The construction of a prototype of a 50MBS free space laser optic transmitter

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ABSTRACT

Light emitting diodes or LEDs, which are special for telecommunications, and laser diodes were characterized. A free space optical data transmitter and its corresponding receptor were built. A power of 10mW semiconducting laser with a wavelength of $\lambda = 640$ nm was tested. It was possible to modulate this laser with a digital signal at a speed of 40 Mbs and to transmit the information for a distance of 250 meters. A LED of high power was tested With this LED it was possible to increase modulation speed with frequencies higher to 50Mbs, but the distance covered by this laser was of only 180 meters due to light diffraction. The LED generates at the wavelength of λ=650nm. The diffraction phenomenon was corrected using the appropriate optics.

Keywords: Diode laser, transmitter, receptor, Mbs, Potency, wavelength, diffraction.

1. INTRODUCTION

The growth of private intranets, e-business, data storage, private virtual networks, videoconferences, voice over IP, Internet and other applications have jammed the telecommunications networks. Every day consumers of these services require a greater bandwidth and to satisfy their needs and thus enormous efforts are carried out in new and last mile technologies such as Xdsl, and ISDN. The fiber cannot be taken directly to the client and eve if with this medium 2.5 to 10 Gbps speeds are reached using DWDM (dense wave division multiplexation), these speeds encounter a bottleneck upon reaching the last mile. Free space optical communications (FSO) appear in this environment as a possibility for having laser Full or Hall duplex point-to-point connections with a great bandwidth and low power consumption[1,2,3]. A free space optical communication system includes an optical transmitter and a receptor. Transfer of information between transmitter and receptor in done by means of optical radiation instead of microwave radiation. The advantages in space of optical communication systems compared with microwave systems are[4,5]: a) high data transfer speed, b) small size a light weight, c) less power. Consumption, and d) a high interference immunity. Another important application of free space optical communication systems are short range wireless internal communications which have an increasingly important role in laptop multimedia terminals, in which, Infrared light emitting diodes(LED) have great applications as inexpensive light emitters, generally considered harmless for the eyes. We report viability, design considerations as well as the construction of an optical transmitter and receptor able to receive information a rate of speed of 50 Mbps. Using a 10 mW potency laser diode and a 640 nm wave length. For information transmission we also use a high potency electro luminescent Led with a 650nm wavelength. Two principal aspects were considered for the accomplishment of this project. The first one consisted of the optical design of the transmitter and receptor and the second most important aspect considered in this project was the effort undertaken in order to maintain the potency of the beam as compact, as possible, that is using optical lenses we tried to maintain the beam collimation.

2. DESIGN OF THE TRANSMITTER

Two sources of light were used in the making of the optical transmitter. One of them was a diode laser of 640 nm wavelength laser with a radiating potency of 10 mW, The second source of light that was used was a high potency Hamamatsu light emitting diode (LED) which has a wavelength of 650 nm. The first optical transmitting system was designed using LED electro light. Two biconvex lenses were used as an image forming system, each one had a 20mm diameter and a focal distance of 50 and 100 mm respectively . An Achromatic lens with a focal distance of 120 mm and a diameter of 40 nm was used as an exit lens, in the figure 1 can show the picture diagram for both transmitter

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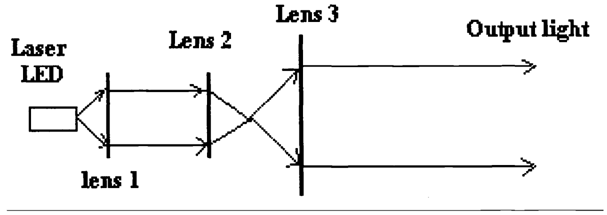

Fig. 1 Representation of Laser and LED Transmitter

With this lens the exit optical potency was distributed better. The second optical transmitter used as a light source the laser diode. In the beam forming system two lens were used. The first one consisted of a plane convex lens and the second lens used was a bi convex lens. With these lenses it was possible to form the beam collimation. In these transmission systems it is important to control the light beam because of the effect that atmosphere diffraction exercises on the beam of light, making it wider[6,7]. The equation that rules the widening of the beam is the following:

$$W(z) = (W_0)\sqrt{1+\left(\frac{\lambda z}{\pi w_0}\right)^2} \qquad (1)$$

Where w is the radius of the beam's waist, and λ is the wave length of the radiating source, Z is transmission distance and W(Z) is the widening that the beam undergoes of the reception side. From the equation (1) it can be observed that controlling the initial radius of the beam W or the wave length of the light source used it is possible to control the widening that the beam undergoes due to diffraction. A image of optic transmitter is show in the figure 2.

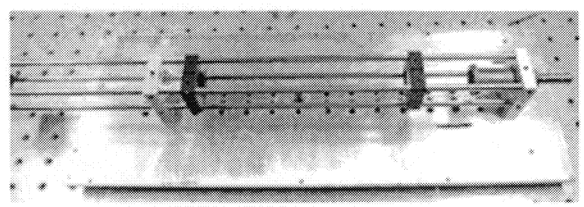

Fig. 2 Optic Laser and LED transmission system

3. RECEPTOR

In order to receive the low signal emitted by the LED and the laser which is attenuated by the atmosphere[2] a receptor module was built. It consists of a photo detector a transimpedance amplifier and a filter. In the entrance to the receptor we used a biconvex lens with a 50 mm diameter and a 300 mm focal distance. The diagram of the receptor system is shown in figure 3.

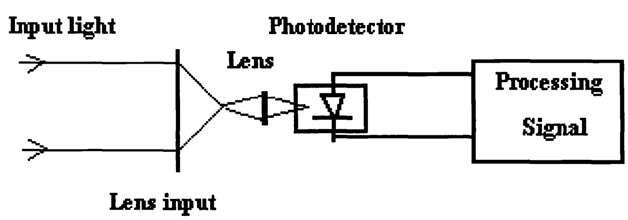

Fig. 3 Optic Laser and LED receptor

It is able to achieve a error bit rate (BER) of 10. To picture of receptor utilized is show in the figure 4.

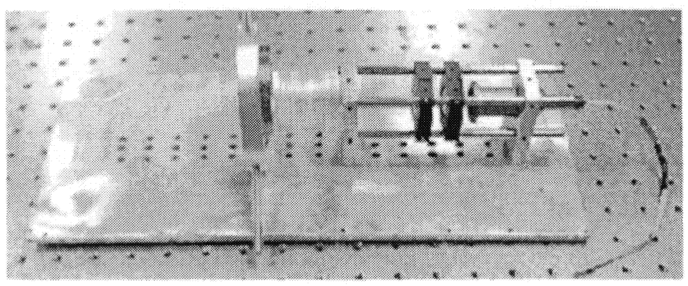

Fig. 4 Optic Laser and LED receptor system

Theoretically, the relation between VER and SNR can be represented as:

$$BER = Q\sqrt{SNR} \qquad (2)$$

Where Q represents the possibility of mistake occurrence. The noise signal relation can be represented as:

$$SNR = \alpha \frac{P^2{}_{sig}}{P_{noise}} \qquad (3)$$

Where P_{sig} is the potency of the signal received, P_{noise} represents noise potency and α is the coefficient deducted by bit rate, the electrical charge, and the detector's responsibility.

4. TEST OPERATION

The operation of the system was proved within the University campus, The transmitter and the receptor were placed 150 meters apart. The potency radiated by the transmitter was of 7.8microwatts. This power was collected by a microchip Hamamatsu characterized to 650 nm. Both light source was modulate to 40Mbps. The send information is collect and processing , but the principal problem is due to beam wider and phenomenon of attenuation. The system of transmitter and receiver in the campus is show in the figure5and 6

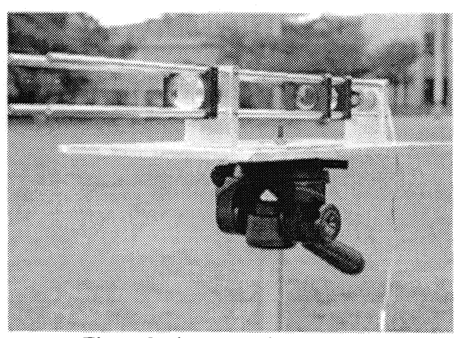

Fig. 5 Optic Transmitter system

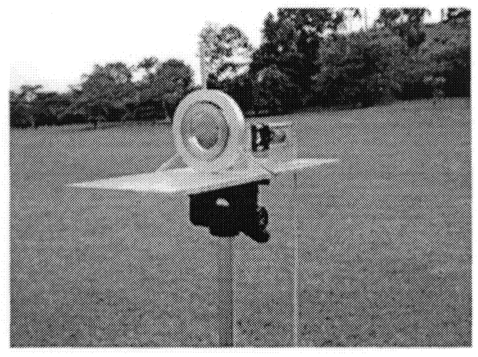

Fig. 6 Optic receiver system

5. CONCLUSION

A free space communication system was develop, with the system was possible send voice and dates, to speed near to 50 Mbps, the principal factor of attenuation of both source of light is the atmosphere due to absorption of red color for it. Is necessary work whit other source of light for have a big distance of transmissions.

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