SCHOOL OF COMPUTING & ENGINEERING

TECHNOLOGY DEPARTMENT

AN INVESTIGATION OF DICODE PPM PERFORMANCE OVER OPTICAL WIRELESS CHANNEL VIA DIFFUSE LINK

Adel M. Buhafa and Dr M. Sibley

University of HUDDERSFIELD

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Abstract

Optical wireless communication via diffuse link is a promising solution for increasing the available communication bandwidth within a room. By using suitable modulation technique, this technology can offer very high-speed data rat. The thesis presents an optical DiPPM system over a diffuse propagation, using ceiling bounce model, for the design of indoor optical wireless channel. Mathematical analysis is developed for this model. The system operating at PCM bit rate of 100Mb/s at a normalised bandwidth of 10 with zero guard and employing a variable bandwidth PIN-BJT receiver cascade with a third-order Butterworth filter. In this thesis the performance analysis of the optical DiPPM is extended in order to include the effects of intersymbol interference (ISI) and some important errors: wrong slot, erasure and false alarm. Maximum likelihood sequence detection (MLSD) is presented to reduce the error probability and increase the receiver sensitivity. Also, the variation in the bandwidth of preamplifier and a third-order Butterworth filters are considered in terms of optimising the system performance in comparison of the relative values of DiPPM and a similarly performing digital PPM system.

Keywords: *DiPPM, Optical Wireless, Diffuse Link, ISI, Error Probability and MLSD*

Aim & Objectives

It is the purpose of this project to investigate and analysis the performance of DiPPM modulation technique, as a novel coding scheme, applied over an indoor optical wireless via diffuse link using a ceiling bounce model (for the first time) and optimising the system performance in comparison of the relative values of DiPPM and a similarly performance of digital PPM system..

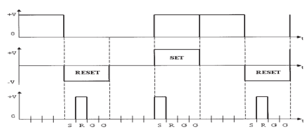
➢ **Main Objectives:**

The specified objectives of the first annual progression report are:

- ➢ Understand general knowledge of indoor optical wireless system and DiPPM technique.
- ➢ Investigate DiPPM scheme over dispersive optical channel using ceiling bounce model.
- ➢ Develop a system mathematical model for this investigation.
- ➢ Analyse a DiPPM system through the use of mathematical models
- ➢ Illustrate received pulse shape and its slope using MathCAD.

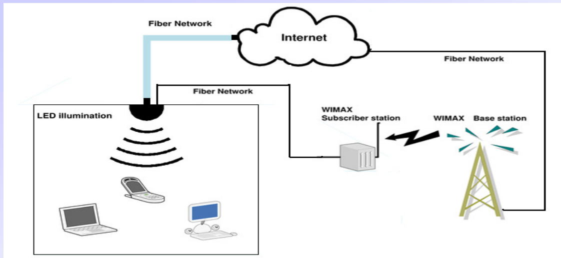
DiPPM Coding Scheme

❑ DiPPM is a very attractive simple coding scheme for coding and implementation. There are four slots used to transmit one bit of PCM. In dicode technique, when the data transitions from logic zero to logic one are coded by positive (+V) and transitions from logic one to logic zero are coded by (–V) and if there is no change in the PCM signal zero pulse is present. However, in DiPPM, as shown in Fig.3.1, two signals SET and RESET are converted into two pulse positions in data frames. If no data transition is present, there is no pulse, while if transitions occur from zero to one or one to zero; there are SET(S) and RESET(R), respectively. If the PCM data is constant, no signal transmitted.

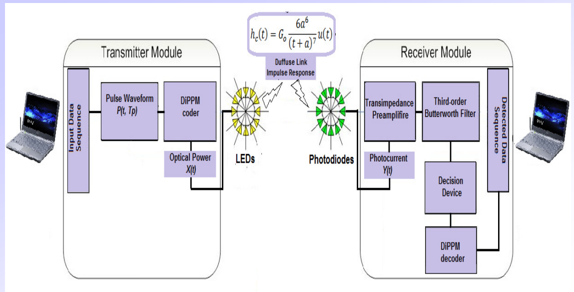


Possible Future of Wireless Networks

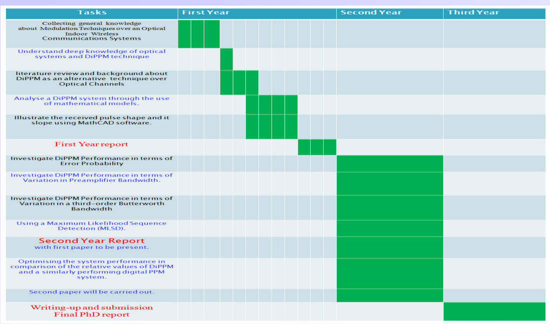
➢High Data Rate Large bandwidth ➢High Security



DiPPM over Indoor Optical Wireless Channel via Diffuse Link



PhD Research Gantt-Chart



DiPPM Errors

❖ As with digital PPM, DiPPM system suffers from three types of errors, wrong -slot, erasure and false -alarm:

- ***Wrong-Slot Errors:*** These types of errors occur while the noise presents on the rising edge of a detected pulse, the pulse appears in adjacent time slots, before or after the rent slot.

$$P_{ewsRG} = 3.\sum_{x=0}^{n-1}\left(\frac{1}{2}\right)^{x+3} P_s(x+1) + \left(\frac{1}{2}\right)^{x+2} P_s(n+1)$$

- ***Erasure Errors:*** An erasure error occurs when the noise level is larger than the pulse signal and reduces the peak signal voltage below the threshold level, thus giving incorrect detection.

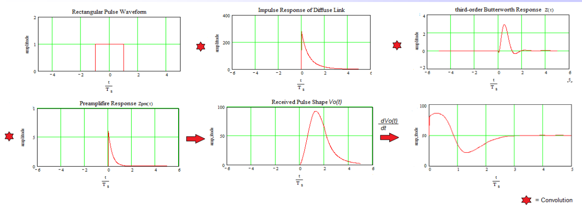
$$P_{erDiPPM} = 2.\left(\sum_{x=0}^{n-1}\left(\frac{1}{2}\right)^{x+3} P_{er}(x+1) + \left(\frac{1}{2}\right)^{x+2} P_{er}(n+1)\right)$$

- ***False-Alarm Errors:*** The false-alarm error occurs when the noise causes a threshold-crossing event in an unoccupied data slot.

$$P_{efDiPPM} = 2.\left(\sum_{x=0}^{n-1}\sum_{k=0}^{x}\left(\frac{1}{2}\right)^{x+3} P_f(x+1-k) + \sum_{k=0}^{n}\left(\frac{1}{2}\right)^{x+2} P_f(n+1-k)\right)$$

Simulation & Results

❖In order to evaluate the error probabilities, the output voltage, *Vo*(t), and the mean square receiver output noise <no(t)2> are required, and these, in turn, depend upon the received pulse shape, the type of preamplifier employed, the associated noise power spectral density, and the type of equalisation filter employed.



Conclusion

➢ The output received pulse and its slope are required as the basic signals to evaluate the performance of optical communication systems. A mathematical models have been developed for a DiPPM system over an optical indoor wireless channel via diffuse link. Thus output received pulse and its slope have been determined and illustrated by using MathCAD software.

Further work

The main further work is to investigate the performance of the optical DiPPM system over a dispersive indoor optical wireless channel via diffuse link with the view to understanding its benefits and limitations in terms of:

- ❖Error probability.
- ❖Variation in the bandwidth of preamplifier filter.
- ❖Variation in the bandwidth of a third-order Butterworth filter.
- ❖Using a Maximum Likelihood Sequence Detection (MLSD).
- ❖Optimising the system performance in comparison of the relative values of DiPPM and a similarly performing digital PPM system.