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Design and Implementation of Free Space Optical Communication System Using Hardware

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ABSTRACT: Free Space Optical (FSO) communication offers the advantages of compact terminals and very high data rates without using scarce radio frequency spectrum. Unfortunately cloud and fog together with scintillation caused by small temperature variations in the atmosphere, can result in significant attenuation and highly variable amplitude fluctuations that degrade the link availability. FSO modem and codec design, that includes a suitably large interleave and strong channel coding scheme using a low-density parity check code, plus synchronization algorithms to provide reliable communication over a 12km optical channel. FSO link offers high data rate and low system complexity but suffers from atmospheric attenuation where communication have lower data rates but are relatively insensitive to weather conditions. A hybrid FSO/RF communication is implemented to combine the advantages of both the systems for providing reliable communication link. By the design of FSO/RF transmission module and highlights the experimental verification of outdoor FSO communication system in combination with the redundant RF application. It provides high availability of uninterrupted communication during link misalignment and also over adverse weather conditions. An image of different data rates has been transmitted successfully under different links. Present communication era demands a communication link with high bandwidth, maximum performance, minimum errors and good channel capacity. All these can be well achieved by using free space optical communication system. Because of FSO system does not require any license for its establishment and the working. In FSO system no. of modulation techniques used to modulate information signal at source side like each FSO system uses towards destination and receiving side high sensitivity receiver used. But the atmospheric attenuation is major challenge for faced by FSO system which affect the performance of the link. The other factors which can affected the FSO are humidity, water vapors, signals absorption, smoke, beam scintillation, spreading and wandering are some of the factors. Performance of FSO link with different wavelength and different aperture area of optical detectors has been analyzed. Effects of different wavelengths on visibility range and quality factor of optical receiver is simulated to find the performance of FSO link. It is concluded that due to reduction in scattering loss at higher wavelength; as wavelength increase quality factor of receiver improves. Quality factor of optical receiver is also improving with increment in aperture area of detector due to increment in sensitivity of receiver due to large aperture area. The link availability calculation was made based on the power budget analysis of FSO link and on the statisticalanalysis of visibility data. Four different cities were selected across different geographical of FSO link for different cities of India is calculated. The visibility of data to the cities throughout the year is found from the website Wundermap. The performance of FSO link is not similar for all the geographical areas as the visibility conditions are different. It is shown that the availability and reliability of FSO link can be improved by making survey of the geographical area where the link has to be established. These data are varying seasonally and with location of particular area. Scattering and attenuation may be caused low visibility condition. The mean and variance of this visibility data should be calculated to find the average visibility of BER performance can be achieved.

KEYWORDS: FSO, channel model, Atmospheric Turbulence, Probability of fade

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I. INTRODUCTION

In this session, an overview of the FSO technology is presented along with the advantages, limitations and applications. Different aspects of atmospheric attenuation in FSO technology and their impacts on the system performance are discussed. The atmospheric turbulence models are described in terms of probability density function (PDF) which characterizes the statistical nature of the optical fluctuations of optical propagation through atmospheric turbulence and scattering. The communication parameters like BER, Outage probability, probability of fade and link margin are also discussed. The rapid development of information technology, overcrowding in RF spectrum and the thrust for the mobile data services has led to a huge demand for establishing high speed ubiquitous wireless networks. Due to the limitation in data rate, security, and power consumption in the traditional RF communication, many of the researches are seeking for a new technology to overcome these problems. FSO communication is one such technology with high bandwidth, low power consumption, and high security. Despite its highdata rate, the performance of FSO links is limited due to weather conditions such as fog, snow, scintillation, etc. and optical line-of-sight (LOS) alignment

II.WORKING OF FSO

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Optical systems work in the infrared or near infrared region of light and the easiest way to visualize how the work is imagine, two points interconnected with fiber optic cable and then remove the cable. The infrared carrier used for transmitting the signal is generated either by a high-power LED or a laser diode. Two parallel beams are used, one for transmission and one for reception, taking a standard data, voice or video signal, converting it to a digital format and transmitting it through free space.

Today's modern laser system provide network connectivity at speed of 622 Mega bits/sec and beyond with total reliability. The beams are kept very narrow to ensure that it does not interfere with other FSO beams. The receive detectors are either PIN diodes or avalanche photodiodes. The FSO transmits invisible eye safe light beams from transmitter to the receiver using low power infrared lasers in the tera hertz spectrum. FSO can function over kilometers.

radiation at 1550 nm tends not to reach the retina of the eye, being mostly absorbed by the cornea. 1550 nm beams operate at higher power than 850 nm, by about two orders of magnitude. That power can boost link lengths by a factor of at least five while maintaining adequate strength for proper link operation. So for high data rates, long distances, poor propagation conditions (like fog), or combinations of those conditions, 1550 nm can become quite attractive. In the transmitting section, the data is given to the modulator for modulating signal and the driver is for activating the laser. In the receiver section the optical signal is detected and it is converted to electrical signal, preamplifier is used to amplify the signal and then given to demodulator for getting original signal. Tracking system which determines the path of the beam and there is special detector (CCD, CMOS) for detecting the signal and given to pre amplifier The servo system is used for controlling system, the signal coming from the path to the processor and compares with the Modulator Driver Laser Transmit Optic Data in Demodulator preamplifier detector Receive optic Data out preamplifier Special detector Tracking optic Processor Servo systems Environmental condition. Generally, equipment works at one of the two wavelengths: 850 nm or 1550 nm. Laser for 850 nm is much less expensive (around $30 versus more than $1000) and are favored for applications over moderate distances. One question arises that why we use 1550 nm wavelength. The main reason revolves around power, distance, and eye safety.

2.1**introduction To Components**

The components which are used in the Free Space Optical Communication are listed as below
Photo Transistor

- Light Emitting Diode
- Resistor
- Dot Laser
- MAX232CPE

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- HD74LSI4P
- SN74LSO5N
- Capacitors

2.1.1.**Photo Transistor**

The phototransistor is a semiconductor device that is able to sense light levels and alter the current flowing between emitter and collector according to the level of light it receives. Phototransistors and photodiodes can both be used for sensing light, but the phototransistor is more sensitive in view of the gain provided by the fact that it is a bipolar transistor. This makes phototransistors more suitable in a number of applications. Although all bipolar transistors themselves are light sensitive, which is why most transistors are encapsulated in metal or plastic cans, phototransistors are a specialised form of bipolar transistor that have been optimised for its light sensitivity, making these electronic components ideal for many light sensing applications. The idea of the phototransistor has been known for many years. William Shockley first proposed the idea in 1951, not long after the ordinary bipolar transistor had been discovered. It was then only two years before the photo-transistor was demonstrated. Since their first introduction and use, phototransistors have been used in a variety of circuit designs and applications, and their development has continued ever since. Phototransistors are widely available and can easily be obtained quite cheaply from electronic component distributors - in view of their use in many electronic circuits and applications, they are available as part of the standard semiconductor device inventory. In view of the fact that these electronic components are cheap and easily available, it is necessary to ensure that the selected component meets the requirements of the circuit design in which it will be used. Understanding the various specifications is important.

2.1.2.Resisotor

Resistor is defined as passive electrical component with two terminals that are used for either limiting or regulating the flow of electric current in electrical circuits. The main purpose of resistor is to reduce the current flow and to lower the voltage in any particular portion of the circuit. It is made of copper wires which are coiled around a ceramic rod and the outer part of the resistor is coated with an insulating paint. The SI unit of resistor is Ohm. Each resistor has one connection and two terminals. We will look at the three types of symbols that are used to represent the resistor. The terminals of the resistor are each of the lines extending from the squiggle (or rectangle). Those are what connect to the rest of the circuit.

2.1.3.Dot

A quantum dot laser is a semiconductor laser that uses quantum dots as the active laser medium in its light emitting region. Due to the tight confinement of charge carriers in quantum dots, they exhibit an electronic structure similar to atoms. Lasers fabricated from such an active media exhibit device performance that is closer to gas lasers, and avoid some of the negative aspects of device performance associated with traditional semiconductor lasers based on bulk or quantum well active media. Improvements in modulation bandwidth, lasing threshold, relative intensity noise, line width enhancement factor and temperature insensitivity have all been observed. The quantum dot active region may also be engineered to operate at different wavelengths by varying dot size and composition. This allows quantum dot lasers to be fabricated to operate at wavelengths previously not possible using semiconductor laser technology. Devices based on quantum dot active media have found commercial application in medicine (laser scalpel, optical coherence tomography), display technologies (projection, laser TV), spectroscopy and telecommunications. A 10 Gbit/s quantum dot laser that is insensitive to temperature fluctuation for use in optical data communications and optical networks has been developed using this technology. The laser is capable of high-speed operation at 1.3 μm wavelengths, at temperatures from 20 °C to 70 °C.

2.1.4. Light Emitting Diode

A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The colour of the light

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(corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor. White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device. Appearing as practical electronic components in 1962, the earliest LEDs emitted low-intensity infrared (IR) light. Infrared LEDs are used in remote-control circuits, such as those used with a wide variety of consumer electronics.

2.1.5.**Capacitors**

A capacitor is a device that stores electrical energy in an electric field. It is a passive component with two terminals. The effect of acapacitor is known as capacitance. While some capacitance exists between any two electrical conductors in proximity in a circuit, a capacitor is a component designed to add capacitance to a circuit. The capacitor was originally known as a condenser or condensate.

2.1.6.MAX232CPE

The MAX232 is an integrated circuit by Maxim Integrated Products that converts signals from a TIAhttps://en.wikipedia.org/wiki/RS-232232 (RS-232) serial port to signals suitable for use in TTL-compatible digital logic circuits. The MAX232 is a dual transmitter / dual receiver that typically is used to convert the RX, TX, CTS, RTS signals. The drivers provide TIA-232 voltage level outputs (about ±7.5 volts) from a single 5-volt supply by on-chip charge pumps and external capacitors. This makes it useful for implementing TIA-232 in devices that otherwise do not need any other voltages. The receivers reduce TIA-232 inputs, which may be as high as ±25 volts, to standard 5 volt TTL levels. These receivers have a typical threshold of 1.3 volts and a typical hysteresis of 0.5 volts. The MAX232 replaced an older pair of chips MC1488 and MC1489 that performed similar RS-232 translation. The MC1488 quad transmitter chip required 12 volt and -12 volt power, and MC1489 quad receiver chip required 5v power.

III.RESULT

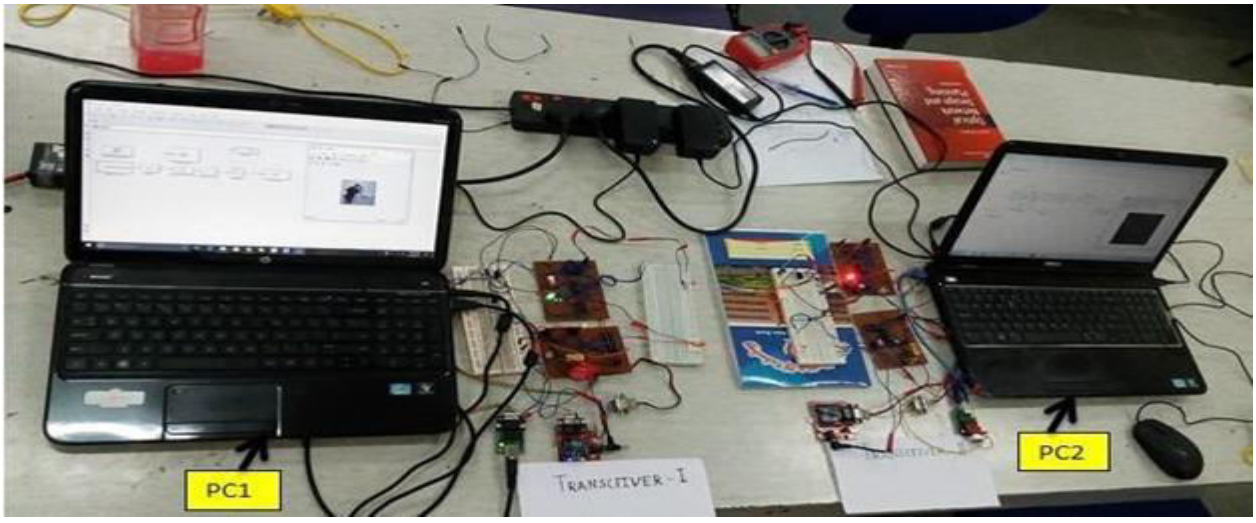

Fig.1 output setup

IV.CONCLUSIONS

Hence the Free space optical communication (FSO) circuit is designed and implemented successfully. It provides a cost effective and high bandwidth access technique, which is receiving growing attention with recent commercialization

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application. FSO offers many advantages over existing techniques which can be either optical or radio or microwave. Less cost and time to setup are the main attraction of FSO system. Optical equipment can be used in FSO system with some modification. Merits of FSO communication system and its application area make it a hot technology but there are some problems arising due to the attenuation caused by medium. FSO system poses some problem like attenuation in medium that can affect the performance of transmissions power loss would be there. But extra care and pre study of the medium can guide what type of parameters to be considered before setting up the system. Many studies are going in this perspective to minimize the effect of attenuation by introducing new system design like WDM based FSO system. Different models based on these studies are used to study the system performance before installing it at the location is can lead to the improvement of the system. Different techniques like OFDM-FSO, WDM-FSO based system are new approach to improve the system performance with high speed and longer distance. So new techniques can be designed by combination of these and, by enhancing these techniques, system designing can be improved and the demerits of FSO system can be reduced to a minimum level. An hybrid FSO/RF system is designed for data transfer between two computers under different channel conditions. This design is tested and verified experimentally where a hard switching is performed under link misalignment of FSO transmission and data is routed through a RF backup communication system. Since some of the RF frequency bands requires licensing an unlicensed radio band would be more suitable when considering a backup for FSO in order to keep the entire communication system unlicensed. Therefore, ISM frequency band is selected for RF communication link. This module will act as a motivation to the current and future transmission systems for seamless and continuous data transmission. An hybrid FSO/RF system is designed for data transfer between two computers under different channel conditions.

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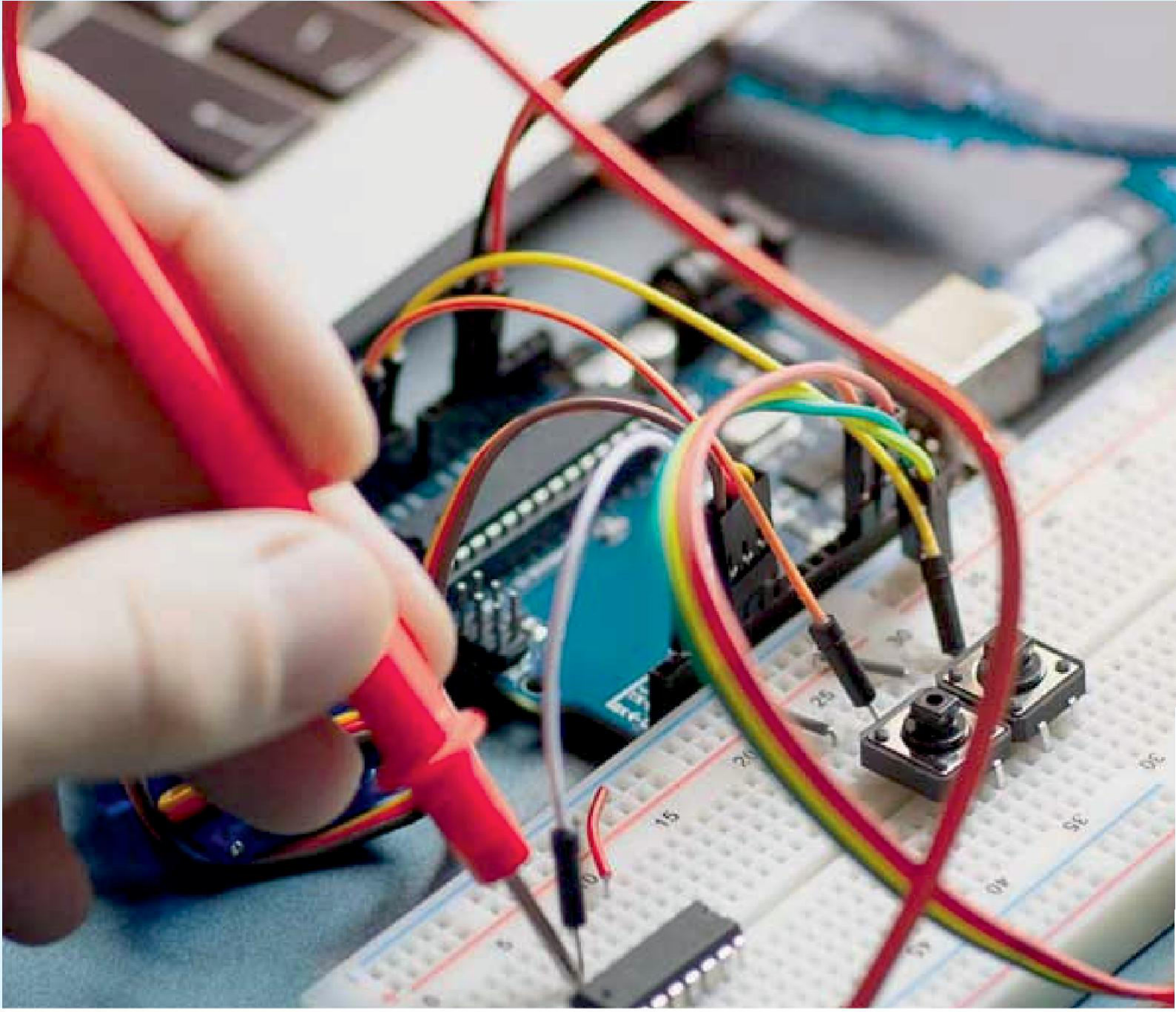

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