ANALYTICAL DESIGN OF ITERATIVE RECEIVER FOR OPTICAL WIRELESS COMMUNICATION BASED ON FLIP-OFDM

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Abstract -- With the rapidly growing demand for data in wireless communications and the significant increase of the number of users, the radio frequency (RF) spectrum become one of the scarcest resources in the world. Motivated by the more and more crowded RF spectrum, optical wireless communications (OWC) has been identified as a promising candidate to complement conventional RF communication, especially for indoor short and medium range data transmission. In the proposed method flip OFDM is used to guarantee nonnegative signals in optical wireless communication (OWC) systems and flipped orthogonal frequency division multiplexing (Flip-OFDM) transmits the positive and negative parts of the signal over two consecutive OFDM sub frames. An iterative receiver is then proposed to improve the transmission performance of Flip-OFDM by exploiting the signals in both sub frames. Simulation results show that the proposed iterative receiver provides significant signal to noise ratio (SNR) gain over the conventional receiver. Moreover, the iterative receiver also outperforms the existing advanced receiver.

Keywords: Flip OFDM, Iterative receiver, Optical wireless communications

1. INTRODUCTION

In olden days people used to communicate with distant counterparts by make usage of traditional approaches like sending the information with birds, sending people as ambassador to convey the information. Most of the researchers termed 21st century as Communication arena due to the high end technological advancement in this area which makes communication fast and reliable. The intense research classified communication into two categories a) wire based communication b) wireless based communications. Wire based communications is considered as most useful tool in world wars to convey information from one end to another in 1940’s and optical fiber plays a crucial role in wire based communication mechanism and after completion of war the dominance of United States of America (USA) and Union of Soviet Socialist Republics (USSR) over the world makes the research on communication so fast that in two decades communication research grows from daily life communication to satellite communication and this
development mainly because of wireless communication.

2. RELATED CONTENT

2.1 OFDM and its Orthogonality

In orthogonal frequency division multiplexing communication model the sub carrier used are orthogonal to each other. The Orthogonality helps in employing the overlapping between the sub carriers in the respective frequency domain. The accuracy of communication model is based on how effective the bandwidth is used and this is technically termed as spectral efficiency or bandwidth efficiency, the acquired bandwidth efficiency is free of Inter carrier interference and the absence of Inter carrier interference (ICI) is mainly because of usage of Orthogonality in orthogonal frequency division multiplexing.

![Figure 1: Orthogonality in orthogonal frequency division multiplexing (OFDM)](image)

2.2 Basic OFDM System

The orthogonal frequency division multiplexing block diagram is illustrated as follows in figure 3. The input random signal data rate streams (high) are converted into data rate streams (low). The important aspect in the OFDM block diagram is the modulation technique which modulates the low data rate streams in parallel way and this parallel stream given input to the IFFT block which transforms the frequency data to time data before it reaches the channel. Adding the cyclic prefix acts as the guard interval and the reverse of transmission is accomplished at receiver end.

![Figure 2: Block diagram of Basic OFDM system](image)

3. PROPOSED METHOD

Proposed Receiver

The conventional receiver is simple and straightforward, but it does not fully exploit the structures of the received signals. In the following, a new receiver is proposed by establishing the relationship between the received signals $y^+$ and $y^-$ the input data $X$.

Where $|x|$ can be expressed as

$$|x| = S(X)x = S(X)W_N^yX,$$ (1)

Where $S(X)$ is defined as

$$S(X) = \text{diag}\{\text{sign}(x)\} \text{ diag}\{\text{sign}(W_N^yX)\},$$ (2)

Then the positive and negative parts can be writes as follows,

$$x^+ = \frac{x + |x|}{2} = \frac{x + S(X)W_N^yX}{2}.$$ (3)

The relationship between the $y^+$ and $X$ can be derived as
\[ y^+ = \frac{mW_N H x^+ X - H X - Z^-}{2} \quad (3) \]

Particularly, in line-of-sight (LOS) channels, the channel response can be expressed as

\[ h(n) = c\delta(n) \quad (4) \]

and finally the iterative receiver becomes

\[
\hat{x}_{LOS}^{(i)} = \begin{cases} 
\text{dec} [y^+ - y^-], & i = 0 \\
\text{dec} \left\{ \frac{1}{2} \left[ I + W_N S(\hat{x}_{LOS}^{(i-1)}) W_N^H \right] y^+ \\
+ \left[ I + W_N S(\hat{x}_{LOS}^{(i-1)}) W_N^H - I \right] y^- \right\} 
\end{cases}
\]

4. Simulation Results

Figure 1: Iterative receiver with number of iterations

Figure 2: NLOS channel in terms of BER

Figure 3: LOS channel in terms of BER

Figure 3: SUI channel in terms of BER

<table>
<thead>
<tr>
<th>SNR</th>
<th>BER(LOS)</th>
<th>SUI Channel(LOS)</th>
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<tbody>
<tr>
<td>0</td>
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<td>8</td>
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<td>10</td>
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</tr>
<tr>
<td>14</td>
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<td>0.0136</td>
</tr>
</tbody>
</table>
Compare the BER results with last 2 figures

5. CONCLUSION

An iterative receiver is proposed for Flip OFDM in IM/DD based OWC systems. In order to improve the receiver performance, the iterative receiver obtains the additional diversity gain by exploiting the signals in both the positive sub frame and negative sub frame. The simulation results show that the iterative receiver with only two iterations provides a significant SNR gain over the conventional receiver. Moreover, the receiver is also superior to the existing advanced receiver.

REFERENCES


