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EFFECT OF DEFORMATION ON THETHERMOLUMINESCENCE IN CaWO4: Dy PHOSPHORS

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ABSTRACT

Thermoluminescence (TL) of CaWO4 phosphors has been studied by many researchers. TL of CaWO4 samples by solid state diffusion method has been studied after gamma irradiation. One peak is observed in the TL glow curve, around 1500C. Enhancement/and decrement of TL with slight shifting of peak are also observed due to increase in concentration and gamma dose. To study the influence of deformation on the TL, a load was dropped on to the phosphor with different impact velocities. Mechanoluminescence due to deformation increases with impact velocity, however TL intensity of both the peaks decreases if the TL glow curve is recorded after deforming the irradiated samples. Photoluminescence study on thephosphor has shown the incorporation of Dy. It is informed that the recombination of released electrons from the traps during the thermal and mechanical excitation is responsible for luminescence in this system.

I. INTRODUCTION

The interest in the rare earth doped tungstate phosphors has been largely due to their high luminescence efficiency under UV, excitation and their ability to maintain their phosphorescence for several hours. Thermoluminescence (TL)is the emission of light from a pre irradiated material on stimulating thermally i.e. by heating, which induces relaxation of electronic charges resulting in radiative recombination causing luminescence. The luminescence is at cost of energy absorbed from ionizing radiation where the charges carriers (electron and holes) are produced by ionization get trapped at the sites caused by imperfection(1).

Thermoluminescence study of CaWO4 phosphors has been subject of many investigations (2-4). The temperature of TL glow peaks induced by a rare earth ion in CaWO4 lattice is found to be determined only by the valance state of rare earth (5).It was proposed that radicals such as Wo4-, Wo3-, and more produced by irradiation from stable trapping sites of varying activation energy are responsible for the thermoluminescence (TL) glow curve(6)

Recently Laxmanan(7) reported that the effect of pressure on the luminescence properties of gypsum, anhydrite, calcite etc. It is concluded that the changes observed in TL should be attributed to the damage of traps or may said luminescence centers rather than to the damage of their original crystal structure.Luminescence property is also produced when certain solids are deformed by mechanical action like pressing, crushing, scratching, etc. This type ofphenomenon is known as mechanoluminescence(ML)(8)

The present paper reports the effect of post irradiation deformation on the thermoluminescence property in CaWO4:Dy phosphors, luminescence due to deformation (ML) is also reported in this paper.

II. MATERIALS AND METHODS

To prepare CaWO4:Dy, known amount of Dy2O3 and equal amount of Na2WO4 for charge compensation were added to the required amount of CaWO4. These powders were thoroughly mixed in a mortar for 1 hour, transferred to a porcelain crucible, dried for 2 hours at 80ºC in oven and then cooled slowly down to room temperature. Again the powder were crushed for 1 hour and heated at 800ºC for 24 hours in open air and cooled down slowly. The resulting compound is again crushed to powder and few part of the powder was annealed at 800ºC for 1 hour and prepared phosphors were used for further studies.

Samples were exposed to gamma rays using 60Co source having the exposure rate of 0.93kGyh-1. The TL glow curves were recorded by usual set-up consisting of a small kanthal strip, temperature programmer, photomultiplier tube (931B), DC amplifier and an X-Y recorder. An aliquot of 1mg of phosphor was heated every time at a heating rate of 90 °Cmin-1. Samples were deformed by dropping a load of different masses from different heights onto it. The light produced due to deformation was also recorded using photomultiplier tube which is connected to storage oscilloscope. Thephotoluminescence(PL) emission spectra of the samples were recorded by using fluorescence spectrophotometer. Emission was recorded using a spectral slit width of 1.5nm.XRD pattern of CAWO4is shown in figure 1which is matched with its standard data available (JCPDS file number 041-1431for CaWO4). The SEM analysis is showing (figure 2) excellent images of these phosphors. The information of particle regarding to different phases, their distribution, grain size, grain boundaries etc. are presented here. The particle size of phosphors is much less, ranging from nano to few micrometer.

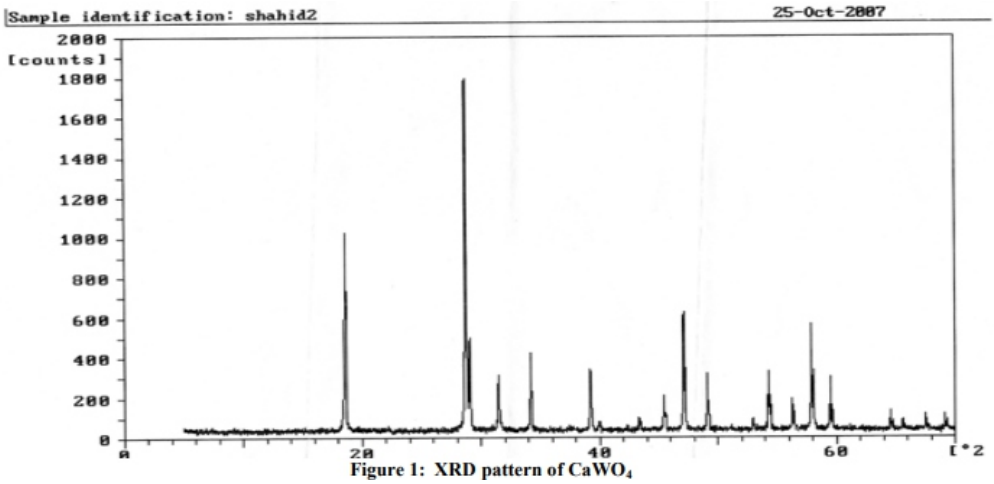

Figure 1: XRD pattern of $CaWO_4$

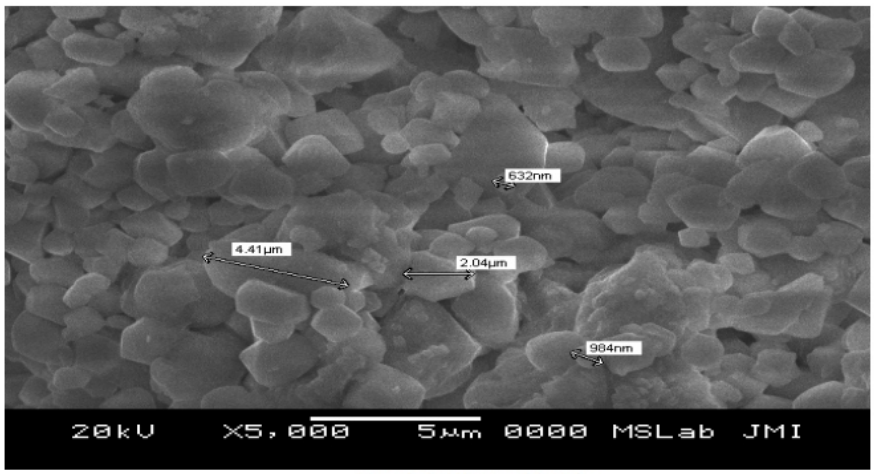

Figure2: SEMimage of $CaWO_4$

RESULTS AND DISCUSSION

Figure3 shows TL glow curves of CaWO4:Dy phosphors having different concentration of Dy. One distinctpeak is observed for all samples. Peak around 150oC is the maximum for 1mol% concentration of Dy. The undoped CaWO4 shows very weak TL.

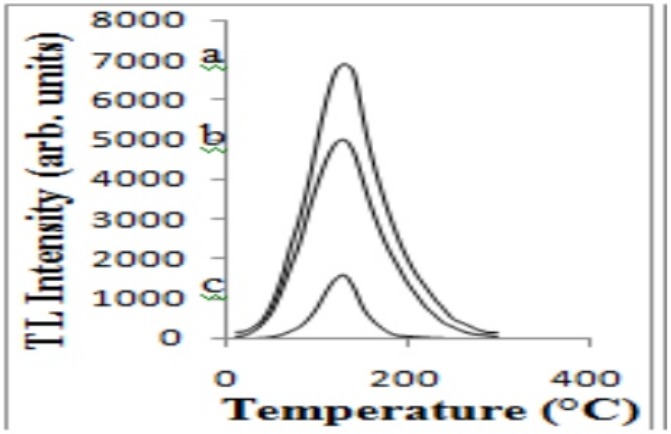

Figure3. TL glow curves of $CaWO_4$:Dy phosphors for different dopant concentration; rate of heating 90°C/min, gamma dose 0.465 kGy.a) $CaWO_4:De_{1\%}$ **b)** $CaWO_4:Dy_{2\%}$ **c)** $CaWO_4:Dy_{0.5\%}$

CaWO4 shows the particle size of 632nm, 984nm.

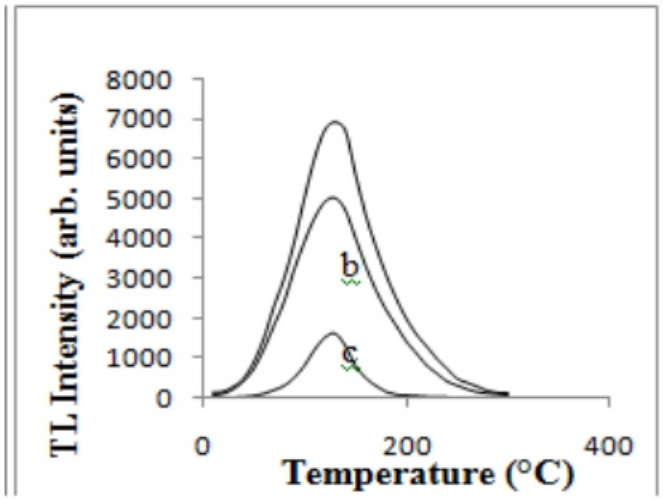

Figure4. TL glow curves of $CaWO_4$:Dy(1mol%) phosphors for different gamma dose; rate of heating 90°C/min.a) 1.395kGy **b)** 0.93 kGy **c)** 0.465 kGy

The number of active luminescent centers is expected to increase with concentration of Dy. As a result glow intensity increases with concentration. However, the glow intensity can not expected to increases indefinitely with concentration, since the rate of formation of active luminescent centers by capturing the holes during the irradiation, might be fading rapidly and concentration is affected. We have also observed that the temperature of main TL peak in the TL glow curve of CaWO4:Dy phosphors slightly shifts towards low temperature side with increasing concentration of Dy. This behaviour can be explained by assuming that either a multilevel or a continuous distribution of trap depth is associated.

Figure4 shows the dependence of TL intensity of CaWO4:Dy(1mol%) phosphors on gamma irradiation. Peak intensity increases with increasing gamma dose, both peaks shift towards lower temperature side with increasing gamma dose. The TL intensity of 150oC peak increases with gamma dose in the rage studied. The increase in TL intensity with respect to gamma dose is attributed to increase of active luminescent centers with gamma irradiation. The saturation of TL can be explained on the assumption that only limited numbers of trivalent Dy ions are available for charge reduction with increasing gamma dose.

Figure5 shows effect of post irradiation deformation on the TL of CaWO4:Dy (1 mol%) phosphors. No drastic change in glow curve structure was seen. However, the intensity of both the peaks decrease with increasing impact velocity of the piston used to deform the sample. The decrease in 210 oC TL peak is more as compared to with 150 oC. The deformation subsequent to irradiation may modify the existing traps, creates new but unfilled traps and/or cause a redistribution of electron or holes along there traps due to passage of recombination in the vicinity of traps. In the present investigation it seems that the de trapping of trapping centers may be responsible for decrease in TL intensity with deformation of the sample.

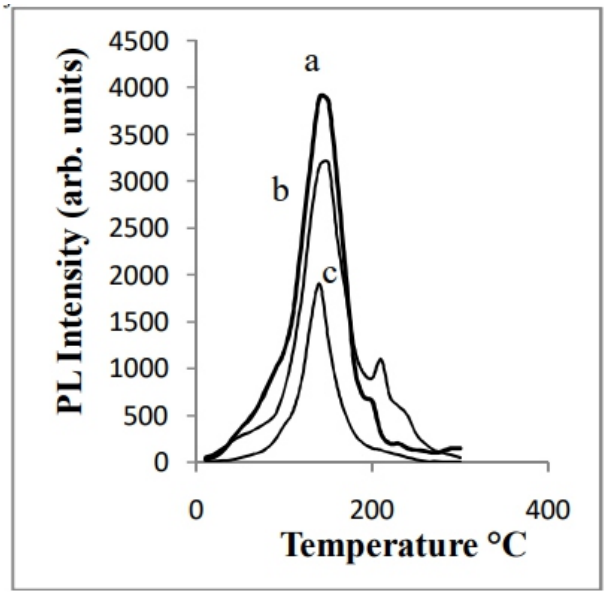

Figure5. Effect of deformation on CaWO4:Dy(1mol%) phosphors;phosphors are deformed by dropping a piston of mass 400 gm onto the samples with different impact velocities. Gamma dose- 1.395 kGy a) 1.4 m/sec b) 1.97 m/sec c)

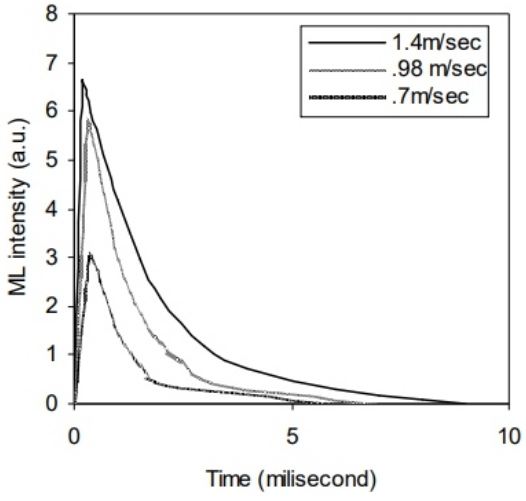

Figure6. Time dependence of ML intensity of CaWO4:Dy(1mol%) phosphors; gamma dose 1.395 kGy

Figure6 shows the time dependence of ML intensity of CaWO4:Dy(1 mol%) phosphors for different impact velocities. A single peak is observed and ML intensity increases with increasing impact velocity of the load.

It may be speculated that when gamma-irradiated phosphor is impulsively deformed, an intense electric field is produced due to charging of newly created surface near the crack tip. This electric field may cause bending of conduction band, valance band and trapping levels releasing holes from the holes traps. Subsequent recombination of holes moving in the valance band with electron trapping centers may release energy, and subsequent de-excitation of excited Dy3+ ion may cause rise to characteristic luminescence of Dy3+ ion. Occurrence only one peak in the ML intensity vs. time curve indicates that the defect centers responsible for ML emission are excited almost at the same time (due to the impact of the load).

In order to know the behaviour of the luminescence centers in CaWO4:Dy phosphors we have recorded the photoluminescence of CaWO4:Dy(1 mol%) samples (Fig.7) the emission spectrum after excitation shows three prominent band two of them 478nm and 594nm which are characteristics of Dy3+ions due to 4F9/2 6H15/2 and 4F9/2 6H13/2transitions respectively and other one at 420nm the occurrence of which needs to be investigated further.

For TL mechanism alkali earth sulphate, Luthra et al (9) proposed that trapping and recombination are the characteristics of host lattice. It may be speculated that when CaWO4:Dy phosphors are exposed to gamma rays the trivalent dysprosium acting as electron traps get induced to divalent dysprosium with the production of trapped holes centers. The holes are released from thermal excitation and recombination of holes with electron at Dy2+ sites. Luminescence is observed during de-excitation of excited Dy3+ ions. Similar to TL mechanism release of holes/electrons from the defect centers might be responsible for ML emission.

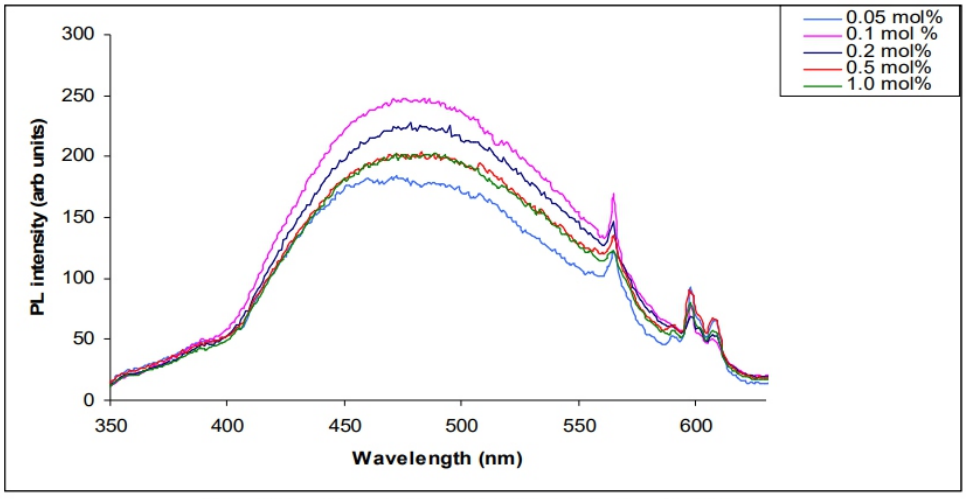

Figure7. PL emission spectrum of $CaWO_4$:Dyphosphors; λex- 390 nm

CONCLUSIONS

In CaWO4: Dy phosphor the TL peak around 150oC may be more useful for dosimetric purpose because of linear dose response and less mechanical bleaching effect.

REFERENCES

[1] Pradhan A. S., Dosimetric aspects of Luminescence, ISLA1, 131-144(2000)
[2] Luthra J. M. and Gupta N. M. J. Lumin 9, 94(1974)
[3] J. Azorin N. and J. RabioO., J. Phy.: Cond. Matt. 6 3831-3837(1994)
[4] Rajesh Kumar, Gundu Rao T. K., Dhabekar B. S., Sanye S. S., Menon S. S. and Batt B. C., Proceeding of NSLA, NPL, New Delhi, 288-294(2003)
[5] Dixon R. L. and Ekstrand K. E. J. Lumin 8, 383(1974)
[6] Huzimura R. J. Appl. Phys. 18,2031(1979)
[7] Laxmanan A. R., Rad. Measurements, 39 (2), 235-240 (2005)
[8] Chandra B. P., Luminescence of solid edited by D. R. Vij Plenum Press New York, 361-386(1998)
[9] Luthra J M, Gupta N M, Nambi K S V and Bapat, V. N.Thermoluminescence and its applications. Proceeding of The National Symposium on Thermoluminescence and Its Applications,Kalpakkam, India. pp. 147-165 (1975).

INTELLIGENT METER READING SYSTEM WITH OVER POWER DETECTION USING IOT AND GSM

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A B S T R A C T

With the electric industry undergoing change, increased attention is being focused on power supply reliability and power quality. Power providers and users alike are concerned about reliable power, whether the focus is on interruptions and disturbances or extended outages. Monitoring can provide information about power flow and demand and help to identify the cause of power system disturbances. The proposal in this paper is to monitor the power consumed by a model organization such a household consumers from a centrally located point. Monitoring the power means calculating the power consumed exactly by the user at a given time. The power consumed by the user is measured and communicated to the controlling substation whenever needed by the person at the substation. The feedback from the user helps in identifying usages between authorized and unauthorized users which helps in controlling the power theft, one of the major challenges in current scenarios. Communication between user/household and substation can be of wired and wireless.

Keywords - *Zig Bee, power theft, GSM, AT commands, wireless meter reading.*

I. INTRODUCTION

Power theft is the biggest problem in recent days which causes lot of loss to electricity boards. In countries like India, these situations are more often, if we can prevent these thefts we can save lot of power. Electrical power theft detection system is used to detect an unauthorized tapping on distribution lines. Implementation part of this system is a distribution network of electrical power supply system. Existing system is not able to identify the exact location of tapping. This proposed system actually finds out on which electrical line there is a tapping. This is a real time system. Wireless data transmission and receiving technique is used. This will provide an additional facility of wireless meter reading with the same technique and in same cost. This will protect distribution network from power theft done by tapping, meter tampering etc.

There are two types of techniques to deliver the information to the authorized agency to control the theft of the electricity via bypassing the energy meter, those are wired and wireless. Wired networks require lot of setup and maintenance cost. In wireless technologies there are many technologies. In this project we implemented using Zigbee technology because of its effective communication, self-healing networks, low power consumption, zero traffic and they can handle over 60000 devices and more over Zigbee communication installation require no special permissions in most of the places. It uses unlicensed 2.4 GHz ISM band which is available worldwide. ZIGBEE has range between 10 m to 2 km and it works well with networks such as Wi-Fi, Ethernet and GPRS and also provides scalable networking solution which makes it suitable to be used in controlling and monitoring application. And we selected other communication network to be GSM to send SMS to authorities in case of theft, because GSM has a built in transport layer encryption, which is supported by most network providers.

GPRS offers a number of security enhancements over existing GSM security. The standards themselves also offer technical features, which a network operator may choose to use. Aside of that, a different form of security might be desired in addition to the provided transport layer security.

II. BLOCK DIAGRAM

The developed prototype consists of a transmitter tapped to meter of the consumer and a receiver at a junction place. Their respective block diagrams are as follows

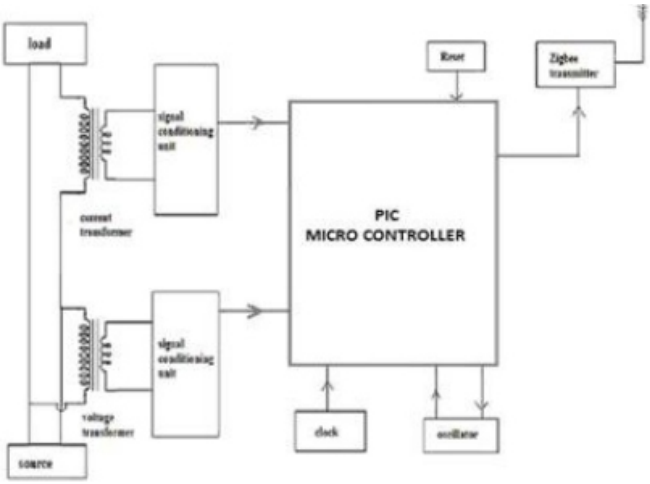

Fig: Transmitter Block diagram

It consists of Load, current transformer, voltage transformer, PIC micro controller, and a differential relay. The household load supplied is connected in series to the AC supply mains through a switch which is operated by the action of a relay. Current transformer is used to measure the current required for the user and the voltage transformer is used to measure the voltage of operation for the user. The measured values are given to the PIC micro controller which has inbuilt ADC with RISC architecture to convert the analog values to the digital values. These values are stored in microcontroller registers and the information is transmitted to the receiver, whenever there is a request for the data from the remote controlling station. Oscillator is provided to the microcontroller for the clock signal and the reference voltage is given for the each of the IC used.

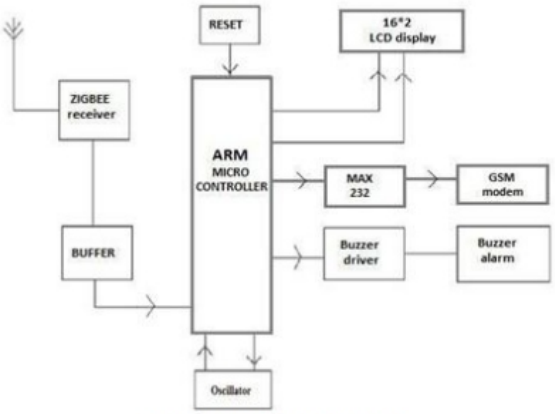

Fig: receiver block diagram

The receiver part of this prototype consists of an ARM micro controller, Zigbee receiver LCD display and alarm to pop out theft case, and also an external GSM modem to inform theft case to authorities via SMS.

III. AUTOMATIC METER READING (AMR)

Now a day utility company personnel goes at every house to take the readings of meters for billing purpose. It will create problem when consumer is out of Town or home is locked due to other reasons. This system of wireless meter reading is based on the same principle of wireless data transmission that is used in power theft detection Utility company personnel will have a device consists of wireless data receiver with microcontroller and display

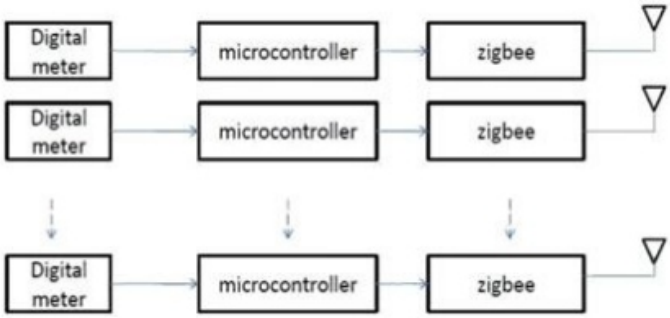

Fig: Architecture of AMR

The Base station unit will be consists of a zigbee module attached with a Transceiver micro-strip antenna, microcontroller attached to digital meter. The frequency of communication will be in 900 MHZ. the data will transmitted to the central station at regular intervals. The end station consists of an ARM micro controller receiving data from different PIC micro controllers through Zigbee receiver. The data thus received is processed and calculated the exact amount of power consumed by specific customer

IV. POWER MEASUREMENT AND THEFT DETECTION

Aim of the Remote power monitoring is to measure the exact amount of power that is consumed by the user at a given instant of time so the power measurement unit is essential and is connected on the consumer side. The power is measured by using the instrument transformers. Instrument transformers are used for measurement and protective application, together with equipment such as meters and relays. Their role in electrical systems is of primary importance as they are a means of "stepping down" the current or voltage of a system to measurable values, such as 5A or 1A in the case of a current transformers or 110V or 100V in the case of a voltage transformer. This offers the advantage that measurement and protective equipment can be standardized on a few values of current and voltage. The types of instrument transformers available are

Voltage transformers
Current transformers.

A. Voltage transformers

The voltage transformer is one in which "the secondary voltage is substantially proportional to the primary voltage and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections." In an "ideal" transformer, the secondary voltage vector is exactly opposite and equal to the primary voltage vector, when multiplied by the turn's ratio. In a "practical" transformer, errors are introduced because some current is drawn for the magnetization of the core and because of drops in the primary and secondary windings due to leakage reactance and winding resistance. One can

thus talk of a voltage error, which is the amount by which the voltage is less than the applied primary voltage, and the phase error, which is the phase angle by which the reversed secondary voltage vector is displaced from the primary voltage vector.

B. Current transformers

A current transformer is defined as "as an instrument transformer in which the secondary current is substantially proportional to the primary current (under normal conditions of operation) and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections." This highlights the accuracy requirement of the current transformer but also important is the isolating function, which means no matter what the system voltage the secondary circuit need be insulated only for a low voltage.

The current transformer works on the principle of variable flux. In the "ideal" current transformer, secondary current would be exactly equal (when multiplied by the turn's ratio) and opposite of the primary current. But, as in the voltage transformer, some of the primary current or the primary ampere turns are utilized for magnetizing the core, thus leaving less than the actual primary ampere turns to be "transformed" into the secondary ampere- turns. This naturally introduces an error in the transformation. The error is classified into two-the current or ratio error and the phase error.

Thus by considering all these parameters we program micro controllers to calculate the amount of power actually consumed.

C. Theft detection method

The simple formula behind theft detection is whenever input power is passing from supplier to the receiver, at that time if the total amount of power is not received by the receiver then there is possibility of theft of energy.

ΣPsent = ΣPconsumed + Loss ……..No Theft ΣPsent ≠ ΣPconsumed + Loss ……..Theft Occur Here,Psent = Power measured by pole side energy meter Pconsumed = Power measured by load side energy meter

Consider a distribution system shown in conceptual diagram. Two single phase loads L1 and L2 are supplied from two different phases. M1 and M2 are the energy meters that measure power consumed by these loads over a period. Pole based system (P) have been installed to detect power theft.

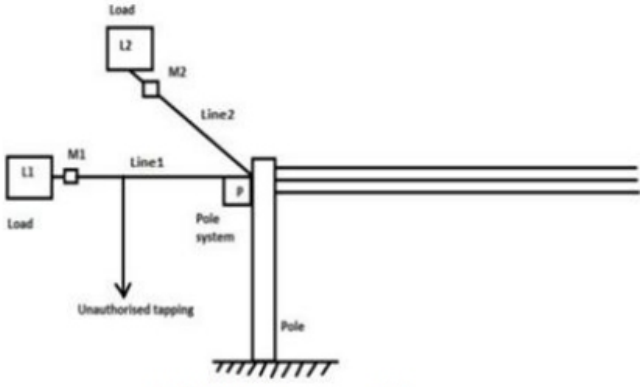

FIG2.3.1: Conceptual diagram

L1, L2 Single phase loads M1, M2 Digital energy meters P Pole based system (installed on a distribution pole)
There are three different types of systems to monitor power sent

A. Pole based system

It consists of Wireless data receiver, Micro-controller, Digital energy meter. Digital energy meter will measure power sent over each line for a certain time period.

B. Pole Side Energy Meter

One energy meter is installed in a pole based system. This meter is capable to measure a power sent over each line connected to that pole.

C. Load Side Energy Meter (M1, M2): Meter is installed on load side to measure a power consumed by load over a time. Also it has an additional feature of transmitting that data to receiver using wireless technique ZigBee network.

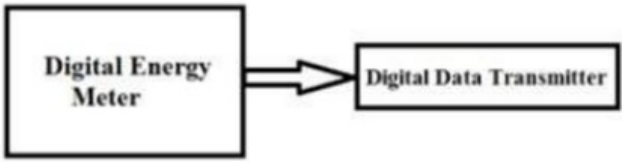

Fig: load side meter

D. Power theft detection

Suppose there is tapping done by any unauthorized person on the line to connect his appliance. Over a certain period there will be difference between meter reading and pole based reading.

Microcontroller will compare these two values and if the measured value on pole is more than value send by meter by some tolerance then power theft is happening on line. This theft signal generated on pole system can be transmitted to substation by power line communication technique, Tolerance should be provided for losses of line. Because over a long period there will be difference in reading of meter on load side and pole side due to loss of line between pole and load. Therefore tolerance should be provided through programming of micro-controller.

V. WORKING

The setup is build such that every consumer is provided with an automated meter reader with inbuilt microcontroller to monitor the data consumed at regular intervals, the PIC microcontroller is employed at consumers end and Arm microcontroller is employed on pole station. PIC sends data continuously and ARM processes data, it already has the record of amount of power sent to each line and it compares this to received feedback, if the difference between these two values exceeds the prescribed limits then the ARM microcontroller understands that power theft was happened and raises an alarm, also sends this information to local authorities via GSM modem.

There is a prescribed limit because, we have to keep track of all general power losses other than theft and PIC was employed at consumers end, while ARM at pole station. This is because both has inbuilt ADC and RISC architecture but PIC is 8-bit and cheaper it serves the purpose perfectly, while on pole station ARM receives data from various PIC's and need higher RAM and architecture to process data quickly, so ARM with 32-bit architecture is employed.

CONCLUSION

The progress in technology about electrical distribution network is a non-stop process. New things and new technology are being invented. The proposed system found to be little bit complex as far as distribution network is concerned, but it's an automated system of theft detection. It saves time as well as help to maximize profit margin for utility company working in electrical distribution network. Utility company can keep a constant eye on its costumer. And the extension of this project with GSM modules helps company to monitor the amount of usage by the specified customer and generate bill periodically and send it to customer via SMS, thus saving lot of labor work, time and cost of reading.

REFERENCES

[1] C. Jägerlind, "Improvements for the automatic meter reading process in electricity distribution companies," Master Thesis, De p. Industrial Info and Control Systems, Royal Institute of Technology, Stockholm, Sweden 2006.

[2] A. Abdollahi, M. Dehghani, and N. Zamanzadeh , "SMS based reconfigurable automatic meter reading system," IEEE International Conference on Control Applications (CCA 2007), Oct, 2007, pp. 1103 – 1107.

[3] C. Brasek, "Urban utilities warm up to the idea of wireless meter reading," The IEE Computing and Control

[4] C. Nunn, P. Moore, & P. Williams "Remote meter reading and control using high- performance plc communication over the low voltage and medium voltage distribution networks," in 7th International Conference on Metering Apparatus and Tariffs for Electricity Supply, 1992, pp. 304-308.

[5] International Conference and Exhibition on Electricity Distribution, Prague, Czech Republic, June 2009, pp. 1–4 .

EXPERIMENTRY RESEARCH ON FLEXIBLE AVEMENT ASPHALT USING FIBERS TO ENHANCE ITS ROPERTIES

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A B S T R A C T

In general, fibres can be used to improve the mechanical properties of bituminous mixtures in road pavements. Fibres may be used as additives to modify bituminous mixtures by fastening a significant amount of bitumen, what allows the increase of the binder content of the mixtures without losing their resistance to permanent deformation. Subsequently, strands are an important added substance for blends containing a high amount of mastic, for example, Stone Mastic Asphalt (SMA). All things considered, bituminous blends adjusted with strands rise as an amazing answer for be connected on thin overlays utilized over split asphalts. The high amount of bitumen in the mastic of these blends ensures a noteworthy protection from the start and spread of weariness and intelligent breaking, what, related with the security offered by strands, creates a material with a magnificent execution, for the most part in street asphalt overlays. The principle target of this paper comprises in assessing the upsides of utilizing acrylic filaments in bituminous blends, by concentrate their primary properties in research facility which are contrasted and those of blends typically connected in street overlays. By utilizing a FEM numerical reproduction, this paper additionally assesses the expected thickness to overlay an existent split asphalt with conventional thick blends or with blends altered with bamboo fibres.

Keywords - *Fiber, bitumen asphalt, concrete, compressive strength.*

I. INTRODUCTION

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others.However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities.

Highways are a fundamental infrastructure in the national economy and social welfare, since they provide mobility and accessibility for motorists and loads. The use of fibres comes out as a need for improving the flexibility and tensile strength of the bituminous mixtures submitted to a higher volume of traffic and to an increase of loads by axis of heavy vehicles. These are some of the causes which lead to the premature distress of bituminous mixtures in road pavements, namely cracking and rutting. Furthermore, mixtures with fibres can be submitted to high and low temperatures without losing their efficiency and with no distresses. That high flexibility hampers the workability and cracking problems which are usually seen in common dense bituminous mixtures exposed to high climatic variations.

a. Fiber-modified mixtures are basically composed by the matrix and fibers. The performance of these mixtures is mainly based on the content and length of fibers and on the physical properties and adhesion of fibers and matrix (Hannant, 1994).

b. The use of fibers emerges as a need for improving the flexibility and tensile strength of the bituminous mixtures submitted to a higher volume of traffic and to the increase of loads by axis of heavy vehicles. These are some of the causes which cause the plastic and viscoelastic deformations in the mixture and, consequently, the rutting formation and the progressive propagation of cracks.

c. Fibers are included in the bituminous mixtures to improve some of their properties such as adhesion and flexibility, in order to increase the resistance of the mixture and to prevent premature distress. Some of the main practical examples of the application of fibers in flexible road pavements are referred below, namely through the incorporation of nylon, carbon, synthetic, polymer, glass and acrylic fibers.

d. Nylon is a usual fiber used in carpet production. After being recycled this type of fiber can be used in the production of mixtures for pavements (Wang et al., 1994). According to Serfass and Samanos´s conclusions (1996), the addition of nylon fibers allows mixtures rich in bitumen to obtain an enhanced behavior concerning resistance to fatigue cracking, aging and moisture.

e. Kim et al. (1999) state that mixtures strengthened with nylon fibers increase the fatigue life of a pavement, approximately 20 to 25 times when compared with mixtures without fibers. In fracture processes, when cracks occur in a material with fibers, these fibers "build" a bridge which will bond both sides of the crack, thus giving additional resistance to its propagation and opening before the rupture of the mixture. By using indirect tensile strength tests, Lee et al. (2005) also conclude that adding nylon fibers to asphalt concrete may improve fatigue cracking resistance by increasing the fracture energy, a fundamental mechanical property of bituminous mixtures. The fracture energy of fiber composite asphalt concretes with a fiber length of 12 mm and a volume fraction of 1% shows an increase of about 85%, higher than that of regular asphalt concretes.

f. The company S&P (2007) studied the use of carbon fibers in several areas of civil construction due to their successful practical uses implemented already. The last development by S&P refers to the metallic nets of carbon fibers covered with bitumen to reinforce cracked areas of asphalt concrete pavements. The metallic nets of carbon fibers prevent and delay the occurrence and progression of reflective cracks. Ultra thin coverings, armed with carbon fibers, offer new possibilities for future innovative solutions.

g. The mixture gripfibre (EUROVIA, 2007) is worth mentioned as a successful example of the use of synthetic fibers in pavements. It is a thin cold bituminous mixture of 0/6 or 0/10 mm with continuous or gap grading. The innovative side of this material consists in the incorporation of synthetic fibers in the mixture composition. These fibers allow applying gap grading mixtures without the risk of segregation, disaggregation and binder drainage, thus assuring surfaces with satisfactory roughness. In addition, fibers eliminate the stripping of aggregates by traffic in the gap grade mixture.

h. Rowlett and Uffner (1985) studied the behavior of bituminous mixtures in road overlays or strengthening of distressed pavements using glass fibers together with polymer modified bitumen to minimize the propagation of cracks. This system was also used to reduce the scaling of deteriorated cracks and joints (avoiding the occurrence of potholes) before the construction of a new road overlay. Bitumen with polymers adheres to the old pavement, to the glass fibers and to the new overlay. It protects the strengthening material (the glass fibers) and works as a membrane to reduce the stress state near the cracks, transferring the stresses for the new road overlay. The glass fiber strengthening system distributes the stresses on the rehabilitated pavement into a value below the fracture strength of the new

overlay. The authors verified that the strengthening system of polymer modified bitumen together with glass fibers was effective in the reduction of reflective cracking. The referred system demonstrated a successful reduction in the maintenance costs (in the order of ten to one), with an equivalent or better performance than the traditional milling and replacement of the material.

i. Acrylic fibers form a three-dimensional net which acts as an armor by increasing the consistency of the mixture, which is thus improved in its mechanical properties, especially those related to shear and tensile strength. Using acrylic fibers improves the following properties of bituminous mixtures: resistance to fatigue cracking and to permanent deformation, durability and the performance of the binder at high temperatures. The behavior of the internal structure of the mixture with fibers improves its cohesion and tenacity, thus guaranteeing a greater resistance to impacts, a decrease of the abrasive effect of traffic and delaying the beginning and propagation of cracks (Amago, 2002). The Spanish centre of research CEDEX (2003) has carried out an extensive study on bituminous mixtures modified with acrylic fibers, concluding that the addition of these fibers in the bituminous mixtures reduces the thermal susceptibility, increases the resistance to permanent deformations and to fatigue cracking, what, jointly, highly enhance the durability of pavements.

j. Recently, one of the main lines of research is the study of recycled fibres as an environmentally friendly material to be used in bituminous mixtures. Labib and Maher (1999) stated that the use of recycled fibres in asphalt mixtures was considered advantageous when using fishing nets. As a result, fibres could be uniformly and consistently incorporated into the asphalt mixture without segregation or introduction of excessive air voids. However, the same authors refer that fibres typically obtained from recycling operations such as those from carpets and car seats were difficult to be utilised with the dry mixing process used in laboratory. Thus a first stage to study these fibres should comprehend the use of virgin fibres to clearly understand how fibres affect the mechanical properties of the mixture, and then apply the results to the use of recycled fibres.

k. After having analyzed several studies about the incorporation of fibers in bituminous mixtures, it was observed that this material has an excellent performance in pavements due to the increase of the fracture energy and the fatigue cracking resistance. These mixtures are particularly useful as road pavement anti-cracking overlays, since fibers delay the occurrence and progression of reflective cracks, what justifies the work herein presented. The acrylic fibers were chosen because they seem to have more advantages, thus assuring a superior performance in the pavement.

II. METHODOLOGY

The project being an experimental effort needs the protocol of accumulating specimens, analyzing them, executing a range of tests and obtaining conclusions from the outcome. The project can be separated in the following parts

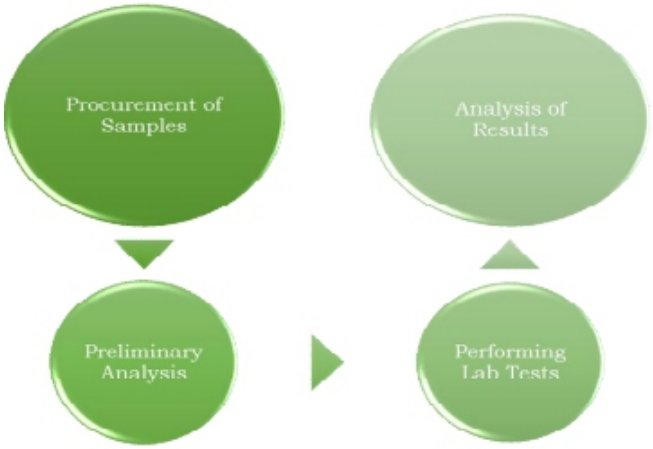

Figure 1 – Methodology adopted

Accumulation of Specimens

Fiber samples were accumulated from the forest area of hoshangabad bhopal Madhya Pradesh. The specimens were brought for the construction purposes at the campus site, so they are fit to be employed for construction purposes.

Performing Lab Tests

From the accumulated specimens, 4 sets were made with different fractions OF cement to locate the density index of the sand specimen. Attaining the maximum and minimum void ratios, the relative densities were calculated.

Compaction Characteristics of Cement Stabilized Gravel

The heavy compaction tests are carried out as per IS 4332 (part 3) -1995 [3] on fiber (bamboo) mixed with 2, 4, 6 and 8 percent content by dry weight of samplefor determining compaction characteristics. Care is taken to complete the compaction test within 30 minutes from the instant of mixing of cement to soil.
The OMC and MDD values of Cement stabilized GW are presented in Table 1

Description of Mix	OMC (%)	MDD (g/cc)
Fiber + 2 % cement	6.87	1.97
Fiber + 4 % cement	7.14	2.02
Fiber + 6 % cement	7.32	2.10
Fiber + 8 % cement	7.41	2.12

It can be seen from Table 1 that the values of M.D.D values of fiber mixed concrete sample increased with increase in percentage of fiber upto some point than gradually decline. However, the increment is marginal. The increased MDD values are due to filling up of voids in concrete. The optimum moisture content is also increased with increasing cement content under study. It is attributed to increasing the specific surface area of cement content.

III. U.C.S TESTING RESULTS:

U.C.S is also known as uniaxial compression tests, is special case of a triaxial test, where confining pressure is zero. UC test does not require the sophisticated triaxial setup and is simpler and quicker test to perform as compared to triaxial test. In this test, a cylinder of concrete without lateral support is tested to failure in simple compression, at a constant rate of strain. The compressive load per unit area required to fail the specimen as called unconfined compressive strength of the concrete As per I.S. 2720-part-10.

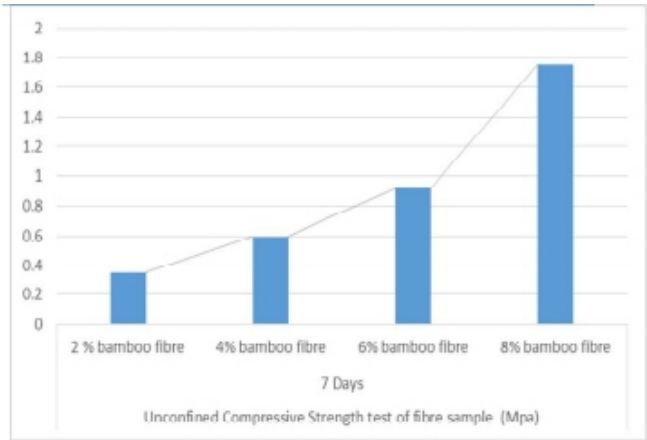

Fig: 2 U.C.S. Test results for sand mix.

IV. INFERENCES

As shown in figure above cement stabilization of a fibre mixed is suitable for construction with 4% fibre mix which shows most suitable result in comparative study.

CONCLUSION

1)
2) The fibre mix conrete in this study can be effectively stabilized by 8 % bamboo fibre as shown in figure 2.
3) The maximum dry density of cement stabilized fibre under study increased with increase in proportion of cement.
4) The compressive strength of well graded fibre mixed sample increases significantly upto 4% than it gradually decline

REFERNCES

[1] ISO15686-5. (2008). Building and constructed assets-service life planning. Part 5: Life-cycle costing. Stockholm: Swedish Standard Institute.
[2] (USDTFHAO) U.S. Department of Transportation Federal Highway Administration Office of Asset Management. August 2002: Life-Cycle Cost Analysis Primer.
[3] Narasimhan, H., (2006) "Life Cycle Cost Design Of Concrete Structures", M.Sc. (Building) Thesis, Department Of Building, National University Of Singapore.
[4] Kong, J.S., And Frangopol, D.M. (2003). "Evaluation Of Expected Life-Cycle Maintenance Cost Of Deteriorating Structures". J. Struc. Eng., 129(5), 682-691.
[5] Li, C., And Guo, S. (2012). "Life Cycle Cost Analysis Of Maintenance Costs And Budgets For University Buildings In Taiwan". J. Asian Arch. And Bild. Eng., 11(1), 87-94.
[6] Kim, S., Frangopol, D.M., And Zhu, B. (2011). "Probabilistic Optimum Inspection/Repair Planning To Extend Lifetime Of Deteriorating Structures". J. Perf. Constr. Fac., 25(6), 534-544

QUANTIFICATION OF DIFFERENT FACTORS FOR ASSESSMENT OF FOLIAR DISESES THROUGH IMAGE PROCESSING

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A B S T R A C T

Agriculture is the primary source of food for the entire humanity. Diseases on crop plants play a significant role in degrading the quality of food products. So, detection of plant ailment is essential to increase the productivity as well as to minimize the crop yield losses too. Image processing techniques have vast applications in the field of agriculture. It leads to early detection and classification of various foliar diseases of plants. This method is more reliable, accurate and less timeconsuming as compared to visual analysis. Image acquisition is the first step in image processing. So, the main focus of our work is to elaborate the factors that are taken as a precautionary while capturing images along with the camera specifications. Different environmental factors are also considered in the present study that affects the assessment of foliar diseases through image processing with the limitation of the work.

Keywords: *Relative humidity; Temperature; Camera specifications; Foliar diseases; Shadow; Angle.*

I. INTRODUCTION

The economy of India highly depends on agricultural productivity as most of the population depends on it for their living. Therefore, it is imperative to find the factors that affect the crop yield. Without the proper assessment of the disease in a particular period controls measures followed will not result accurately[1].

Now a days, production of crop declines every year due to various plant ailments that cause a significant reduction in both quality and quantity of foodproducts with the economic, ecological and social loss to growers. So, early disease detection is necessary to enhance the productivity of crops [2]. Pathogens (like fungi, bacteria, viruses, etc.) are the main disease causing agents of plants [3]. Similarly, environmental factors are also responsible for causing disease in plants [4].

Lots of techniques or methods were available for analyzing the plant diseases. The conventional disease recording method through naked eyes is expensive, time-consuming as well as less accurate in case of huge fields and with large number of samples[5]. So, to analyze the various plant diseases with more accuracy in less time, image processing techniques have been used [6].

Digital image processing has many applications in the field of agriculture i.e. in disease identification on leaves, stems and on fruits, in the classification of weeds, in pest identification, etc. [7]. It includes three steps for processing images i.e. capturing, manipulating and final output [8]. Image acquisition is the first stage of any vision system, and images can be captured using mobiles, cameras, satellites or through scanner [9]. As, image reveals the colour, quality and fine details of the object hence, careful adjustment of the camera is required to ensure that image contains fine details of information. Image captured should be a high-quality image with greater resolution, which helps in proper image analysis and should

d be stored in PNG format to restore all its fine details [10, 11].

For assessing plant health in plant pathology using image processing, digital photographic images play a significant role. For that images of leaves were taken at a specific interval of time to spot the disease [12].If the images were captured correctly by considering all the factors discussed in this paper, then it is easy to detect the affected lesions from the image accurately.

Besides image acquisition, fungicidal applications also play a vital role in declining the growth rate of disease.

II. FACTORS AFFECTING GROWTH RATE OF PLANTS

The growth and development of the disease depend on a number of factors like supply of nutrients, environmental conditions, etc. [13]. Besides these factors temperatures, relative humidity and fungicidal applications plays the major role for the development of foliar diseases.

The optimum temperature for development of disease ranges in between 25-30 °C with high relative humidity ranging between 80-90% [14]. Factors affecting growth rate of foliar diseases are discussed below:

A. Relative humidity

It is defined as the measurement of an amount of water vapour present in the air and expressed in percentage [15]. It is an important environmental parameter taken into the consideration which affects the transpiration, nutrient uptake and respiration of the plants [16]. High and low relative humidity extremely affects the yield of crop [17]. High relative humidity not only affects the plant growth but also affects the development of the pathogen on the plant. So, it is the major environmental factors which havehigh influence on the growth rate of the disease.Relative humidity is given by equation (1):

$$R_H = \lim_{K \to m} \sum_{i=n}^{m} \Delta R_H(i) \quad \text{.....(1)}$$

Similarly, change in relative humidity is given by equation (2) :

$$\Delta R_H = \frac{n-m}{k} \quad \text{.....(2)}$$

Where,

k is a total number of days, $\Delta R_H(i)$ is the change in relative humidity and m, n are upper and lower limit of relative humidity.

B. Temperature

Similarly, the temperature is another environmental factor that has a major role on growth and development of disease. Fluctuations present in temperature, influence the plant growth as well as the development of the disease. Many scientists have reported the temperature below 15 oC adversely affects the growth as well the development of the population of the pathogen. Similarly, temperature above 35 oC is also decline the growth and development of the disease [18].

Temperature is given by equation (3):

$$T = \lim_{K \to m} \sum_{i=n}^{m} \Delta T(i) \quad \text{.....(3)}$$

Similarly, change in temperature is given by equation (4);

$$\Delta T = \frac{n-m}{k} \quad \text{.....(4)}$$

Where; k is the total number of days, T(i) is change in temperature, n, m are lower and upper limit of temperature

C. Effect of environmental conditions on growth rate of disease

Table 1 shows the effect of temperature and relative humidity on the growth rate of the foliar diseases.

Table1: Temperature, relative humidity and growth rate of foliar diseases (recorded in year the 2016)

Temperature	Relative humidity	Growth rate of foliar disease
37.5	28.5	0.26
34.85	38.5	0.42
33	59.5	0.67
28.5	72	1.26
29.75	82.09	1.26
29.4	86.04	1.30
27	81	1.37
27.95	65.5	1.09
29.5	52.5	0.96

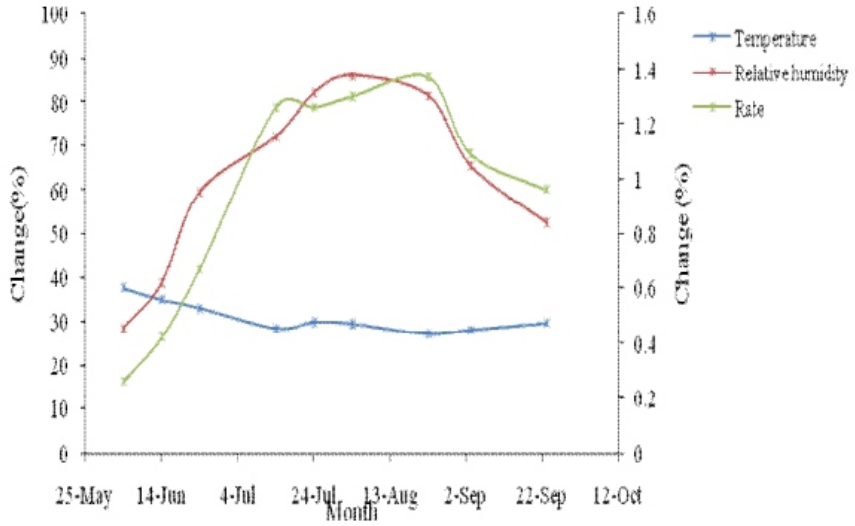

Fig.1. Comparative growth rate of disease with increase and decrease of relative humidity and temperature

Figure 1 indicates the cumulative effects of temperature and relative humidity on growth rate of disease which is divided into three categories i.e.

1) When there is a rise in temperature and fall in humidity: on the basis of the observation recorded during the period June to July 2016 an increase in the temperature and decrease in relative humidity lower down the growth rate of the disease.

2) When there is optimum relative humidity and temperature: the favorable conditions were recorded during the month of August and September 2016. The relative humidity lies between 80-90%, and temperature ranged between 25-30 oC. These both the conditions are optimum for the disease growth.

3) When both humidity and temperature declines: under such condition it was observed that growth rate of the disease is also adversely affected. If such condition prevails for the longer time, it retards the development of the disease.

D. Fungicidal applications

Application of different fungicides at appropriate time plays an important role to manage the plant diseases. By applying fungicides, crop losses can be minimized. Earlier available methods are time consuming and less accurate too. So, using image processing one can save the time required in analyzing the economic threshold level at an early stage to minimize the crop losses.

III. CHALLENGES OF IMAGE PROCESSING

Following parameters taken into consideration while capturing leaf images:

A. Angle

It is an important parameter to be considered during image acquisition. If camera angle is not correct, the output may have errors. The angle containing dark shadows may give the false perception of the images. In the case of leaf, if an angle is not accurate, then the observations recorded mislead. For example, if images were taken from 45 degrees less or above then it may appear twice or the half of the original image. But when the camera is placed parallel to the image and clicked at 90 degrees, which gives an exact image with its background.

Figure 2 shows the images of leaf captured with different angle.

(a) (b)

Fig.2. (a & b) Shows different foliar diseases captured with different angle

B. Shadow

It plays an imperative role in the acquisition of images because darkness and brightness show variations in colour. Shading is caused by nonuniform illumination, sensitivity of camera or even due to dust and dirt on camera lenses. In some cases,image may be bright in centre, and brightness decreases towards edges of image or it may be dark on left side and light on right side. For example, when leaf images were taken in shadow, it will give patches of white (sun light) and dark light (shadow of some leaves) which gives the false perception to image processing. Because healthy area is reflected in place of the infected area which leads to miscalculation of the diseases cluster.

Figure 2 shows the different images of leaf captured in different lighting conditions.

(a) (b)

Fig.3. (a & b) Shows shadow images foliar diseases

C. Lighting conditions

When the images were not captured in perfect lighting conditions, final outputs show colour variations. For example, if leaf images were captured in different shades of light having Lux nearby 1000-2000, colour temperature between 4500-5500 K, then output received in the result will be more accurate as compared to the images captured below the range as cited above. Because blue colour temperature will gives little information about infected areas whereasthe golden and yellow temperature will give the false information of infection on the area all over the leaf.

Equations of Lux and colour temperature are given by equation (5) and (6):

$$L = \lim \sum_{i=1000}^{2000} \Delta L(i) \quad \text{.....(5)}$$

Where,

L is the luminosity of light whereas $_{\Delta}$L(i) is the change in luminosity of light.

$$C_T = \lim \sum_{i=4500}^{5500} \Delta C_T(j) \quad \text{.....(6)}$$

Where,

C_T is the colour temperature whereas $\Delta C_T(i)$ is the change in colour temperature.

Figure 4 shows the different colour temperature.

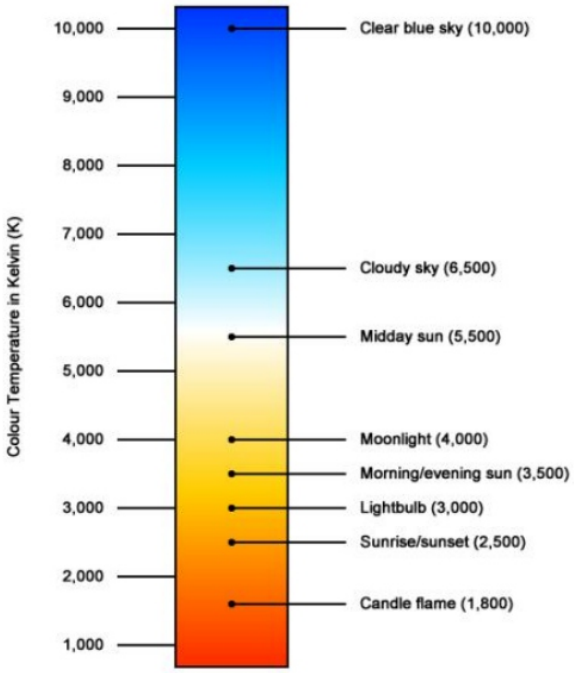

Fig.4. Colour temperature [19]

IV. REQUIRED PARAMERTER TO ACHIEVE BETTER IMAGES FOR THE ASSESSMENT OF FOLIAR DISEASES

Table 2 shows the parameters of camera with their specification for the acquisition of images in the estimation of foliar diseases through image processing.

Table.2: Camera specification

Parameters of camera	Specifications
ISO	250
Camera frame per second	29.7 fps
Zoom lens	29-216 mm
Lux	1000-2000
Colour temperature	Between 4500-5500 K
Distance of camera lens with object	1 ft
Shutter speed	$1/8000^{th}$ sec

V. LIMITATIONS OF EXISTING WORKS

Lots of research has been done on identification and classification of disease. But still, some aspects are needed to be resolved. Some of them are pointed out as follows:

1) Few diseases have been covered, so work needs to be extended to envelop more diseases.

2) Database extension is needed to reach accuracy.

3) As disease symptoms vary from one plant to another, more training samples are requiredto cover more cases, and more optimized process is needed to predict disease more accurately.

4) Consideration of environmental conditions to achieve better results as they also play an important role in the progress of disease.

CONCLUSIONS

This paper gives an idea to growers for considering the factors that plays a vital role in image acquisition to process the foliar diseases of crops using image processing techniques to follow the management practices at appropriate time. In present studies, visual and image processing analysis are also taken into consideration to investigate the factors that are responsible for the growth rate of foliar diseases on plants.

REFERENCES

[1] Vijay S.Bhong Prof.B.V.Pawar, "Study and Analysis of Cotton Leaf Disease Detection Using Image Processing, International Journal of Advanced Research in Science",Engineering and Technology, vol.3, issue2, pp.1447-1454, February 2016.
[2] Singh, Vijai, and A. K. Misra, "Detection of Plant Leaf Diseases using Image Segmentation and Soft Computing Techniques", Information Processing in Agriculture, vol.4, no. 1, pp.41-49, 2017.
[3] David S. Ingram, N.F. Robertson, "Plant Disease", Harpercollins Publisher, pp.1-288, 1999.
[4] GN Agrios, "Plant Pathology", Elsevier Academic Press, pp.1-922, 2005.
[5] Khirade, Sachin D., and A. B. Patil, "Plant Disease Detection Using Image Processing", International Conference on Computing Communication Control and Automation (IEEE), pp.768-771, 2015.
[6] Wang, Haiguang, Guanlin Li, Zhanhong Ma, and Xiaolong Li, "Application of neural networks to image recognition of plant diseases", International Conference on Systems and Informatics (IEEE), pp.2159-2164, 2012.
[7] Revathi, P., and M. Hemalatha. "Classification of Cotton Leaf Spot Diseases usng Image Processing Edge Detection Techniques", International Conference on on Emerging Trends in Science, Engineering and Technology (IEEE), pp. 169-173, 2012.
[8] Sankaran, Sindhuja, Ashish Mishra, Reza Ehsani, and Cristina Davis. "A Review of Advanced Techniques for Detecting Plant Diseases", Computers and Electronics in Agriculture, vol.72, no.1, pp. 1-13, 2010.
[9] Shailendra Kumar Dewangan, "Importance and Applications of Image Processing", International Journal of Computer Science & Engineering Technology, vol.7, no.7, pp.316-320, 2016.
[10] Nasrabadi, Nasser M., and Robert A. King. "Image Coding using Vector Quantization: A Review", IEEE Transactions on Communications, vol.36, no. 8, pp.957-971. 1988.
[11] Mitkal, Prajakta, Priyanka Pawar, Mira Nagane, Priyanka Bhosale, Mira Padwal, and Priti Nagane, "Leaf Disease Detection and Prevention Using Image Processing using Matlab", International Journal of Recent Trends in Engineering & Research (IJRTER), vol.2, pp. 2455-1457, 2016.

[12] Hemming, Jochen, Eldert J. van Henten, Bart AJ van Tuijl, and Jan Bontsema, "A Leaf Detection Method using Image Sequences and Leaf Movement", International Conference on Sustainable Greenhouse Systems-Greensys, vol.691, pp. 765-772, 2004.
[13] Grange, R. I., and D. W. Hand, "A Review of the Effects of Atmospheric Humidity on the Growth of Horticultural Crops", Journal of Horticultural Science, vol.62, no.2, 125-134, 1987.
[14] Spitters, C. J. T., H. Van Keulen, and D. W. G. Van Kraalingen", A Simple and Universal Crop Growth Simulator: SUCROS87", In Simulation and Systems Management in Crop Protection, pp.147-181, 1989.
[15] Nilsson, H, "Remote Sensing and Image Analysis in Plant Pathology", Annual Review of Phytopathology, vol.33, no.1, pp.489-528, 1995.
[16] Grange, R. I. and D. W. Hand", A Review of the Effects of Atmospheric Humidity on the Growth of Horticultural Crops", Journal of Horticultural Science, vol.62, no.2 (1987): 125-134.
[17] Ibrahim, M., A. B. Rabah, B. Liman and N. T. Ibrahim, "Effect of Temperature and Relative Humidity on the Growth of Helminthosporium Fulvum, "Nigerian Journal of Basic and Applied Science, vol.19, no.1, 2011.
[18] Sannakki, Sanjeev S., Vijay S. Rajpurohit, V. B. Nargund, and Pallavi Kulkarni. "Diagnosis and Classification of Grape Leaf Diseases using Neural Networks", Fourth International Conference on Computing, Communications and Networking Technologies (IEEE), pp.1-5, 2013.
[19] Lee, Honam, Hyungjin Choi, Bonggeun Lee, Sewoong Park, and Bongsoon Kang. "One-Dimensional Conversion of Color Temperature in Perceived Illumination", IEEE Transactions on Consumer Electronics, vol. 47, no.3, pp.340-346. 2001.

PRACTICAL ANALYSIS OF BIT ERROR RATE WITH RESPECT TO LINK DISTANCE IN FREE SPACE OPTICAL COMMUNICATION

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A B S T R A C T

In this investigation, we are trying to analyze the relation between Bit Error Rate (BER) versus link distance between trans-receiver in Free Space Optical Communication (FSO) system. This paper deals with the performance evaluation of BER with respect to path length under normal atmospheric conditions. A terrestrial FSO link is designed that offers high data rate optical communication system. BER is the most important parameter in case of FSO system that highly get affected by the others. During this analysis, a relation between minimum BER, optical power of laser and link distance would be observed because of which it becomes necessary to set the level of BER for experimental purpose so that an optimize and efficient system is created. Absorption, scattering and turbulence are the three major adverse effects that cause serious degradation in the performance of BER that may lead to communication link inoperable.

Keywords: *Free Space Optical communication, Optical Wireless Communication, laser, scintillation, Line of site.*

I. INTRODUCTION

Optical Wireless Communication (OWC) denoted as the other name of optical communication that consistsultraviolet (UV) light, infrared (IR) or unguided visible light for carrying information. It has been classified into two major groups. One is indoor OWC, which is also termed as wireless infrared communication, and outdoor OWC. FSO is also known as outdoor Optical Wireless Communication (OWC) or Free Space Photonics (FSP) system that is defined as a clear line of site (LOS) technology that uses invisible infrared light to carry information from one place to another[1]. Currently, the commercial available terrestrial FSO system offer the data rate ranges from 100 Mbps to 2.5 Gbps. Although, in laboratories, 160 Gbps data rate is achieved by the scientists and researchers.

Like optical fiber, FSO also uses laser beam for delivering data, but in place of encapsulated data stream in a glass fiber, it is delivered through air. In Terahertz spectrum, FSO involves precise alignment in form of clear LOS to achieve point-to-point laser link in which a low power infrared laser is used for transmission purpose. Highly efficient telescopes focused on photon detector receivers that are highly sensitive towards transmission of beam of light. These detectors are connected with telescopic lenses and have the capability to gather the photon stream and transfer digital data containing a bunch of messages, videos and data in form of computer files. The advantages of FSO communications include quick link setup, immense transmission security, free license operation, full duplex transmission, huge bit rates and protocol transparency. In case of shortrange FSO link, the value of optical power of laser should be very accurate because a significant fraction having precise value of the sent power can incident on the receiver (e.g. a photodetector). However, it is less efficient than optical fiber because of the presence of services is lower than with a cable due to which the link may be altered either by atmospheric influences or by flying objects such as birds or planes. Due to this, FSO is less robust than

other wireless technologies, but it has a greater transmission capacity and is secured towardselectromagnetic interference, and does not get easily affected by electro-smog. Along with that it does not lead to interference between data links which are at different points. Therefore, there is no requirement oflicense for operating purpose.It is far more remarkable in terms of data security, since it is more challenging to intercept due to the presence of tightly collimated laser beam than a radio link and uses of schemes of quantum cryptography [2]. Finally, thedependability can be upgraded by opting various ways like with backup systems, different multiple diversity techniques including multiple beam architectures and larger power margin.

II. MAIN CHALLENGES IN FSO LINK DESIGN

Performance of FSO link is highly affected by atmosphere and physical characteristics of installation location. Major problem associated with an FSO system is 'Turbulence' that is occurred when the route of light changes because of the changes in refractive indices of the layers existing in the air. It occurs due to the presence of in-homogeneities in form of atmospheric temperature and pressure that lead towards the variations occur in refractive indices along with the distribution path. These refractive index variations cause fading that is generated due todeviation present in spatial and temporal regions in optical intensity incident on a receiver. In case of transmitter i.e. LASER; due to turbulence, it also experiences three types of major issues. First, due to the changing refractive index cells, the beam can be altered frequently through the path known as beam wander. Second, the beam phase front can deviatedue to which intensity fluctuates that is known as scintillation. Third, the beam can be widen due to which diffraction occurs. Another major problem is 'Attenuation', which is of many kinds. First one is geometric attenuation that generates due to widening of the delivered beam of source between the transmitter and the receiver. Because of this attenuation even in clear weather conditions, detector receives less signal power. Another one is system attenuation that includes coupling losses, transmitter receiver losses, misalignment losses and solar radiation losses. Third one is atmospheric attenuation. Atmosphere is composed by aerosols that is the combination of small-suspended particles and different molecular species. In case of absorption attenuation, it causes due to the interaction between atoms or molecules and photons, which is manifested by the absorption of the incident photon and an elevation of the temperature Molecular absorption is wavelength dependent, which results in atmospheric transmission windows. Last one is scattering absorption which is caused by the presence of fog, mist, haze, drizzle, snow particles and rain [3].

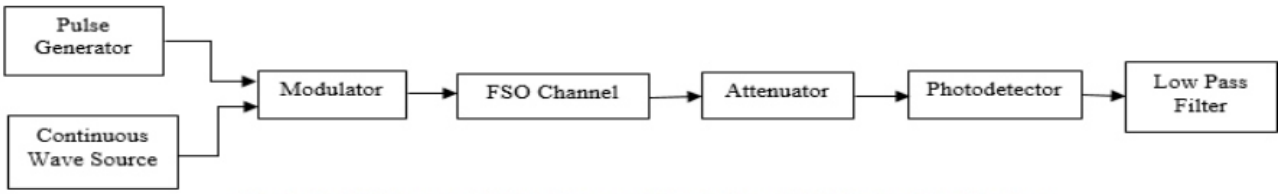

Fig. 1. Block Diagram of Set-up in case of Simulation of FSO System Link Design

External modulation inflates the attainable link distance by broadening the linewidth of directly modulated lasers due to which laser chirps are automatically eliminated. The important element of an optical receiver is a photodetector that uses photoelectric effect. The elementary photodetectors that are typically a semiconductor based device in the field of telecommunications and contrived from Indium gallium arsenide (InGaAs). Other examples of photodiodes are p-n, p-i-n and avalanche photodiodes. Another form of photodetector that is frequently utilized due to its appropriateness for circuit integration wavelength-division multiplexers and regenerators is named as Metal-semiconductor metal (MSM) photodetectors. For this paper, at the receiver end, photodetector in form of PIN diode is connected [5].

Optical-electrical converters are frequently clasped by a limiting amplifier and trans impedance amplifier i.e. utilizes for the production of digital signal. After that clock recovery from data (CDR) performed signal processing by a phase locked loop.These processes are applicable before the data is crossed on. After the data received, it is highly affected by the noise and signals are in distorted form. Because of that for wave shaping and noise removing purposes, a Low pass Butterworth filter is required.Optical intensity shows the optical power of the laser which is calculated for per unit area. Optical power is the most fundamental unit to check the performance of a laser which ranges from Nano-watts to several kilo watts. Currently, different types of lasers having wide variety of specifications are present, so that optical power plays a major role in selection process [6].

III. SYSTEM DESIGN

A free space optical link system is designed in which continuous wave LASER is taken as an optical source that is operated at 1550 nm wavelength, which means the operable frequency required is in Terahertz i.e. 193.1 THz. On transmitter side, a continuous wave source i.e. a semiconductor laser is used for achieving high output power by emitting light through stimulated emission in place of spontaneous emission Furthermore, because of short recombination time, modulation process happen directly at higher frequencies through semiconductor lasers. Design of transmitters using semiconductor laser in optics comprise VCSEL (Vertical-Cavity Surface-Emitting Laser) which is operable at 850 nm, on the other hand Fabry–Pérot andDistributed Feed Back are used at 1550 nm operating wavelength [2]. Oftenly, laser diodes are precisely modulated which means that current is directly applied to the device to control light output. For the purpose of very high data rates, a laser source coordinated as continuous wave, and modulation of light occurred by an extrinsic device in form of using interferometer named as Mach-Zehnder or a modulator like an electro-absorption modulator[4].

TABLE I: SYSTEM PARAMETERS FOR DESIGNING FSO LINK

S. No.	Parameters	Values
1.	Type of laser	Continuous wave
2.	Optical power	(0.01-200) W
3.	Attenuation in FSO channel	(118-130) dB/km
4.	Transmitter Aperture Diameter	2.5 cm
5.	Receiver Aperture Diameter	8 cm
6.	Beam Divergence	2 mrad
7.	Responsivity	1 A/W
8.	Dark Current	10 nA
9.	Attenuation of optical attenuator	(0-5) dB

IV. RESULT ANALYSIS

Table 2: Result Analysis of simulation of FSO link design

S. No.	Distance / Parameters	100 m	150 m	200 m	250 m	300 m	350 m
1.	Optical Power	0.01 W	0.1 W	1 W	10 W	100 W	1000 W
		10 dBm	20 dBm	30 dBm	40 dBm	50 dBm	60 dBm
2.	Attenuation of FSO Link (dB/km)	118.173	121.695	124.193	126.132	127.715	129.05
3.	Attenuation of Optical Attenuator (dB)	0	1	2	3	4	5
4.	Minimum BER (dB)	1.248×10^{-11}	1.999×10^{-10}	9.33×10^{-11}	8.397×10^{-13}	9.321×10^{-15}	2.472×10^{-19}

4.1Link Distance of 100 m and 150 m

Consider the link distance between transmitter and receiver is 100 m and 150 m respectively. For designing of an ideal FSO system, the value of BER is 10-9at the wavelength of 1550 nm [8]. But in this investigation, conditions are practical so BER must vary and highly dependable on the values of optical power of continuous wave laser, attenuation level of FSO channel and attenuation of optical attenuator. By the help of Free Space Path Loss, attenuation levels have been calculated at various values of linkdistance so that optical power of laser should be adjusted accordingly. Here the values of optical power of the laser is starting from 10 dBm and 20 dBm for the link distance of 100 m and 150 m respectively.

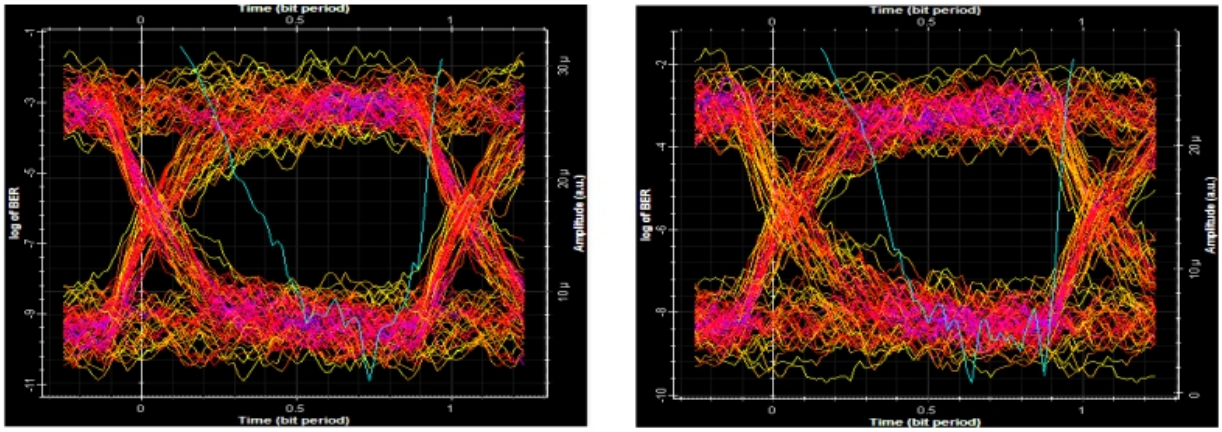

Fig. 2. Representation of Min. BER with the respective Eye Diagram (a) 100 m and (b) 150 m respectively

The BER may be upgraded by selecting a slow and robust modulation scheme like forward error correction codes and by selecting a stable signal strength (unless this originates cross-talk and high bit errors). Here, for the link distance of 100 m and 150m, the values of minimum BER in above cases are 1.24824 × 10-11 and 1.99951 × 10-10 respectively.In the above eye diagrams, opening of an eye it is clearly visible which means that the link design or the layout of simulation is successfully run. Now the randomness in the eye diagram shows the presence of noise in the channel. This eye diagram is divided into two level for analysis purpose, first one is upper decision level and another one is lower decision level.

4.2 Link Distance of 200 m and 250 m

Distance is increased in a sequential pattern, due to which the optical power of laser is also further increased by 10 dB for every 50 m link distance. Here, in these cases the values of optical powers are 30

dBm and 40 dBm for 200 m and 250 m respectively. Tuning of optical attenuator is also necessary and for that the attenuation levels are set to 2 dB and 3 dB respectively.

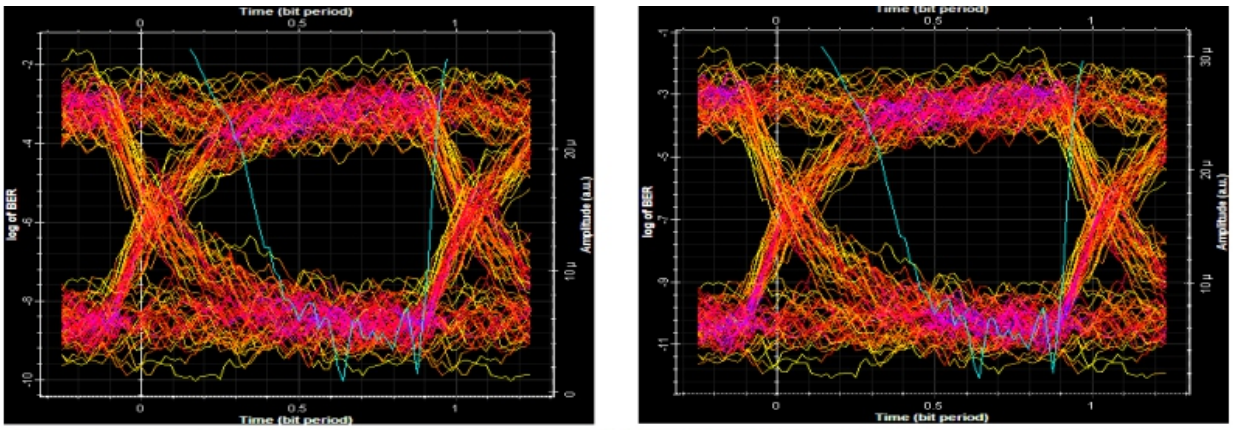

Fig. 3. Representation of Min. BER with the respective Eye Diagram (a) 200 m and (b) 250 m respectively

From the above results, the opening of the eyes is still visible which means that the link designs are ready to provide outputs in form of BER and other parameters. Although, randomness in the eye diagram increases which means that the amount of noise in the channel would be inflated. The values of minimum BER are 9.33979 × 10-11 and 8.39752 × 10-13 for the link distance of 200 m and 250 m respectively which means that he values of minimum BER decreases and going towards lower zone.

4.3 Link Distance of 300 m and 350 m

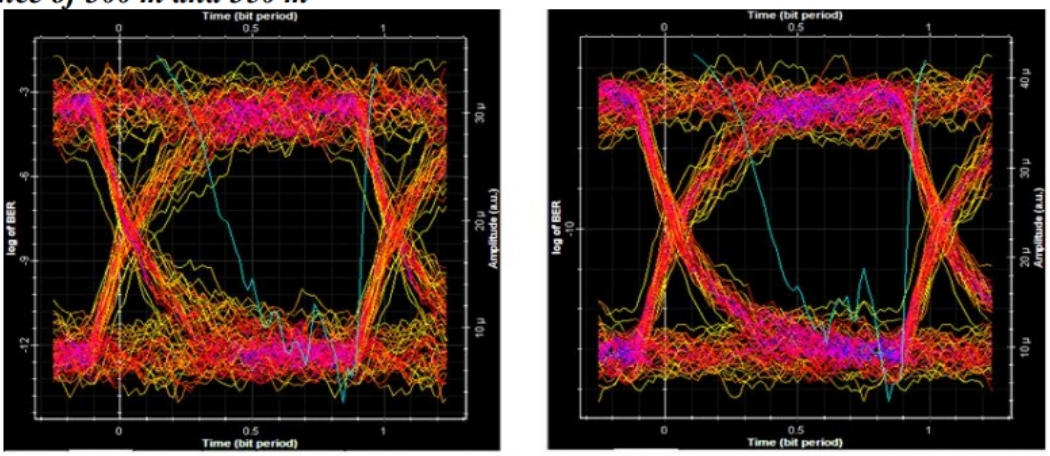

Fig. 4. Representation of Min. BER with the respective Eye Diagram (a) 300 m and (b) 350 m respectively

Link distance of FSO system is further raised due to which optical power of laser is set on 50 dBm and 60 dBm for the respective distances. Attenuation level of attenuator is also increased due to whichresulting minimum BER are 9.32151 × 10-15 and 2.47269 × 10-19 respectively. Randomness in the signal of eye diagram decreases in 350 m link distance which means that it contains less noise than the previous cases due to the use of highly powered coherent laser beam. However, practically it is not possible to use such a high power laser in an open environment due to the safety issues. Eye opening is still present but the values of minimum BER are far lower than the standard value. Whenever the value of optical laser moves towards higher side, minimum BER goes towards the lower side under normal atmospheric conditions. Practically the value of BER lies in between 10-9to 10-12. Hence, to cover large distance, there is a need to find out the substitute of high power laser output and lower the value of BER. After that, an optimized version of FSO link is achievable.

CONCLUSIONS

Link distance play a major role during the design process of hardware. These results benefit us to check the feasibility of channel link. In this simulation, minimum BER with respect to link distance of FSO system have been thoroughly examined. So, in future there is a need to design a spatial FSO link that is highly optimized regarding receiver aperture dimension and its transmitter beam width, arisingaperture averaging effect, link range, awareness of Channel State Information and weather circumstances. Eye diagram also analysed, so the visibility level estimates the threshold points. Also, analysis of eye diagram with respect to distance is achieved. These readings would play a major role during the implantation of hardware dealing with live conditions.

REFERENCES

[1] 1.Deva K Borah, Anthony C Boucouvalas, Christopher C Davis, Steve Hranilovic and Konstantinos Yiannopoulos, "A Review of Communication-Oriented Optical Wireless Systems", EURASIP Journal on Wireless Communications and Networking, Vol. 91, No.1, April 2012.

[2] Mohammad Ali Khalighi and MuratUysal, "Survey on Free Space Optical Communication: A Communication Theory Perspective", IEEE Communication Surveys & Tutorials, Vol. 16, No. 4, Fourth Quarter 2014.

[3] Mircea Hulea, Zabih Ghassemlooy, Sujan Rajbhandari and Xuan Tang, "Compensating for Optical Beam Scattering and Wandering in FSO Communications", Journal of Lightwave Technology, Vol. 32, No. 7, April 1, 2014.

[4] Dhaval Shah and Dilip Kumar Kothari, "Optimization of 2.5 Gbps WDM-FSO link range under different rain conditions in Ahmedabad", Annual IEEE India Conference (INDICON), 2014.

[5] Ke Wang, Ampalavanapillai Nirmalathas, Christina Lim, Efstratios Skafi das and Kamal Alameh, "High-Speed Reconfigurable Free-Space Card-to-Card Optical Intrconnects", IEEE Photonics Journal, Volume 4, No. 5, October 2012.

[6] Alexander Soibel, Malcolm W. Wright, William H. Farr, Sam A. Keo, Cory J. Hill, Rui Q. Yang, and H. C. Liu, "Midinfrared Interband Cascade Laser for Free SpaceOptical Communication", IEEE Photonics Technology Letters, Vol. 22, No. 2, January 15, 2010.

[7] C. W. Chow, C. H. Yeh,Y. F. Liu and P. Y. Huang, "Mitigation of Optical Background Noise in Light-Emitting Diode (LED) Optical Wireless Communication Systems", IEEE Photonics Journal, Volume 5, Number 1, February 2013.

[8] S. Mohammad Navidpour, Murat Uysal and Mohsen Kavehrad, "BER Performance of Free-Space Optical Transmission with Spatial Diversity", IEEE Transactions on Wireless Communications, Vol. 6, No. 8, August 2007.

[9] Hassan Moradi, Maryam Falahpour, Hazem H. Refai, Peter G. LoPresti and Mohammed Atiquzzaman, "BER Analysis of Optical Wireless Signals through Lognormal Fading Channels with Perfect CSI", 17th International Conference on Telecommunications, 2010.

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