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Study & Implementation of ANN based Optical Wireless System: A Review

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ABSTRACT: This paper reviews on optical wireless system using wavelets and neural network. High-speed wireless optical communication links have become more popular for personal mobile applications. This is a consequence of the increasing demand from the personal information service boom. Compared to the radio frequency domain, optical wireless communication offers much higher speeds and bit rates per unit power consumption. This work presents the use of wavelet transform and artificial neural network as elements of optical wireless communication receiver. The main objective is to minimize the error on receiver side. Indoor wireless links usually have to operate in presence of noise generated by light sources. In this, adaptive modulation technique will be used. The performance of this system is analysed based on BER value.

KEYWORDS: Artificial neural network (ANN), optical wireless communication (OWC), wavelet transform, survey papers.

I. INTRODUCTION

Communication is one of the important aspects of Life. Previously various methods like sign languages were used for this purpose. With the advancement in age and its growing demands, there has been rapid growth in the field of communications. By the turn of 19Th century, a great leap in the field of communication was observed. Signals, which were initially sent in analog domain, are being sent more and more in digital domain now Today's society is becoming increasingly dependent on wireless connectivity with continuously converging technologies. The increasing demand for bandwidth had driven researchers to explore new technologies to accommodate more data throughput over the decades.

Optical wireless communication attracted considerable attention from the academic community. Starting from short distances and low speed experimental links, the optical wireless communication domain became a viable addition to communication systems, and showed promising prospects. Optical and wireless access networks were originally developed for different communication scenarios. Optical networks aim to provide long distance, high -bandwidth communications while wireless networks aim to provide ubiquitous, flexible communications mainly in community areas. Various kinds of optical and wireless access network architectures have been proposed and deployed as solutions for access networks separately Optical wireless communication (OWC) is an alternative solution that provides safety for healthcare system.

Optical wireless is safe for electro medical devices and is proposed to be employed for healthcare services. For wearable health monitoring, optical sensor technologies are being investigated. Furthermore, optical wireless communication provides some advantages such as high speed data rate, ease of instalment low cost front ends, license free operation, and high security.

The free space optical wireless link mainly been applied in short range and inter building data connections complementary to existing RF networks. Although challenged by several competitive RF bands, including the industrial, scientific and medical (ISM) radio bands, and the local multipoint distribution service (LMDS) bands, optical wireless showed the promising features of higher data throughput and immunity to the interference usually suffered by RF systems. The origin of optical wireless communication can be traced back to ancient times when fire

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beacons were used to transmit simple message over long distances. It was the pioneering research work done by F.R. Gfeller and U. Bapst in 1979 that inspired the technical community to explore further the potential of the indoor optical wireless communication.

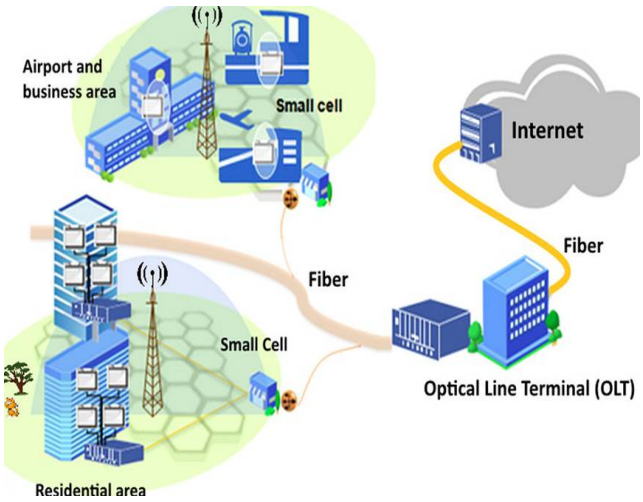

Figure 1: An Optical Wireless System [1]

In comparison to RF, optical wireless communication enjoyed benefits such as: lower implementation cost, higher security, unregulated spectrum and operational safety. On the other hand, the channel can be severely interfered with by background noise: shot noise induced by the background ambient light (radiation from the sun if the system operated near a window or outside) and the interference induced by artificial light sources. IR systems can suffer from multipath distortion (in a diffuse system). Despite of its good attributes that an optical wireless system has as one of the higher speed wireless system, although it is weather dependent as well. In temperate region fog and snow are the limiting factors in this regard. In tropical region, however, rain and haze are other factors limiting FOS performance

II. RELATED WORK

Hao Du et. al. [1] provides the in-depth discussion and analysis on the design and performance of MIMO system based on a 2×2 infrared OOK modulation and regulated at 100 kHz, 1 MHz and 10 MHz bandwidth. This described the advantages of an OOK based infrared MIMO system through evaluating the BER performance, and making comparisons of the SISO system, the diversity and multiplexing gain processes. It can be concluded that further research shall be conducted on infrared MIMO technology applications in association with issues concerning interference and background lighting.SujanRajbhandariet. al. [2] presented the investigation of the DWT-ANN-based receiver for baseband modulation techniques including OOK, pulse position modulation, and digital pulse interval modulation. The proposed system was implemented using digital signal processing board and results were verified by comparison with simulation data. The multipath-induced intersymbol interference (ISI) and fluorescent light interference (FLI) were the two most important system impairments that affected the performance of indoor optical wireless communication systems.Steven De Lausnayet. al. [3] described the use of optical Code Division Multiple Access (CDMA) codes for an indoor localization system using Visible Light Communication. VLC used Intensity Modulation and Direct Detection (IM/DD) so the CDMA codes can be used as baseband signals which made the driving electronics less complex. There were two groups of Optical CDMA codes namely uni- and bi- polar. When bipolar codes were used, the receiver should be equipped with an appropriated High Pass Filter (HPF). The results showed that there was no large difference in cross- correlation between the codes but bipolar codes can reduce the distance error and so the position error even when there was static surrounding light like e.g. sunlight.Jiang Liu et. al. [4] addressed the indoor propagation channel model which takes multiple reflecting surfaces into account was addressed. Theoretical analysis of the pulse response of direct light and reflected light was given. Bit error rate (BER) of this system was analyzed considering reflected light, background light, avalanche photo-diode (APD) noise, thermal

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noise, and multi-user interference. The results proved that the BER of the system was influenced by the reflected light and the effect of reflected light is related to the room size and receiver position. With the increase of user number, the effect of reflected light becomes stronger and it is a significant source of inter-symbol interference.
WasineeNoonpakdeeet. al. [5] presented an indoor optical wireless communications using adaptive wireless optical transmission scheme for health monitoring system. Since radio frequency (RF) networks can present electromagnetic disturbances with medical devices, an alternative system based on infrared (IR) technology was studied. In this scheme, optical wireless communication was proposed to transmit the obtained measurements from sensors to a central node and a medical center using intensity modulation-direct detection (IM/DD) with on-off-keying (OOK) modulation. An image sensor was utilized as a receiver, and the signal to noise ratio (SNR) at the image sensor was analyzed with consideration of the half power angle of the optical source, the transmitted power, data rate, and the patient's location.
Georgia Ntogariet. al. [6] investigated the performance of diffuse optical wireless systems, employing Space Time Block Coding (STBC) techniques. Discrete Multi-tone modulation (DMT) was used to mitigate the effect of inter-symbol interference due to the channel's impulse response. The performance of STBC systems, employing two transmit elements, was compared against Single Input/ Single Output (SISO) and Maximum Ratio Combining (MRC) systems operating with the same total optical transmitter power. It was shown that STBC techniques can be used to increase the capacity of diffuse optical wireless systems, improve their coverage and decrease the required optical power at the transmitter.JariyaPantaet. al. [7] proposed partial pre-equalization for indoor optical wireless transmissions based on asymmetrically clipped optical orthogonal frequency division multiplexing (ACO-OFDM) with intensity modulation and direct detection (IM/DD). Bit loading was applied to minimize the transmit optical power for a fixed target BER. Similar to pre-equalization, for diffuse indoor optical wireless channels, partial pre-equalization can reduce the transmit optical power over post-equalization for point-to-point transmissions. In addition, they considered broadcast transmissions to multiple users with possibly different channel qualities, where pre-equalization was not applicable.PoompatSaengudomlertet. al. [8] analyzed the performances of indoor optical wireless data transmissions based on uni-polar orthogonal frequency division multiplexing (OFDM). In particular, it is shown that using frequency-domain pre-equalization can provide benefits in terms of the reduction in the required optical transmit power for a given desired bit error rate (BER) from un-coded transmissions. Known for its power efficiency, asymmetrically clipped optical OFDM (ACO-OFDM) is considered as a uni-polar modulation scheme for intensity modulation with direct detection (IM/DD). In addition, flip-OFDM is also considered as an alternative uni-polar modulation scheme which is known to be as power efficient as ACO-OFDM.Suriza Ahmad Zabidiet. al. [9] proposed specific rain attenuation parameter that best fit tropical region using measured data in tropical region for optical wireless system. Other features of optical wireless system were higher speed, low cost and time of deployment and broader broadband technology. However, the availability of optical wireless transmission was very much weather dependent. In temperate region fog and snow were the two restrictive of the link propagation availability. In tropical region however heavy rain was expected to be the limiting factor of optical wireless link availability. The effect of rain on optical wireless link was expressed in term of specific rain attenuation.Zeyu Zheng et. al. [10] aimed to study the network throughput gain in FiWi network subject to peer-to-peer communications and parameters which can affect the network throughput gain. They first have a fair modeling of FiWi networks and traditional WMNs. They then presented an LP based routing algorithm for FiWi networks. Extensive simulations had been carried to study the network throughput gain in FiWi networks subject to peer-to-peer communications compared with traditional WMNs.

III. INDOOR OPTICAL WIRELESS COMMUNICATION NETWORK SYSTEMS

1. Modulation for Optical Wireless Communication

The optical channel is quite different from the conventional RF channel. This consequently resulted in a different approach when it came to the modulation design. Modulation schemes which fit well in electromagnetic channels were not necessarily perform well in the optical domain. Modulation techniques remained an active topics amongst both academic researchers and industrial communication system engineers. Depending on the nature of the information source, modulation can be summarized as analogue or digital formats.

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1.1 On-Off-Keying (OOK)

The OOK modulation scheme was one of the simplest modulation techniques. It was commonly used because of its easy implementation. By default, the OOK modulation refers to the Non Return to Zero (NRZ) OOK, and this is different from the Return to Zero (RZ) OOK modulation by a fraction of γ, where $\gamma \in (0,1]$.

1.2 Pulse Amplitude Modulation (PAM)

The PAM modulation technique belonged to pulse amplitude level modulation scheme. Consider L-level PAM (L-PAM), That is, one of L possible amplitude levels transmitted from the transmitter to represent a specific value.

1.3 Pulse Position Modulation (PPM)

In PPM, transmitted optical signals were represented by the location of the pulse within a clock cycle. As a result, synchronization between transmitter and receiver was required or assumed when comparing PPM schemes with other schemes. In addition, the PPM modulation scheme was also regarded as particular version of an L-position PPM (L-PPM) system.

2. Bit error rate and ISI

It's a narrowband technology that uses multiple transmits and receives antennas. If H is the channel matrix then we have Y = Hx + n (1) The number of independent channels that a signal travels from the sender to the receiver is called as the diversity gain. The proper operation of MIMO systems requires careful design, with the encoded signals received from each transmitting antenna and the multiple communication channels achieving specified orthogonality conditions. The better combination of number of transmitting and receiving antenna for MIMO systems in BPSK modulation technique that satisfy the good SNR is to be investigated primarily. The following multi-antenna MIMO communication system consist of n transmit antenna and m receive antenna, and in some case with a slowly time-varying channel. Due to the wireless nature of the system, each receive antenna receive transmission from all transmitter.

By slowly time-varying, we assume the channel remain constant over a block of data consists of N symbols.

$$P_e = \frac{1}{2}\text{erfc}\left[\sqrt{\frac{E}{No}}\right]^*$$

Where E is the energy signal, the value of the bit error increase as the energy increases, the value of complementary error function erfc decreases and the value of bit error reduce.

Bit error rate The measure of performance of any communication system is usually bit error rate (BER).Bit Error Rate is given as follows BER= Errors/Total Number of Bits With a strong signal and an unperturbed signal path, this number so small as to be insignificant. It becomes significant when we want to maintain an adequate signal-to-noise ratio in the presence of inadequate transmission through electronic circuitry and the medium for propagation.

3. Artificial Neural Network Adaptive Equalizer

Fundamentally, the problem of adaptive equalization can be formulated as a classification problem and modern classifying tools like ANN can be utilised. ANN is more suitable for channel equalization because of highly parallel structure, adaptability and learning capability. Since there is no need for channel inversion then ANN equalization can be implemented in any channel. The functional unit of ANN is a neuron. A neuron cannot perform a complicated task on its own, but when combined and interconnected in some predefined manner, the composed ANN create a powerful tool for difficult tasks including nonlinear signal processing, adaptive learning, solution of nonlinear equations to name a few. Haykin has pointed out the rationale behind using ANNs instead of the traditional signal processing tools, the most importantly being the nonlinearity, universal approximation, adaptability to change its free parameter based on the environmental changes.

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IV. PROPOSED SYSTEM

That paper is about indoor optical wireless systems, in that paper the data stream is used that will get first modulated and then get demodulated as in the all cases. The different types of errors are getting introduced in the system which are ISI, artificial light interference and Bit error. The ISI caused by multipath propagation and artificial light interference from fluorescent lamp driven by electronic blast are two major interferences, and these need to be taken into account when validating modulation schemes. The main challenge faced by this work is to seek the most optimized modulation scheme that can provide maximum system throughput while capable of withstanding most if not all of the intense channel interferences at a target BER requirement. Bandwidth efficient schemes such as the OOK and PPM are prone to artificial lighting interferences. This led to a natural conclusion of a modulation scheme that can combine benefits from both above candidates and able to avoid the drawbacks of each individual scheme. So, in this work, ANN-based receiver for baseband modulation techniques including OOK, pulse position modulation (PPM) is proposed.

V. CONCLUSION AND FUTURE WORK

This work presents the review on an optical wireless system that will include the wavelet and ANN at receiver side. Optical wireless communication is become an attractive alternate technology to optical fiber and RF communications for certain applications such as the last mile access in the indoor systems. This work presents the use of indoor optical wireless systems, which can meet the need of different applications. With the help of wavelets and ANN based receivers the different type of problems comes in that system are get reduced. The ANN network is used for the minimization of error and the wavelets are used for better receiver response. With the help of this, it may prove the better stability of system.

REFERENCES

1. HaoDu, Roger Green, 'Optical Wireless 2x2 Indoor MIMO System Based on OOK Modulation', IEEE ,2013.
2. SujanRajbhandari, ZabihGhassemlooy, 'Wavelet—Artificial Neural Network Receiver forIndoorOptical Wireless Communications', IEEE Journal of Lightwave Technology, Vol. 29, No. 17, September 1, 2011.
3. Steven De Lausnay, Lieven De Strycker, 'Optical CDMA Codes for an Indoor LocalizationSystem using VLC', IEEE 3rd International Workshop in Optical Wireless Communications, 2014.
4. Jiang LIU, Wasinee NOONPAKDEE, 'Evaluation of Reflected Light Effect for IndoorWireless Optical CDMA System', IEEE WCNC, 2011.
5. Wasinee NOONPAKDEE, 'Adaptive Wireless Optical Transmission Scheme for Health Monitoring System', IEEE Third International Conference on Consumer Electronics, 2013.
6. Georgia Ntogari, Thomas Kamalakis, 'Performance Analysis of Space Time Block CodingTechniques for Indoor Optical Wireless Systems', IEEE Journal On Selected Areas In Communications, Vol. 27, No.9, December 2009.
7. JariyaPanta, PoompatSaengudomlert, 'Performance Analysis of Partial Pre-Equalization forACO-OFDM Indoor Optical Wireless Transmissions', 9th International Symposium on Communication Systems, Networks & Digital Sign, 2014.
8. PoompatSaengudomlert, 'On the Benefits of Pre-Equalization for ACO-OFDMand Flip-OFDM Indoor Wireless OpticalTransmissions Over Dispersive Channels', IEEE Journal of Lightwave Technology, Vol. 32, No. 1, January 1, 2014.
9. SurizaAhmad Zabidi, Islam MdRafiqul, 'Rain Attenuation Prediction of Optical Wireless System in Tropical Region', IEEE International Conference on Smart Instrumentation, Measurement and Applications, 2013.
10. Zeyu Zheng, JianpingWang,'A Study of Network Throughput Gain inOptical-Wireless (FiWi) Networks Subject toPeer-to-Peer Communications', IEEE Communications Society, 2009.