Project Plan: Design of a Codec over a Rayleigh Channel with MIMO Architecture

Boikanyo Radiokana (1386807)
Supervisor: Prof Fambirai Takawira
ELEN4000A/4011A: Design II (Telecommunications)

School of Electrical & Information Engineering, University of the Witwatersrand, Private Bag 3, 2050, Johannesburg, South Africa

1. INTRODUCTION

This document briefly states the forward operation methods chosen for the design of a Codec that achieves a Spectral Efficiency (SE) of at least 2 bs/Hz operating over a Rayleigh fading channel. The system must have a MIMO Architecture to combat the effect of fading caused by the channel. The following block diagram illustrates the overall system overview which will be discussed in Section 2.

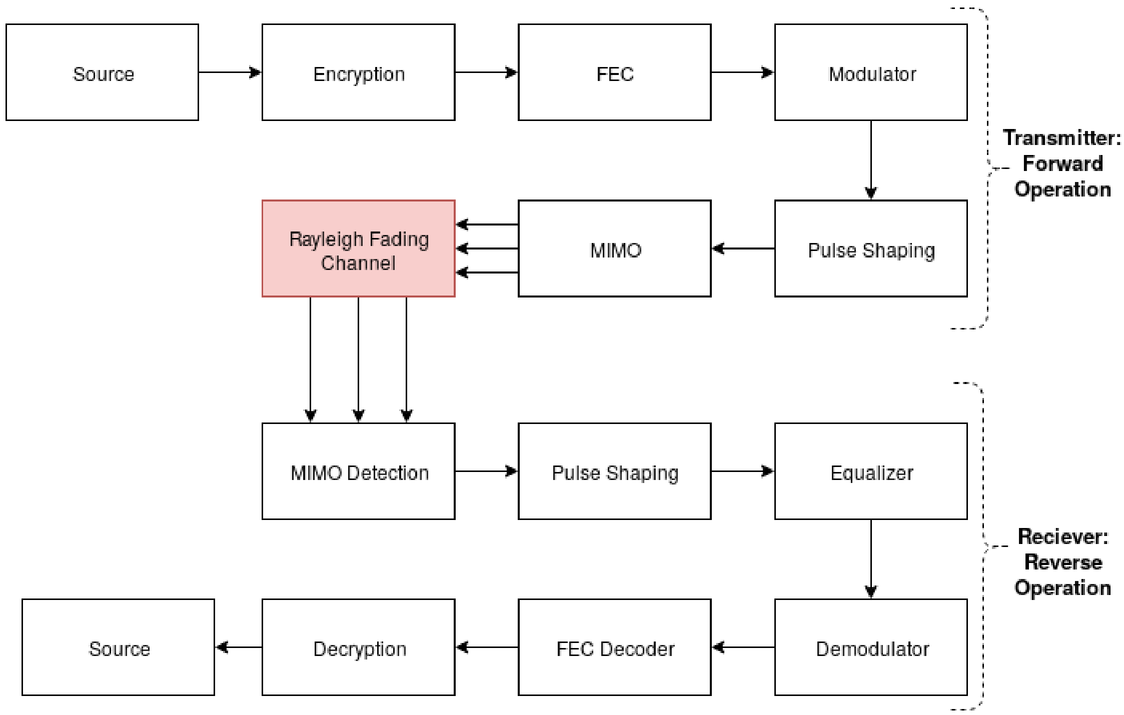

Figure 1 : System Overview

2. DESIGN METHODOLOGY

This section will focus only on specifying the methods that will be used in the forward operation subsystems as depicted in 1.

2.1 Source

Initially a random binary number generator will be used as a source. Provided that the system has been successfully simulated, design specifications have been met and there is still time available, the source will be changed to a text.

2.2 Encryption

Encryption will not be considered at this stage since it is not a primary key component in this project, however if time permits it will be implemented as an additional feature.

2.3 FEC - Forward Error Correction

The forward error correction algorithm that will be used is a BCH(63,45) code. Literature has shown that BCH codes generally have an exceptional performance in Rayleigh fading channels compared to other block codes and convolutional codes. Since BCH codes can correct a limited number of errors, a matrix type interleaver will be used together with the BCH code to combat burst errors. In literature it has been shown that BCH codes combined with an interleaver perform much better compared to BCH coded used independently. The interleaver will only be implemented provided that the overall system has been successfully simulated and time permits.

The parameters of the chosen BCH code are as follows:

Table 1 : BCH(65,43) Parameters

Parameter	**value**
n	65
k	43
r = n/k	0.714

2.4 Modulator

The modulation scheme that will be used is an M-QAM scheme with modulation orders ranging from 64 to 256. The performance of the different modulation schemes will be compared. M-QAM is chosen over other modulation schemes due to its ability to attain high data rates in noisy channels. The rectangular constellation structure of M-QAM allows it to perform better compared to other schemes.

The estimated SE of the system assuming that value of α_m is 1 is as follows:

$$SE = \frac{r \log_2 M\alpha_m}{2} \tag{1}$$

For M = 64:

$$SE = 2.109bs/Hz \tag{2}$$

2.5 Pulse Shaping

To eliminate intersymbol interference and improve the spectral efficiency of the codec, a pulse shaper with a raised cosine filter amongst other filters will be used. The raised cosine filter is popular for its ability to satisfy the Nyquist criterion and has a cosine shape in the frequency domain.

2.6 MIMO

To improve the reliability of data transfer in the system the data will be replicated using a Space Time Block Code (STBC) with a number of nxm antennas for the transmitter and the reciever. The value of n and m will range between 2 and 8. STBC is chosen amongst other MIMO spatial multiplexing techniques due to its spatial and temporal diversity which introduces a significant diversity gain. STBC also combats the effects of fading and noise introduced in the channel.

3. CONCLUSION

The methods used for the Codec design were presented. The parameters of the system fullfills the success criteria of the system with an estimated spectral efficiency of 2.1 bs/Hz.