savory. SDM is extremely challenging technology, of requiring developments in all areas of Photonics Technology. The optical communication systems are being upgraded every day .There is a rapid development taking place in this field at the global level in the space division multiplexing. Space Division Multiplexing (SDM) is conceptually simple, SDM is extremely challenging technologically, requiring the development of new fibers, amplifiers, multiplexers, digital signal processing circuits, and other components. The multiplexing means the utilization of channel by the division of the space. It is suggestion that the SDM technology would be the adopted by the operators provided the cost of the technical operation reduces, 1) lowers the cost per bit (i.e., SDM-based systems must be less costly than multiple independent systems), 2) provides there is a larger requirement of flexible photonic network .It must allows flexibility to an extent. 3) allows a reasonable transitional strategy from systems based on standard single-mode fibers [8].

Omid Zia-Chalabi and et.al have proposed a computationally efficient frequency-domain implementation of a fractionally spaced block-least-mean-square (LMS) equalization. Polarization division multiplexing (PDM) and digital signal processing have helpful to a paradigm shift in optical communication systems, by providing greater spectral efficiency than Intensity-Modulated. Digital equalization of chromatic dispersion (CD) and linear polarization-dependent effects usually preferred the dual-stage receiver architecture. A fractionally spaced equalizer (FSE) is mostly preferred for increase robustness of the receiver. Where the input signal is sampled at twice or more the symbol rate 1/T. It has been proving more efficient for real-time processing to implement filtering in the frequency-domain (FD)as compared in the time-domain (TD). FD equalizers (FDE) could bring significant computational savings in the second stage, compared to TD equalizers (TDE).But requires the insertion of the block of the transmitter with a circular prefix. Another attractive solution is FD adaptive filtering based on the overlap-save technique (OS-FDE). Thus, the proposed equalizer architecture appears as a promising solution for 100 Gb/s and beyond real-time digital coherent receivers, which impose stringent constraints on algorithm complexity. Finally, the proposed FDE may be extended to weight update criteria other than LMS or CMA, by modify in accordingly [9].

Kun Shi and et.al have proposed frequency domain adaptive filters require very simple circulations hence simple circuitry to implement by using the overlap-and-save implementation method. FD algorithms may improve the convergence speed in comparison to the Time-domain algorithms. To optimize the convergence behavior of the adaptive filter a step size control scheme proposed for each frequency bin. A step-size control method is also proposed in to improve convergence behavior for systems working in a non-stationary environment .Discrete Fourier transformis proposed to improve the convergence rate. Step sizes that are inversely proportional to the signal power levels in the frequency bins of the discrete Fourier transform (DFT). A variable step-size algorithm is proposed for obtaining the low residual error. Therefore, overcome the compromise between fast convergence and low steady-state error in the existing method the proposed method achieves faster convergence rate as well as smaller MSD and MSE [10].

Multiple input multiple outputs (MIMO) has been performed using stokes algorithm in a frequency domain (SSA).The unique work is the analysis of the convergence speed and frequency offset of the SSA. It is not compulsory to go for pre-compensation of frequency offset. There is tremendous growth in the transmission capacity of the optical fiber link. The hardware has improved which allows lower losses and longer distances of optical cable. The less line consuming algorithms can further increase the channel width. The research is going on in SDM [11].

II. CONCLUSION

We have carefully examined all the technological advancements in the use of fiber communication link as a smart channel with larger capacity to carry the digital data. The modern era is marked by the smart hardware better picture and sound quality means more data. All these requirements can only we met by the smart communication link i.e. the fiber communication system. The revolution in this field is need generated. The industry and researchers have joined hands to meet out this global demand.

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