Indirect Detection of Multi -Wave Length for Infrared Wireless Communications In the Room and Public Area Services

S. Sudkaew, J. Sartthong, S. Noppanakeepong and A. Manyanon
Faculty of Engineering and Research Center for Communications and Information Technology (ReCCIT)
King Mongkut's Institute of Technology Ladkrabang, 3 Moo 2 Chalongkrung Rd.
Ladkrabang Bangkok, Thailand 10520
Phone: 66-2737-3000 Ext.3354
e-mail: sunsudkaew22@yahoo.com

Abstract- In this paper, optical multi-wavelength modulation is proposed to reduce the effects of intersymbol interference (ISI) on the artificial light noise and multi path channels. The noise model in the room is the Additive White Gaussian Noise (AWGN), and multi wavelength optical modulation schemes are used for On Off Keying (OOK). An infrareds link in the room or public area services used Intensity Modulation and Direct Detection (IM/DD). The normal room and some interior in this case are used to study the obstruction and the reflex effect to the communications speed rate at 10-100Mbps. Finally each performance of BER per Transmitted light power of Multi-wavelength Infrared system is compared. The carrier characteristic of Multi-wavelength will be improved to be same as RF- carriers on mobiles applications.

Keywords
OOK.IM/DD, ISI, Multi Wavelength.

I. INTRODUCTION

Infrared communications play more importance role than the last time of communication. The computer infrared port, PDAs short distance infrared links of AD HOC network and hand telephone are examples of the application of infrared in the room or public areas as shown in Fig.1.

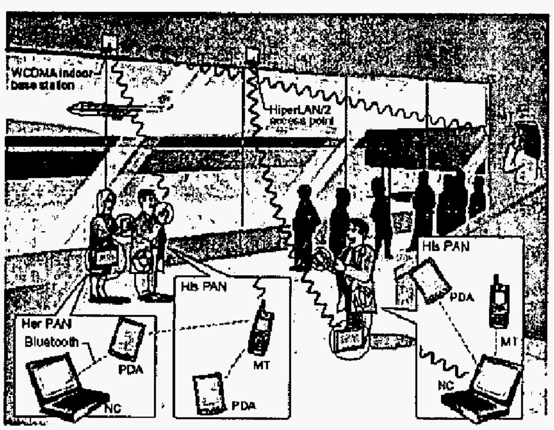

Fig. 1. Infrared links in public area service.

Nowadays the research on infrared light source [LED] in industry product development to high power more and difference wavelength than the last one. The importance rule about the relationship of the links distances and the links performance depend on the transmitted power from infrared light source with the performance of receivers unit and the type of carries modulations. The application of transmitted infrared and received signals in free space looks like the radio carries facility. The advantage of infrared over radio carries is the infrared carries have more bandwidth than radio carries. The wireless infrared links are devided two main categories: Diffuse Link and Line Of Sight (LOS). They are shown in Fig.2,[1-3].

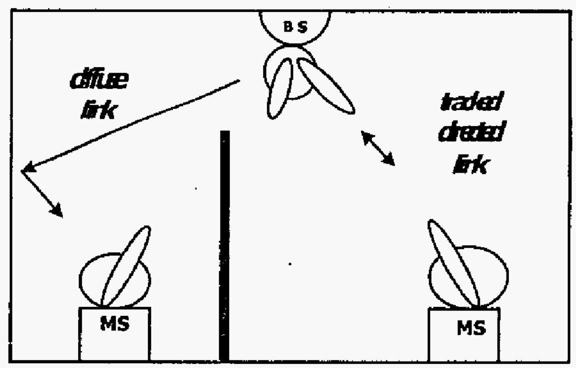

Fig. 2. Two link modes for wireless infrared communication system.

Infrared radiation has properties very similar to visible radiation. Typical surfaces of indoor environments are, in general, good reflectors of infrared radiation (the main exception are dark transparent surfaces). This property has two important consequences. First, infrared radiation can propagate through multiple reflections on the propagation on the environment. Propagation through multiple paths can provoke time dispersion of the received pulses, which is called multipart dispersion. The effects of multipath dispersion are observed as intersymbol interference (ISI). Second, having obstacles between the emitter and the receiver can provoke a significant attenuation of the collected optical power, which is called shadowing. The Infrared Data

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Association (IrDA) was established in 1993 as collaboration between major industrial organizations in order to establish an open standard for IR data communication. The resulting IrDA protocol was aimed to provide a sample, low-cost, reliable means of IR communication between devices such as portable computers, desktop computers, printers, PDAs, Mobiles other peripherals, and LANs using directed point-to-point connectivity. The hardware typically consists of an IR transceiver module contain IR LED with output driver and IR detector and receiver, and encode/decoding circuitry. This can be as a plug-in adapter to the serial port or as a built-in IR port as with many laptop and portable computers. The modulation scheme used return-to- zero (RZ) with On Off Keying (OOK) in 3/16-bit time pulse duration. The Universal Asynchronous Receiver Transceiver (UART) or IR frame is shown in FIG.3, [4-5].

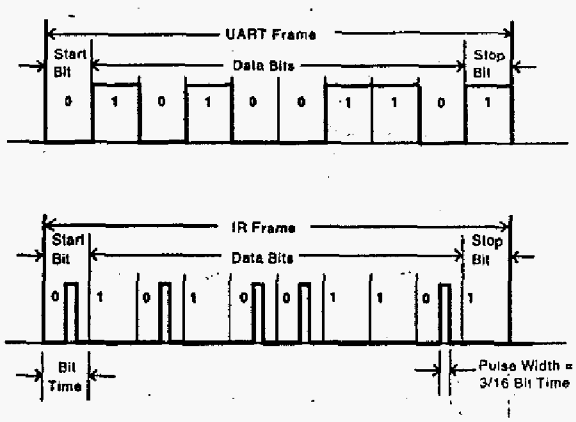

Fig. 3. IrDA data transmission standard.

II. OOK WITH MULTI-WAVE LENGTH

The multi-wave length focuses on OOK signals to up links and down – links for concentrating to combat the artificial light source witch fluorescence lamp with electronics ballast. The mechanical light filter and protected angle of light interfering included in the transmitted and received process of infrared communications is

$$\psi_{UP} = \phi_1 k_F k_{L1}[1 - 0.3\cos(\beta)]\cos[(\frac{\pi}{2} - \theta)/k_{L1}] + N(s) \quad (1)$$

$$\psi_{DOWN} = \phi_2 k_F k_{L2}[1 - 0.3\sin(\beta)]\cos[(\frac{\pi}{2} - \alpha)/k_{L2}] + N(s) \quad (2)$$

N(s) = Artificial noise + Multi path dispersion

ψ = Optical flux density in free space Lux./sr

ϕ_1 = Up-links (λ_1) Ir – interf. flux Lux.

ϕ_2 = Down-links (λ_2) Ir –signal flux Lux.

K_F = Filter co-efficient %

K_{L1} = Density/angle for up-links %

K_{L2} = Density/angle for down-links %

θ = Upper angle rad.

α = Down angle rad.

β = FOV angle rad.

N(s) = Total power light noises Lux.

The equation 1 and 2 show the two multi-wavelength in free space communications which up-links must be near spectrum of light power noise of spectrum environments than down link spectrum because of more difference in wave length or receive signal of down-links and wave length of artificial light from fluorescent lamp with electronic ballast is better to chose be avoid of the detected process to easier and improve the performance of receiving signals. The indirect detection of the transmitted and received procedure is the same as the direct detection (IM/DD) because of the indirect transmitted and received is the process of the Infrared light slip away of obstruction of the object in the room or Infrared profile and in another hand look like the mobiles base station want to distributed the carries beam to coverage any surround which k_F factor of the reflex co-efficient and divided or means of average of transmitted light – power signals and the received of any direction or means the diversity receiving technique to decision the best of the receiving signals (in process of MRC , part select , Equal-Gain) to approved the beast performance of the communications indoor wireless links. The light system models are many kinds in this framework such as the living room; lave room, kitchen, bathroom, office room and service counter of public area or some of open restaurant, the classroom and conference room. The system function or the impulse response of the Infrared signals compose of amplitude and delay time result on the table of Ir-room models to collected about the approximated value of amplitude and delay times each any of possible branch (2-5) of multi-part of room components (3-12) configuration And each branch distances of the room classification to investigate on design problem Infrared network or analysis about the Infrared carries mod selected. The OOK modulation is the simple Infrared carries to send from transmitter to receiver unit Non - LOS or Indirect detection by Perfect reflected co-efficient, the part distances indirect detection the bit-error rate a control by power of the transmitted and the FOV Angle in 3-branch of diversity receiving unit which constant receiving sensitivity R indirect profile and The resultants are difference on an amplitude and Delay times and static or constant environment. This concept is shown the separated framework between noise reductions and the modulations process because Of the modulations is the procedure between noise reductions and the modulations process because of the modulations is the procedure of channel capacity or The speed rate on the accuracy acceptance in BER and noise floor limited.

III. THE MULTI BEAM INDIRECT TRANSMITTION MODEL

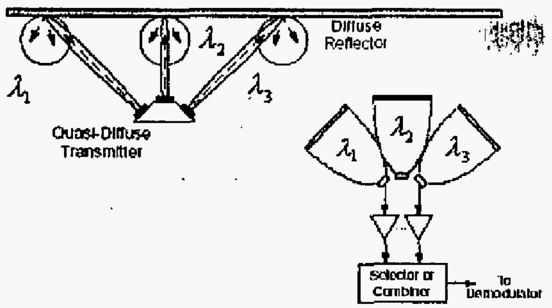

Fig. 4. System model with multi-wave length

A. The Transmission Units

In Fig.4, the transmitted units look like the mobile base station to transmitted and distribute the Infrared power signals to cover the service target area which slip way the obstruction object profile by multidirectional of transmitted.

$$P_e = [K_e \sum_{I=1}^{K=3} K_F \sum_{M=1}^{N=9} P_I] \qquad (3)$$

P_e = Total power of transmitted of each links (mw)

P_I = Total power of each LED (mW)

K_e = Link efficiency (%)

K_F = Power requirement factor of each Links, 0.2 - 5 (Beam /multi beam) (%)

I.K = the branch of directional links, 1-3

M,N = the number of LED - Infrared light Source which used for produce Infrared intensity, 1 – 9 /unit

B. The Receiving Units

The indirection receivers signals of multi-direction are received by diversity receive units. The communication signals compose with multipath dispersion signal form any direction depend on room configuration and power light noise from fluorescence lamp which driven by electronic ballast.

$$R_{UP} = \left[\sum_{I=1}^{k=3} \left(\psi_{UP} k_{LI} k_F \left(1 - 0.3\cos(\theta_I / k_{LI})\right) + \psi'_{DOWN} k'_{DOWN} + N_I k_I \right) \right] + N_W \qquad (4)$$

$$R_{DOWN} = \left[\sum_{I=1}^{k=3} \left(\psi_{DOWN} k_{LI} k_F \left(1 - 0.3\cos(\theta_I / k_{LI})\right) + \psi'_{UP} k'_{UP} + N_I k_I \right) \right] + N_W \qquad (5)$$

$$R_{UP} = \left[\sum_{I=1}^{k=3} \left(\psi_{UP} k_{LI} k_F \left(1 - 0.3\cos(\theta_I / k_{LI})\right) \right) + N_I k_I \right] + N_W \qquad (6)$$

$$R_{DOWN} = \left[\sum_{I=1}^{k=3} \left(\psi_{DOWN} k_{LI} k_F \left(1 - 0.3\cos(\theta_I / k_{LI})\right) \right) + N_I k_I \right] + N_W \qquad (7)$$

R_{UP} = Up-links signals power mW

R_{DOWN} = Down- links signals power mW

ψ_{UP} = Up-link flux density each I branch at the receiver

ψ_{DOWN} = Down-link flux density each I branch at the receiver

k_I = Receiver cover filter factor %

θ = Received power signals angle rad.

I, k = Diversity branch of receiver, 1-5

L, N = Multi-part dispersion components, 1-5

ϕ_L = Multi-path dispersion fluxes each component Lux.

N_T = Total power light noise mW.

α = Received angle rad.

N_W = Additive White Gaussian Noise mW.

C. Receiver Noise Model

The rooms channel models are natural response about the room and room components index reflex which the size of room and room components and transceiver total noise equal thermal noise added AWGN. It is given by

$$N(t) = N_{SYSTEM} + N_W(t) \qquad (8)$$

Each noise has individual path the receiver noise of each branch of diversity branch is call 'pre-Amp noise' Received noise = shot noise + Thermal noise

$$\sigma^2_{total} = [2q\, RP_n\, I_2\, R_b]^2 + Thermal\ Noise(k) \qquad (9)$$

In single channel multi beam Ir/multi path on Line Of Sight (LOS) and Non Line Of Sight (Diffuse) normal case.

$$Y(t) = \sum_{i=1}^{n=3-5} RX_i(t) \otimes h_i(t) + N_i(t) \qquad (10)$$

Multi channels of multi beams are received by diversity technique. By the diversity receive signal equals multi part dispersion added light interference noise.

$$Y_i(t) = [RX_i(t) \otimes h_i(t) + N_i(t)] + K_{FOV} \sum_{i-1}^{i+1} Y_I(t) + N_i(t) +$$

$$K^{i}_{FOV} N_{PL} \quad (11)$$

Diversity receiver with FOV + light filter cover + Ac. ≥ 500 KHz High pass filter

$$Y_i(t) = [RX_i(t) \otimes h_i'(t) + N_i(t)] + K_{FOV} \sum_{i-1}^{i+1} Y_i(t) + N_i(t) \quad (12)$$

The indirect system light interference has the different path of the signal profile. The any path are had individual path. The multi wavelength transceiver and receiver create up/down links are detected through pass the light filter cover K_λ to reduce self interfering signals of multi beam case.

$$SNR = (RP)^2 / \sigma^2_{total} \quad (13)$$

$$BER = \bar{Q}(\sqrt{SNR}) \quad (14)$$

$$Q(X) = \frac{1}{\sqrt{2\pi}} \int_{x}^{\infty} e^{-y^2/2} dy \quad (15)$$

The SNR and Bit Error Rate (BER) for OOK signals can be follow the equation 13-15.

IV. MULTI WAVE LEGTH MODEL

We interested in the room size with high for power of Transmitted and the kind of beam service configuration by type of room in OOK modulation. Fig.1 shown the living room by ceiling cover beam by single/double/triple beam which 80^o/2x80^o/ 3x80^o of ceiling transceiver and single receiver 10^o, 30^o FOV by R = 0.62 A/W, λ = 850 nm. A10/100 Mbps. The each type of room parameter from [1-3] can through pass the light filter cover K_λ to reduce self-interfering signals of multi beam case.

λ_1 = 850 nm has speed rate 10-100 Mbps Tx/Rx simplex / haft duplex Mode

λ_2 = 970 nm has speed rate 0.1-0.8 Mbps

10-100 / 0.1-0.8 Mbps

Or used λ_2 for sych-frame pilot /start bit preamble

Room factor and classification: living room, class Room, office room and public area. All of Ir carrier can be Classification Ir to the services carrier follows as.

1. Short links and low speed data rate: LOS Horizontal communications.

2. Vertical slide angle ceiling or wall reflex / Select path communications. Short range 2-4 m/ LOS and non-LOS: high speed rate 10-100 Mbps simplex/haft duplex communications.

3. Multi beam distribution channel by multi spot vertical down links/simplex. CDMA / TDMA / IEEE 802.11 single carrier multi wavelength carrier. The living room is two kinds of Ir links vertical for cordless telephone and horizontal for electrical devices Remote control. The classroom and office room are the same living room but more complex and number of links than the living room by Ir short links, which network

SYSTEM MODEL OOK

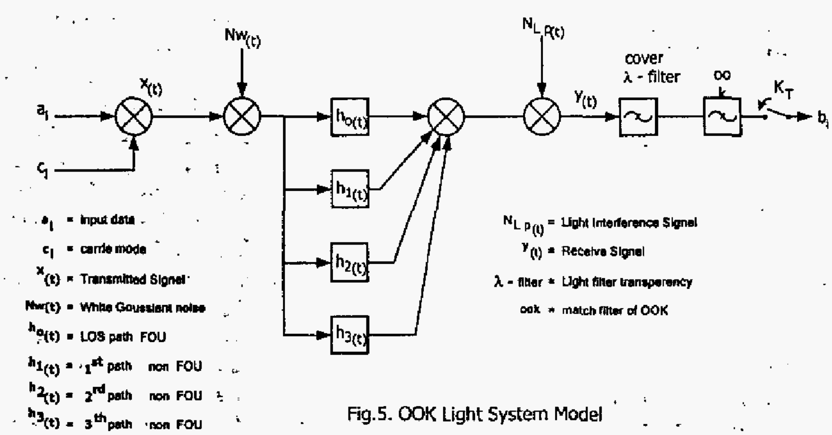

Fig.5. OOK Light System Model

V. SIMULATION RESULTS

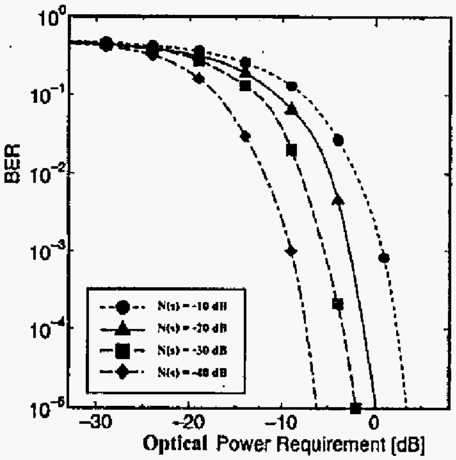

Fig.6. The power optical requirement under power light noise at each level of background noise of simplex or one way communications in room model 4X4X3 meter of LOS system.

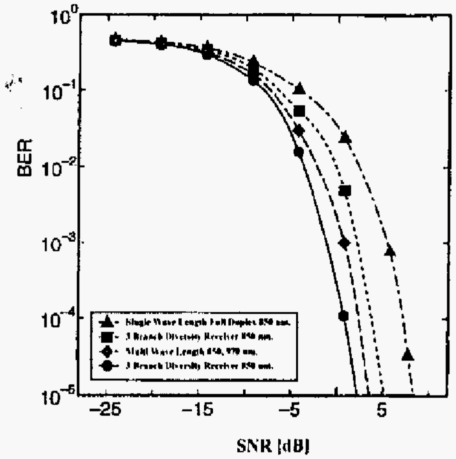

Fig.7. The power optical requirement under power light noise at -20 dB of background noise of simplex multi wave length diffuse transmitted in room model 4X4X3 meter .

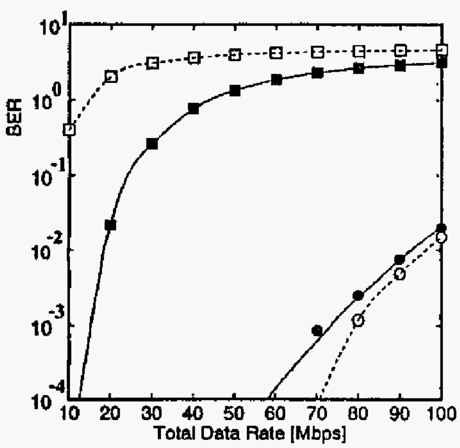

Fig.8. Link Budget of short wave length < 30 nm and long wave length > 950 nm of infrared links at any Data speed rate.

VI. CONCLUSIONS

This paper has discussed considerations for wireless indirect detection of multi wave length from diffuse infrared transmitted source and receive by diversity receiver unit at speeds range of 10-100 Mb/s. The analysis and simulation on OOK signal which nearly to the electrical signal model are carried out in order to improve the infrared wireless links so that it can replace the RF signals.

The detail of Ir -base transceiver and receiver /multi-beam-diversity /up-links and down-links spectrums for light Interference combat/multi-part dispersion Indirect Transmitted scheme / Ir power/sr/m and kf -factor with room classification Diversity receiver channel with wave-length filter cover with DEF receiver System model and analysis BER 1E-6 /10-100Mbps.

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