Exploring Potential of indoor ir optical wireless communication for 4th generation hetrogeneous networks

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Abstract—
Infrared communications were mainly studied during 1960's as an alternative for mobile radio communications. But, no real system for indoor coverage using infrared links was seriously considered. Recently, infrared has gained ground with operators seeking to cover area that require high bit rate services such as the office areas. Serious work on indoor optical wireless systems started during early 90's. At present it is a very rapidly developing research are and there is huge interest and commitment in this area by major communication industries due to its enormous commercial applications. In order to correctly and reticently deploy a communication system, the system designer must have a sound knowledge of the channel. This can be done through experimentation and modeling with methods that are accurate enough for all significant channel characteristics. This thesis deals mainly with the study of measurement and modeling in indoor diffused optical wireless systems. In this paper, we explain the experimental characterization of indoor infrared channels that use intensity modulation with direct detection. The measurement set up consists of an optical transmitter with an infrared LASER and an optical receiver with a Avalanche photodiode. The frequency response is plotted for different receiver locations without changing the transmitter location. From this we compute the channel's frequency response. *The measurement was to prove the practical feasibility of a high bandwidth system for next generation networks or 4G networks.*

Index Terms: Indoor infrared wireless communications, local area networks, Optical wireless, wireless communication

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1. INTRODUCTION

A Reliable communication can be made possible by the design of efficient transceivers, which in turn depends on the designer's knowledge on the propagation properties at infrared frequencies. Any change in the position and/or orientation of transmitter and/or receiver changes the channel characteristic. Blockage and shadowing also will vary the properties of channel. There will be wide variation in the observed properties if the transmitter or receiver rotates. Effective design of an infrared wireless communication system requires channel measurements under different conditions and optical configurations. These measurements give an idea about the distortions that are encountered in the actual application of these systems. The experimental setup employed for conducting the FSO channel measurements and modelling.

2. EXPERIMENTAL SETUP AND MEASUREMENT PROCEDURE

A indoor diffuse optical wireless link consist of a transmitter, a receiver and a prototype of a typical room with dimensions 30cm×25cm ×30cm. The link consist of two terminals one for transmission and other for reception. Table1summarizes the OW transmitter and receiver elements Components Parameters Values

Table 1 summary of choosen components

COMPONENTS	PARAMETERS	VALUES
Laser	Wavelength Output power	1550nm 2mw
	Beam divergence Beam diameter	2mr 2mm
Avalanche photodiode	Peak wavelength Responsivity Detector area	1550nm 0.75A/W 2 mm2

The modulating signal is obtained from a high frequency Signal generator, which gives a constant amplitude sinusoidal signal, which is then converted to the optical domain using a transmitter. The transmitter has an infrared Laser Diode and the necessary driver circuits. The electric signal from the signal generator directly modulates the intensity of the light emitted by the Laser. The receiver consists of a avalanche photodiode and an amplifying stage for achieving good signal to noise ratio of the measured signal. The received signal is viewed on spectrum analyzer.

The experimental set up is shown in Fig1 and Figure1(b) shows vertical profile of the setup (diffuse infrared indoor optical wireless (non directed non line of sight) channel) Tables1 and 2 give the important measurement set up parameters and the position co-ordinates of the different frequency response measurement trials.

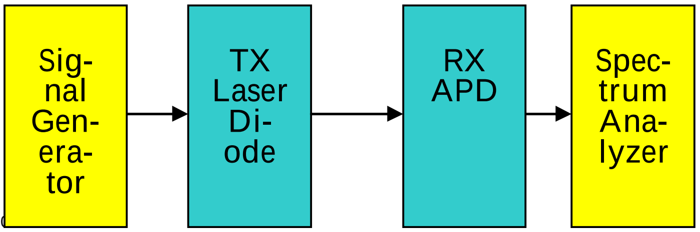

Figure 1(a) Block diagram of measurement setup

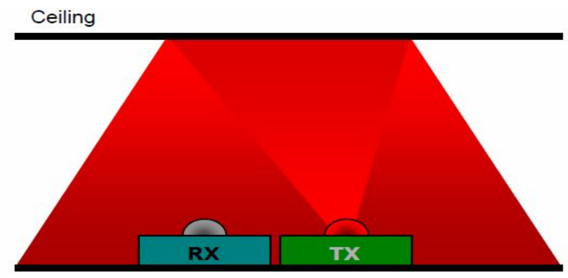

Figure1(b): vertical profile of the setup (diffuse infrared indoor optical wireless (non directed non line of sight) channel)

Table 2Measurement Setup Parameters

Measurement parameters	Values
Operating Wavelength	1550 nm
Frequency Range of Measurement	100 KHz-55MHz
Average Optical Output Power of IR Laser	2mW
Area of the Photodiode	2mm2(Circular)
Responsivity of Photodiode	0.75A/W

Table 3 Position co-ordinates (in cm) for different trials

Transmitter Location	(7,13,05)
Receiver Location(1)	(13,10,0)
Receiver Location(2)	(18,05,0)
Receiver Location(3)	(07,04,0)

3. RESULT AND DISCUSSION

Frequency response is the fundamental characterization of any communication system. For FSO systems, the atmospheric channel, excluding the electronic systems at the transmitter and receiver, is virtually unlimited in bandwidth. Limitations come mainly from the electronic components that build up the transmitter and receiver limiting the useful bandwidth. For the available FSO link, the frequency response should be determined to characterize the IR indoor optical wireless transmitter channel.

The results are based on the frequency profiles collected in the prototype of a room, with transmitter (Tx) remaining at the same position and changing the location of the receiver (Rx). For each location of the Rx, the corresponding frequency response of the Tx-Rx pair is plotted. Figures 2 to 4 represent the magnitude responses for three different locations of the receiver. The frequency plots show a peak response at 250-700 KHz range. For all the plots, this remains the same. But for different plots, the value of the peak is different. This clearly shows that the value of the response depends on the location of the receiver.

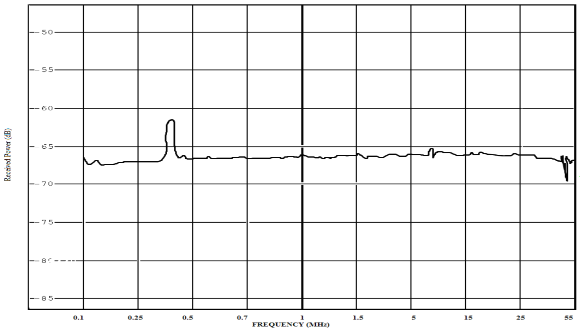

Figure2 Received power at location 1

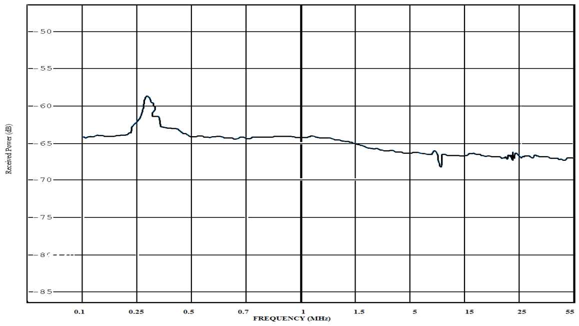

Figure3 Received power at location 2

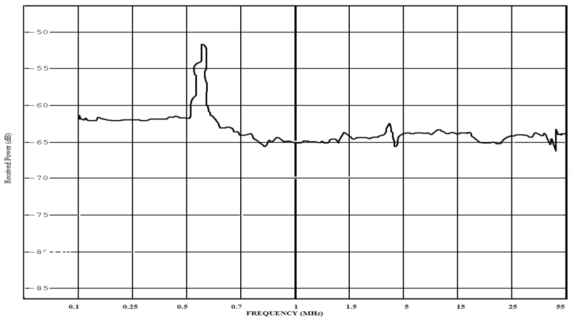

Figure4 Received power at location 3

An attempt is made to all the obstacles so that there are significant shadowing and blockage effects. Shadowing and blockage increase the path loss and thus reduces the response magnitude. The details of channel responses depend on the particular link geometry. However, all responses exhibit a qualitative similarity. There is an initial peak in all responses, which represents the line of sight and significant initial reflections. Later the response magnitude decreases due to the reduction in amplitude of power in the higher order reflections.

4. CONCLUSION

This paper Explore Potential of indoor IR optical wireless communication for 4th generation heterogeneous networks. we developed a hardware system that can achieve IR non directed non LOS optical wireless communication over laser and present measurement procedure for an infrared indoor optical communication link and obtained its frequency-domain characteristics. We have experimentally characterized the frequency response of a diffuse channel. Results show that the magnitude response depends very much on the position of the receiver and the transmitter. To the authors' knowledge, these are the first set of measurements for indoor optical wireless links with diffused configuration and 1550 nm laser for transmission.

It is anticipated that these experimental and theoretical studies will provide enhanced foundations for important new developments in this very rapidly growing area. Future wireless standards offer a good opportunity for the wider adoption of OW. In particular, as 4G networks will be highly heterogeneous, OW based air interfaces can be incorporated to terminals in addition to the conventional RF based ones.

5. FUTURE WORK

The existing setup along with the developed hardware systems are a major step toward the experimental verification of many theoretical results in FSO communication systems. A variety of developed modulation, signalling, and coding techniques are waiting for experimental investigation over a real world FSO link. The implemented buffering system makes such a step straightforward. Research areas such as M-ary OOK and M-ary PPM, nonuniform signalling and capacity-achieving distributions, and coded versus un-coded performance have not been experimentally investigated at the gigabit per second rate.

The developed FSO channel measurement system database can be used to build comprehensive statistical models and empirical formulas that directly relate with the channel statistics and the performance of the communication link.

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