**深 圳 大 学 实 验 报 告**

**课程名称： 现代通信原理**

**实验项目名称： 实验八**

**学院： 电子与信息工程学院**

**专业： 电子信息工程**

**指导教师： 陈真**

**报告人： 余韦藩 学号： 2020285102 班级： 文华班**

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**实验报告提交时间： 2023年5月11日**

**教务部制**

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| **实验目的与要求：**  微信截图_20230509000032 |
| **内容和步骤：**   1. **Generate binary bipolar random sequence**   In the experiment, we generate a random binary bipolar sequence with the length=1000. At the same time, we record the position of voltage 1 and voltage -1 in convenience to plot the scatter figure. The related codes are shown in the following figure.  微信截图_20230509000947   1. **Let the signal traverse a AWGN channel (2 different SNR setup SNR = 5/SNR = 15)**   Here we use the awgn() function for the signal to imitate travel a AWGN channel. For the result analysis finally, I additionally add the SNR=20 noise. The codes are shown in the following figure.  微信截图_20230509000955   1. **Design zero-forcing equalizer and plot the samples before equalization and after equalization**   I write a force\_zero() function to calculate the tap coefficient. The input parameter includes h (multi-path impulse response) and N (The number of tap). First, we should promise that h is symmetric. If h is not symmetric, we should perform zero-padding. MID presents center point of h(t) that is equal to 1. After that, we calculate the sequence x=[(-2N), (-2N+1),......,0,......(2N-1),(2N)]. We fill h into x from center point to its two sides. If the length of x larger than h, we let rest value of x to be 0. Next, we create the matrix X by fliplr() function which reverses the sequence of the input array. Finally, we solve the linear matrix equations to obtain the tap coefficient C. All the related codes are shown in the following figure.  微信截图_20230509001251  微信截图_20230509001306  In the experiment, we randomly define a multi-path h=[0.2,0.1,1,0.2,0.1] and number of tap N=5. The function of multi-path h(t) is to occur ISI for the signal. Then we use the force\_zero() function to solve the tap coefficient C. We first let signal added noise to pass through the h(t), then perform equalization by convolution with C. Plot all the related figures. The codes are shown in the following figure.  微信截图_20230509001014  微信截图_20230509001031  微信截图_20230509001040  微信截图_20230509001051  微信截图_20230509001102  微信截图_20230509001109  The following figure shows the samples for adding different noise before equalization and after equalization. We observe that all the samples are exactly drop on the line 1 and line -1 for the original signal. However, when adding noise for the original signal, the sample points will locate around the line 1 and line -1. Different SNR will determine the degree of dispersion. Back to the figure, we find that the smaller SNR, the more dispersed of the samples. After equalization, samples of signal with different SNR will more close to line 1 and line -1 which indicates that equalizer could reduce the effect of noise in the channel. However, if the noise is too intense, the effect of equalization may be poor as shown in the SNR=5 signal after equalization.  微信截图_20230509122130   1. **Use cosine roll-off waveform and plot the eye pattern before and after the equalization**   Before pass through the roll-off system, we should upsample the received signal. Here, sample interval N should be equal to the sps which is a parameter of roll-off system. The codes are shown in the following figure.  微信截图_20230509001206  Then we let all the signal before equalization and after equalization with different SNR pass through the roll-off system. Here we set alpha=1, span=4 and sps=10. Then plot the eye pattern. The codes are shown in the following figure.  微信截图_20230509001212微信截图_20230509001219  The following figures show all the eye patterns. For adding noise SNR=5, the effect of equalizer is extremely poor: the eye still don’t open. And it seems that the equalizer amplify the effect of noise. For adding noise SNR=15, the effect of equalizer is relatively better compared to SNR=5. The eye does open a little. For adding noise SNR=20, the effect of equalizer is best compared to the signal adding noise SNR=5or15: the eye open a lot.  From the above analysis, we can make a conclusion that when the noise in the channel is acceptable, the ZF equalizer does perform well. However, if the noise is too intense, the ZF equalizer perform poor.  微信截图_20230509132857 微信截图_20230509132914  微信截图_20230509132930 微信截图_20230509133039  微信截图_20230509132942 微信截图_20230509133055 |
| **实验结论：**   1. An equalizer is a signal processing device that is used to compensate for the distortion caused by the transmission channel. Mostly, it deal with the effect of multi-path effect. 2. For ZF equalizer, the equalizer coefficients are determined by solving a set of linear equations. The equalizer coefficients are then used to adjust the amplitude and phase of the received signal to compensate for the distortion caused by the channel. 3. However, one disadvantage of the ZF equalizer is that it may amplify noise and other interference present in the received signal. This is because the equalizer does not take into account the noise and interference present in the channel. |
| **指导教师批阅意见：**    **成绩评定：**  **指导教师签字：**  **年 月 日** |
| **备注：** |

注：1、报告内的项目或内容设置，可根据实际情况加以调整和补充。

2、教师批改学生实验报告时间应在学生提交实验报告时间后10日内。