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High Datarate in Multimode Fiber Using Vector Intensity Modulation

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Abstract: Multimode fibers(MMFs) are generally used for transmission of light signals over optical fiber for small distance. Here multimode fibers are used for long haul transmission using vector intensity modulation. By using this method we can obtain higher datarates over multimode fibers.The use of channel feedback preserves the full multiplexing gain and avoid the losses of datarates. This is preffered because the ultimate aim is to improve the robustness of links as well as to increase data rates. Precoding is used for pre processing the signals so that the effective transmission modes can be identified. The vector intensity modulation technique with multiple sources and detectors and post processing minimizes the modal dispersion. The compensation methods improve the bandwidth and the wavelength product of MMFs. By using the above methods a 50% increase over the single laser and detector is obtained.

Keywords: MMFs, precoding, post processing, OFDM.

I. INTRODUCTION

Optical fiber technology is preferred due to its greater advantages. The optic fiber used is small in size and its bandwidth is greater than metallic cable. Also the lower data rates can be easily upgraded to higher rate without replacing the fibers. Losses are independent of bandwidth. It is electrically non conducting and electrical problems are not present here. Cross talk doesnot occur. It do not have multipath fading and travels very long distance. Interference problems are not present and high data rates are obtained. The above advantages are not present in single mode fibers. The single channel transmissions and multiplexing in them are explained in [1] and [2].Multimode fibers are used in centralized cabling, fiber to the telecom enclosure, backbone applications in buildings etc. The multicore fibers and its space division multiplexing and their advantages are studied [3]-[5].

Multimode fiber is designed to carry multiple light rays or modes concurrently each at a slightly different reflection angle within the optical fiber core. Here the modes tend to disperse over longer lengths which are defined as modal dispersion. Modal dispersion is the dominant source that minimizes the data rates. In the inter modal dispersion the pulse spreads at each mode at different speeds. As the pulse spreads energy is overlapped. Hence inorder to avoid modal dispersion single mode fiber is preferred. One of the most promising concepts for high capacity communication systems is wavelength division multiplexing (WDM) in single mode fiber coherent technique. Each communication channel is allocated to a different frequency and multiplexed onto a single fiber. At the destination wavelengths are spatially separated to different receiver locations. In this configuration the high carrier bandwidth is utilized to a greater extent to transmit multiple optical signals through a single optical fiber[3].The coherent technique is very costly and the data recovery process is very complex.

We use the incoherent technique in multimode fibers so that it is cost effective and is advantageous since it is used in long transmission with high data rates.It is made by avoiding the modal dispersion by using modulation technique and dispersion compensation methods.The use of incoherent technique for multiplexing consists of square law detection method and group division multiplexing [6]-[8].

II. SYSTEM DESCRIPTION

The aim of the work is to produce long haul incoherent transmission in multimode fiber. Also to produce high data rates and high signal to noise ratio.

A. The Different Processes Present

The different processes present are

1) *Modulated Streams*
2) *Precoding*
3) *Channel*
4) *Post Processing*
5) *Data Detection*
6) *Channel State Feedback*

1) Modulated Streams: In this there are many orthogonal modes present.These modes are calculated so that it will be easy to select the effective modes.The input streams of data are selected randomly.

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2) Precoding: Precoding is used for the transmission of multiple modes that are given as the input data streams.The constellation for the modes have been done using quadrature amplitude modulation.Vector intensity modulation technique finds the spatial distributions of polarization.This method gives high resolution and is very stable.The precoded signals are given to the channel.

3) Channel: Multimode optical fiber is used as the channel for transmission of discrete datas that have been precoded. Dispersion usually occurs in channel. Vector intensity modulation system and the dispersion compensation systems removes the dispersion present in it [9]. Hence the large diameter core of the MMF free from dispersion produces transmission of high datarate.

4) Post processing: Post processing is generally used for the enhancement of optical nonlinearities, spatial filtering and mode conversion. Spatial filtering is the signal processing technique used for directional signal transmission or reception.This is achieved by combining elements in a phased array in such a way that signals at particular angle experience constructive interference while others experience destructive interference.

5) Data detection: Simple channel estimation and equalization methods are used for speeding the data rates.The data that have received must have lower bit error rate.We have obtained higher data transmission for long wavelengths with decreasing bit error rate.It is possible since here we use incoherent system of multimode fibers.

6) Channel State feedback: We feedback the channel for better refinement of data rate of the system. The transmitted datas are obtained accurately by feedbacking method. Also it makes the recovery of the data easy at the receiver side.

B. Results

The use of vector intensity modulation with post processing and channel state feedback reduces the modal dispersion to large extent. The dispersion that have been minimized in the fiber for increasing wavelength is shown in the fig.1.

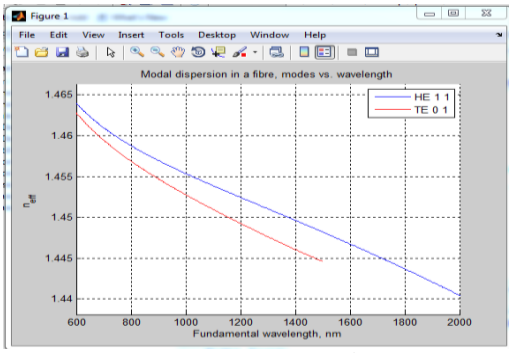

Fig.1 Dispersion minimized graph for increased wavelength and n_{eff}

Effective refractive index n_{eff} depends on wavelength and the mode in which light propagates. This effective refractive index and its relation between wave lengths and V-parameters are shown in fig.2.As the V-parameter increases the effective refractive index increases. V- parameter is the array of post processed data.

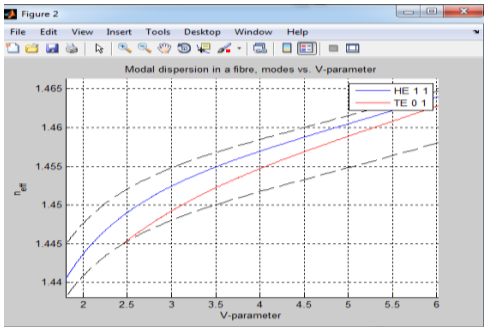

Fig.2 Relation between modes and V-parameter

TE and HE present in the graph are the modes selected for transmission.

The vector intensity build for transmit and receive vectors are shown in fig.3.

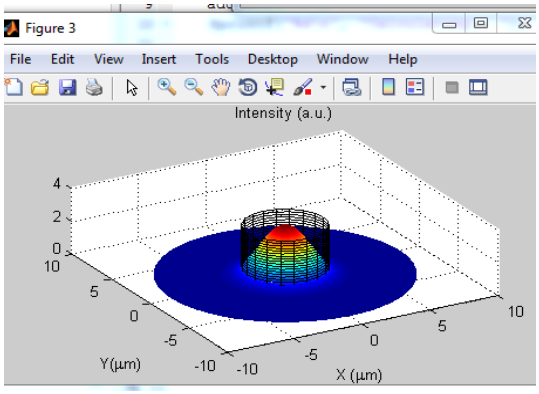

Fig.3 Intensity build for the input and the output

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The modal dispersion minimization for increased diameter is obtained here. This is shown in fig.4.

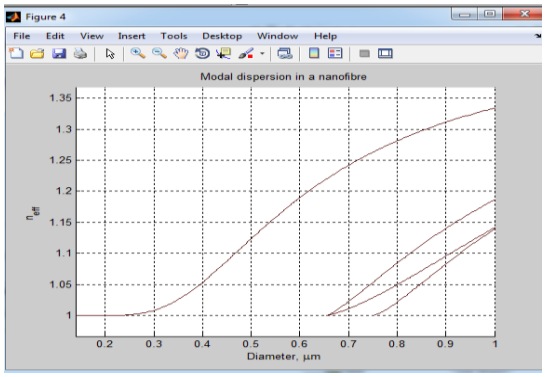

Fig.4 Dispersion minimized in the modes for increased diameters

The performance can be analysed using the graph shown below in fig.5.Here as the signal to noise ratio increases the symbol error rate decreases. Hence the vector intensity modulation with channel state feedback is seemed to have good performance.

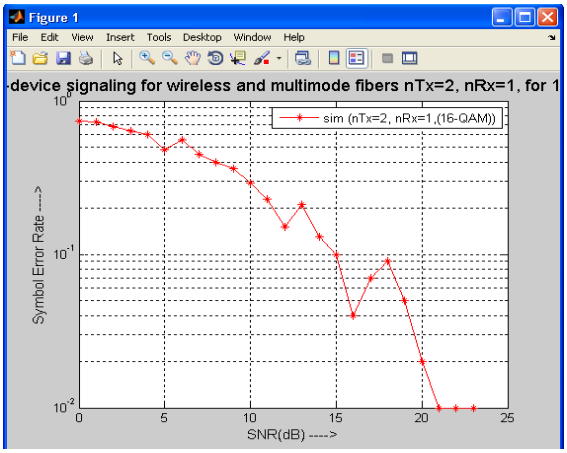

Fig.5 Graph between SNR and symbol error rate

III. CONCLUSION

The incoherent vector intensity modulation have minimized the modal dispersion in the multimode fiber. Hence long transmission link is established.Also the precoding and post processing methods increased the datarate of the system.The channel state feedback retrieves the data and refine the datarates accurately.Thus we have obtained high datarate transmission for long distance with large signal to noise ratio.

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