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OPTICAL CDMA-BASED FIBER-RADIO NETWORKS WITH IMPROVING POWER EFFICIENCY OF THE OPTICAL LINK

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***Abstract*— The aim of the project is to design an CDMA based fiber optic system using BPSK modulation and to evaluate the power efficiency of the optical link. More over the system performance is analyzed under the influence of Gaussian noise channel. The project also aims at the calculation of BER at different SNR values. The communication model has to be designed using Matlab toolboxes. Both power efficiency and carrier-to-noise ratio at the decoder of the proposed scheme are improved. Simple encoding/decoding structures is proposed to reduce the cost of today's mobile radio networks**

***Index Terms*—OCDMA, BPSK, BER, SNR, Gaussian noise channel**

I. INTRODUCTION

CDMA is a form of Direct Sequence Spread Spectrum communications. In general, Spread Spectrum communications is distinguished by three key elements: 1. The signal occupies a bandwidth much greater than that which is necessary to send the information. This results in many benefits, such as immunity to interference and jamming and multi-user access, which we'll discuss later on.2. The bandwidth is spread by means of a code which is independent of the data. The independence of the code distinguishes this from standard modulation schemes in which the data modulation will always spread the spectrum somewhat. 3. The receiver synchronizes to the code to recover the data. The use of an independent code and synchronous reception allows multiple users to access the same frequency band at the same time. In order to protect the signal, the code used is pseudo-random. It appears random, but is actually deterministic, so that the receiver can reconstruct the code for synchronous detection. This pseudo-random code is also called pseudo-noise (PN).

II. QPSK MODULATION

QPSK uses four different states to encode each symbol. The four states are phase shifts of the carrier spaced 90_ apart. By convention, the phase shifts are 45, 135, 225, and 315 degrees. Since there are four possible states used to encode binary information, each state represents two bits. This two bit "word" is called a symbol. Figure 3 shows in general how QPSK works. First, we'll discuss Complex Modulation in general, applying it to a single channel with no PN-coding (that is, we'll show how Complex Modulation would work directly on the symbols). Then we'll discuss how we apply it to a multi-channel, PN-coded, system.

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2.1.COMPLEX MODULATION

Algebraically, a carrier wave with an applied phase shift, Y(t), can be expressed as a sum of two components, a Cosine wave and a Sine wave, as:

$$A(t)Cos(\omega_c t + \phi(t)) = I(t)Cos(\omega_c t) + Q(t)Sin(\omega_c t)$$

I(t) is called the real, or In-phase, component of the data, and Q(t) is called the imaginary, or Quadrature-phase, component of the data. We end up with two Binary PSK waves superimposed. These are easier to modulate and later demodulate. This is not only an algebraic identity, but also forms the basis for the actual modulation/demodulation scheme. The transmitter generates two carrier waves of the same frequency, a sine and cosine. I(t) and Q(t) are binary, modulating each component by phase shifting it either 0 or 180 degrees. Both components are then summed together. Since I(t) and Q(t) are binary, we'll refer to them as simply I and Q. The receiver generates the two reference waves, and demodulates each component. It is easier to detect 180_ phase shifts than 90_ phase shifts. The following table summarizes this modulation scheme. Note that I and Q are normalized to 1.

Table 1QPSK angles

Symbol	I	Q	Phase shift
00	+1	+1	45°
01	+1	-1	315°
10	-1	+1	135°
11	-1	-1	225°

For Digital Signal Processing, the two-bit symbols are considered to be complex numbers, I +jQ.

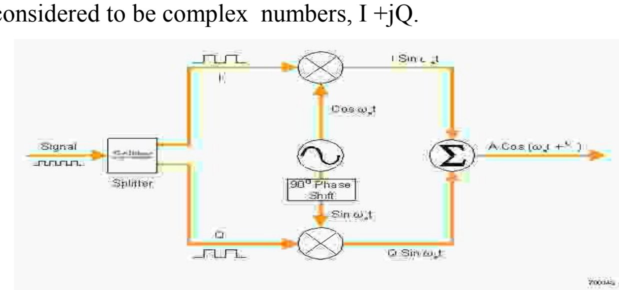
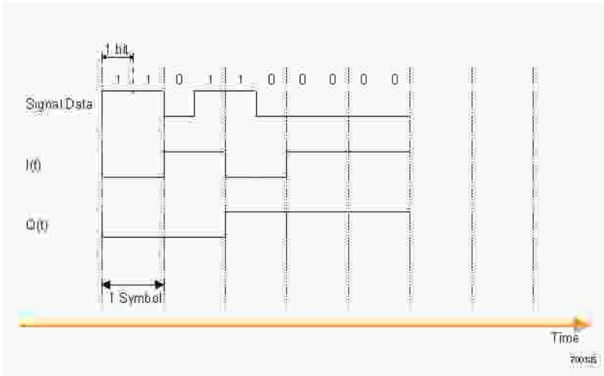


Figure 1.Complex Modulation



III. WORKING WITH COMPLEX DATA

In order to make full use of the efficiency of Digital Signal Processing, the conversion of the Information data into complex symbols occurs before the modulation. The system generates complex PN codes made up of 2 independent components, PNi +jPNq. To spread the Information data the system performs complex multiplication between the complex PN codes and the complex data.

3.1.SUMMING MANY CHANNELS TOGETHER

Many channels are added together and transmitted simultaneously. This addition happens digitally at the chip rate. Remember, there are millions of chips in each symbol. For clarity, let's say each chip is represented by an 8 bit word (it's slightly more complicated than that, but those details are beyond the scope of this discussion). all the statistical properties of QPSK transmission, including Bit Error Rate.

3.2.AUTOMATIC POWER CONTROL

The RCS gets bombarded by signals from many FSUs. Some of these FSUs are close and their signals are much stronger than FSUs farther away. This results in the Near/Far problem inherent in CDMA communications. System Capacity is also dependant on signal power. For these reasons, both the RCS and FSU measure the received power and send signals to control the other's transmit power.

3.3.NEAR/FAR PROBLEM

Because the cross-correlation between two PN codes is not exactly equal to zero, the system must overcome what we call the Near/Far problem.

- The output of the correlator consists of two components:
- The autocorrelation of the PN code with the desired coded signal

The sum of the cross-correlation of the PN code with all the other coded signals.

Mathematically, if we are trying to decode the k^{th} signal, we have:

A_j is the amplitude of the j^{th} signal,r_{jk} is the cross-correlation between the k^{th} and j^{th} signal, andS is the sum over all the j signals (excluding k).

Since the cross-correlation is small (ideally, it is zero), the sum of cross-correlation terms should be much less than the amplitude of the desired signal. However, if the desired signal is broadcast from far away, and undesired signals are broadcast from much closer, the desired signal may be so small as to be drowned out by the cross-correlation terms.

Note that this problem only exists in the reverse direction. The RCS is receiving signals from many FSUs at different distances, but the FSU is receiving all signals from one RCS. The RCS controls the power of each FSU so that the signals received from all FSUs are the same strength.

IV. PROBLEM FORMULATION

- The performance of the modulation technique can be well estimated in fixed point to point optical link in a LAN.
- But in case of optical systems , the performance fully depends on the channel conditions and the power efficiency.

4.1.PROPOSED SOLUTION

- Our aim is to analyse the system performance under perfect channel and conditions along with AWGN.

We analyse BPSK based modulation technique under CDMA

V. IMPLEMENTATION

A communication system had been developed using matlab communication tool box. A packet has been framed using (rand function) with 8 bit data and transmitted using a BPSK type of modulation. AWGN noise have been added to that and a simulation had been performed for 10000 iterations and BER had been calculated. Results have been plotted for various values of SNR against the BER.

5.1. SYSTEM UNDER CONSIDERATION

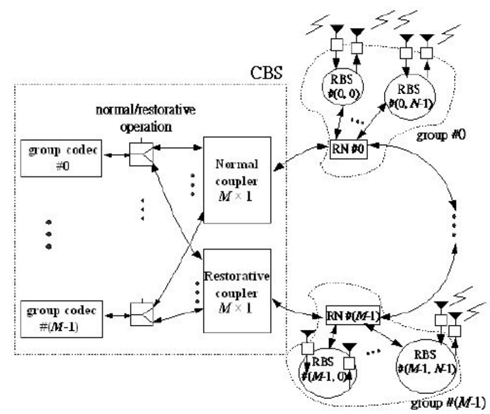


Fig 2. fiber radio network with OCDMA

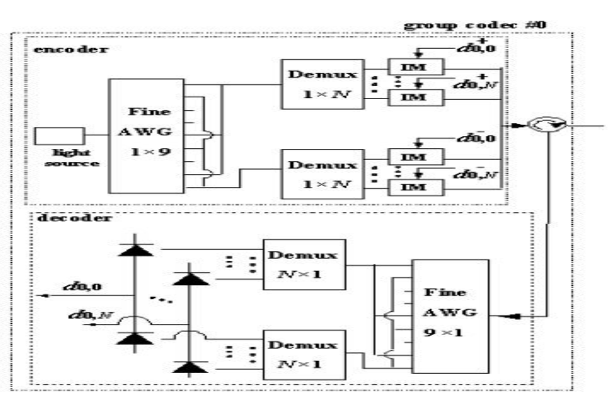
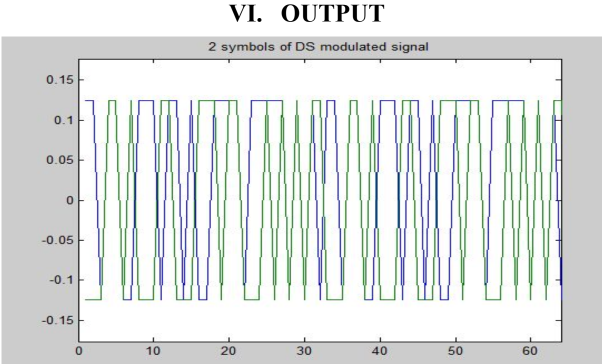


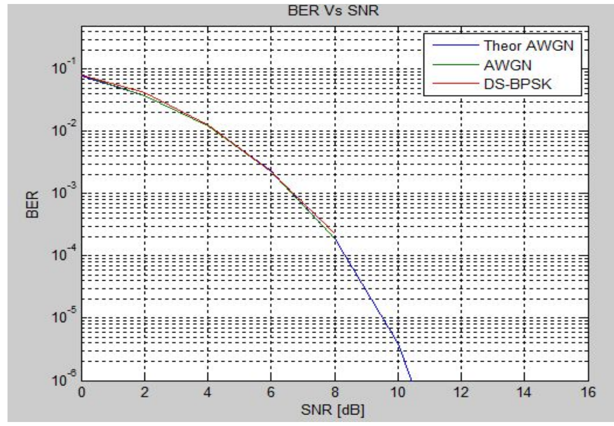
Fig 3.group code

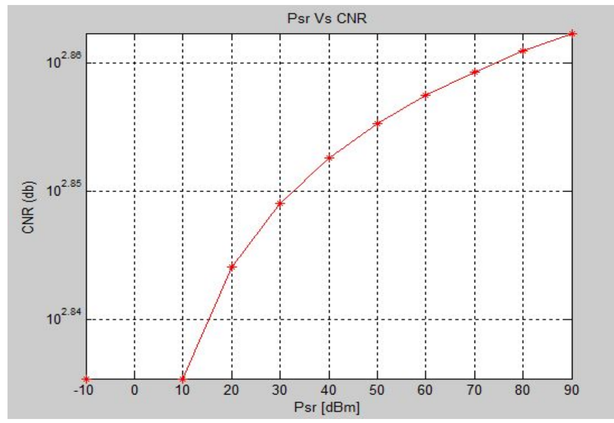
The fiber-radio network based on OCDMA is shown in fig 4. There are one CBS and *M* groups of RBSs in this ring network, where *M* is a positive integer. Each RBS contains transmitting and receiving antennas for the communication with the mobile terminals roaming nearby and these RBSs are indexed as RBS #(*m*, *n*) (*m* = 0, 1, . . . , *M*-1, *n* = 0, 1, . . . , *N*-1). RBS #(*m*, *n*) with the same number of *m* belongs to group #*m* and they are connected to the remote nodes (RNs) in the corresponding group using star topology.
However, all the RNs and CBS are connected by the use of ring topology for self-healing function provision. In the CBS, there are M group codecs (encoders/decoders) responsible for the transmission and reception of the signals for each RBS group. These group codecs use the corresponding 1x2 optical switches to determine the transmission and receive behavior for the normal/restorative operation. If one specific group codec is in normal (or restorative) operation, it should be connected to the normal (or restorative) coupler in the CBS for transmitting and receiving signals.

There are two operations for the bi-directional transmission etween one specific RN and the corresponding group codec in the CBS: normal and restorative. For normal operation, the CBS transmits encoded signals clockwise to RNs while RNs transmit anti-clockwise to CBS in the ring core network. However, for restorative operation, the CBS transmits anticlockwise to RNs while RNs transmits clockwise to CBS in the ring network. If the link between RN #*a* and RN #(*a*+1) is broken, the RN #*m* (*m*<=*a*) is in normal operation and the RN #*m* (*m*>*a*) is in restorative operation. The operation of one specific RN and the operation of the corresponding codec in the CBS should be the same, and the operations of different group codecs in the CBS may be different. For upstream transmission, the radio signals from the receiving antenna in each RBS are encoded with the corresponding upstream codewords and then transmit to the CBS through the core network for further processing. In the CBS, these signals enter one of the two *N*x1 couplers according to the operation of the corresponding RN and are broadcast to each group codec in the same operation. For the downstream transmission, each group codec in the CBS transmit the fiberradio signals encoded by the downstream codewords of the destined RBSs. After combining with the ones from other group codecs of the same operation in the *N*x1 couplers, these signals are transmitted to the core network. The RNsin the core network pass part of these signals to the next RN, and the remaining signals are distributed to the RBSs in the corresponding group. After the decoding process of the RBSs, the resulting radio signals are transmitted to the mobile terminals by the transmitting antennas in these RBSs.

VI. OUTPUT







VII. FUTURE ENHANCEMENT

The project can be enhanced by means of detecting the SINR in the presence of network load. And actually we want to prove that the 'poor users' are actually benefited because this accurate calculation of SINR. It is very obvious that the network load plays a great role in the interference. What we have shown in this phase is the calculation of SINR without network load. The same things shall be extended in future to find the interference with network load. We shall try to simulate the improvement in the throughput under the newly calculated SINR. This may be done using certain network simulators like NS-2, opnet or using Glomo sim. The same project can be still made realizable as an hardware where we implement all the algorithms in the form of hardware in the application specific integrated chip (ASIC). But we implement this in future in simulations in any one of the network simulator software mentioned above.

CONCLUSION

One bi-directional fiber-radio network based on optical code-division multiple access using hybrid star/ring topology is proposed. This scheme has the advantages of interference elimination and partial self-healing ability. As compared to the previous OCDMA-based fiber-radio schemes, the proposed scheme eliminates the addition of direct current signal before the optical encoding process. Performance analysis also shows that the corresponding carrier-to-noise ratio is better than that of previous schemes. Since simple encoding/decoding structure can be used in the control base station, the proposed scheme is suitable for today's mobile radio networks with a large number of remote base stations.

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BIOGRAPHY

Dr.V.BALAJI has 13 years and 8 months of teaching experience. Now he is working as a principal in Sapthagiri college of Engineering, Dharmapuri. His current areas of research are model predictive control, process control, and Fuzzy and Neural Networks. He has published 36 research papers in national and international journals and conferences. He got the world's Greatest Teacher Award. He is a member of ISTE, IEEE , IAENG, IAOE and IACSIT. He is also serving as a Editor-in – Chief, International Advisory Board Member, Associate and Advisory Editor Editorial Board Member and reviewer in the reputed National and international journals and conferences