Delft University of Technology

Wireless Networking

ET4394

Assignment

DYNAMIC TRANSMIT RATE CONTROL ALGORITHM

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INTRODUCTION

Rate adaptation is required for reducing packet loss and improving the throughput. There is no set mechanism for choosing the modulation and coding scheme(MCS) in IEEE 802.11. The purpose of this assignment is to come up with an efficient algorithm to control the MCS for consecutive packets so as to maximize throughput while keeping the Packet error rate low. The standard used here is IEEE 802.11ac which has an MCS range of 0-9. The bit error rate is affected by transmission channel noise, interference, distortion, fading, etc. A robust algorithm must avoid the random packet loss by taking into consideration the above factors.

PROPOSED ALGORITHM

The adaptive rate control has been implemented using Fuzzy logic designer from Fuzzy logic toolbox of MATLAB. Fuzzy logic not only includes the extreme cases of true or false but also the cases that may fall between the two thereby defining degrees of truth such as partially true and partially false. Fuzzy systems provides flexibility to the object by means of membership functions. It helps bring preciseness to vague systems. Membership functions describe the fuzziness of the system by representing various states of truth. The conditional statements that comprise the fuzzy logic are formulated using IF-Then rules. Fuzzy logic was used instead of threshold method since even a small deviation from the set threshold would change the entire system and render results that were not anticipated. For example, if the range for low SNR was declared as 0-5, then 5.1 will be considered as high SNR. But in a fuzzy logic, due to the property of membership functions, 5.1 will not be considered as strictly high. We have proposed two different algorithms using the fuzzy logic and are described below.

Algorithm 1

Our Fuzzy logic designer has Signal to noise ratio(SNR), Bit error rate(BER) and the present Modulation and coding scheme index as inputs and the output is the most suitable Modulation and coding scheme index for the current packet under consideration. The system is depicted in figure 1.

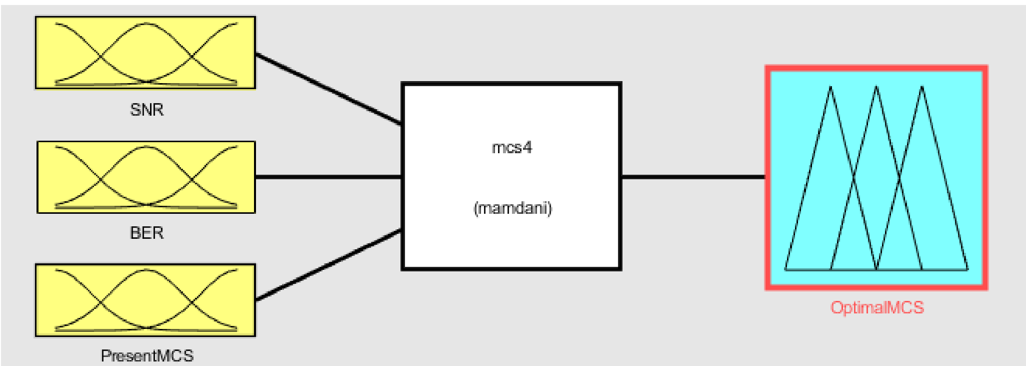

Figure 1: System block diagram

Three membership functions are taken for SNR: Low, Medium and High. The SNR range is updated during runtime according to the given system SNR. For BER the first membership function is for zero error and two other functions for medium and high SNR are taken. BER always ranges between 0 and 1. Since MCS index varies between 0-9 for IEEE 802.11ac, ten member functions are taken for present MCS and the output Optimal MCS. The algorithm is such that, when the system SNR is high and there are bit errors in the packet, the MCS of the packets are decreased by 1 and maintained till the SNR reduces or bit error disappears. In all other cases the If-Then rules of the fuzzy controller are followed.The If-Then rules are written to compare the three inputs and accordingly select the optimal coding scheme for the current packet. With a high SNR and a low BER, the MCS of the packet is increased by 1 index from the present MCS. But when the BER is high the MCS is decreased by 2 index and when when the BER is Medium the MCS is decreased by 1 index in order avoid further Errors and to keep the throughput from dropping considerably.

Algorithm 2

The second algorithm is using only the SNR as an input to the fuzzy control designer. The system is as given in figure 3.

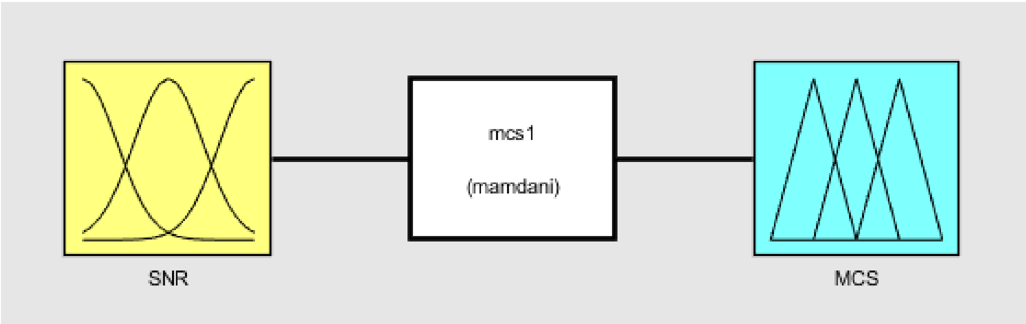

Figure 2: System block diagram

Ten different membership functions are taken for SNR. The range of the SNR is set at 5 to 40. The output membership functions for the MCS are the same as in algorithm 1. The If-Then rules are fairly straight forward in this algorithm since each member function of the SNR is matched to a corresponding MCS value of the output.

Results and Analysis

The performance of the algorithm 1 is studied by testing the algorithm for various SNR but we have plotted for 2 different cases. SNR is generated by a sin wave with a mean value of 15 and amplitude of 5 which is depicted in figure 3 and with mean value of 22 and amplitude of 14 as shown in figure 4.

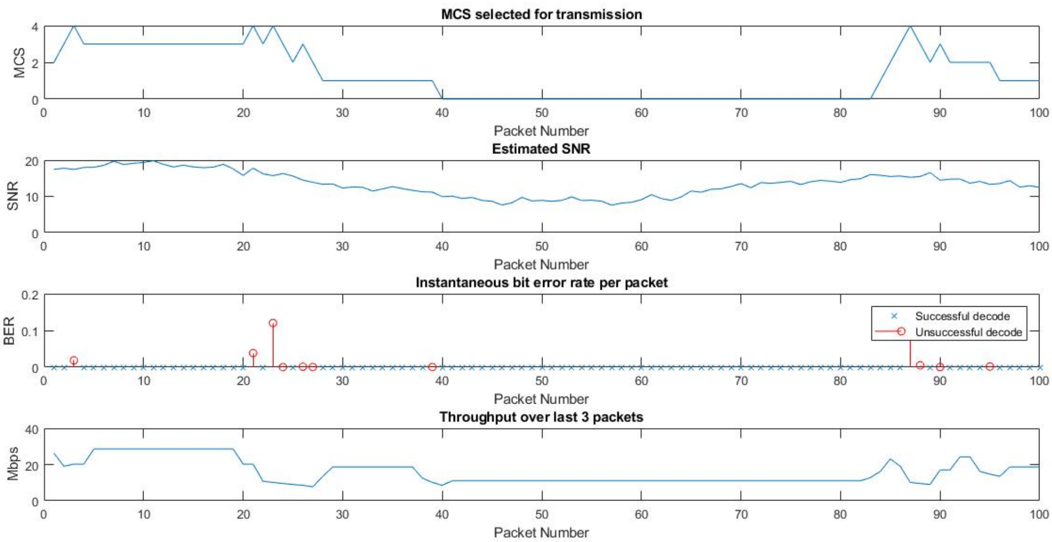

Figure 3: Performance of algorithm 1 for mean SNR = 15 and amplitude = 5

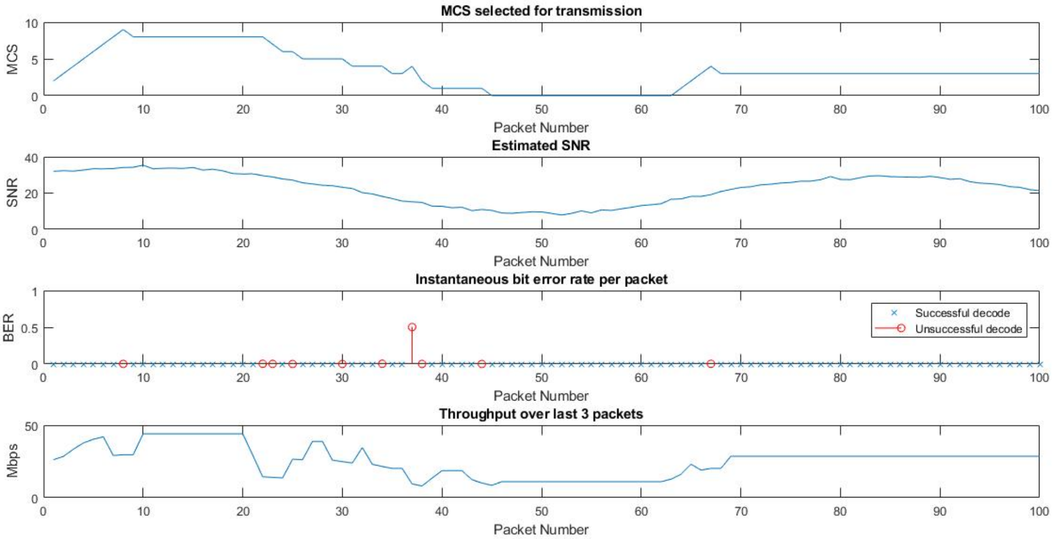

Figure 4: Performance of algorithm 1 for mean SNR = 22 and amplitude = 14

The performance of algorithm 2 is as in figure 4 obtained with the same SNR setting as the previous algorithm.

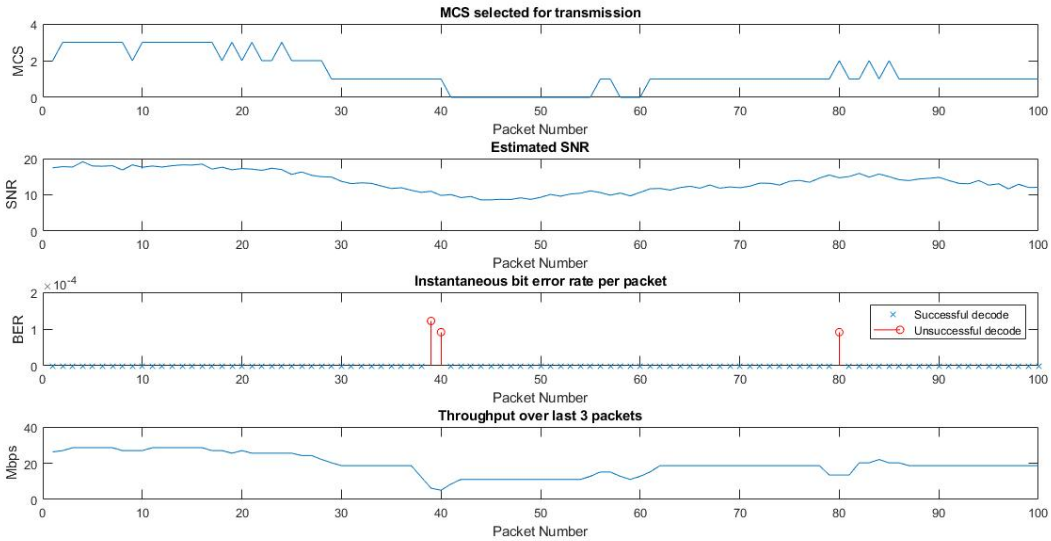

Figure 5: Performance of algorithm 2 for mean SNR = 15 and amplitude = 5

Analysis:

From the performance of the two algorithms, we can see that the latter performs better in terms of throughput and bit error rates for the same SNR parameters. In the first method, the MCS is updated only after the bit error has been detected. In this case, the fuzzy logic is being applied only after a worst case has occurred. This method now becomes a corrective measure. Moreover We know that SNR and BER are related and hence keeping just one of the two can also give a better rate adaptability. Therefore the second algorithm was implemented by eliminating BER and we can see an improvement as the MCS is modified before it encounters a BER.

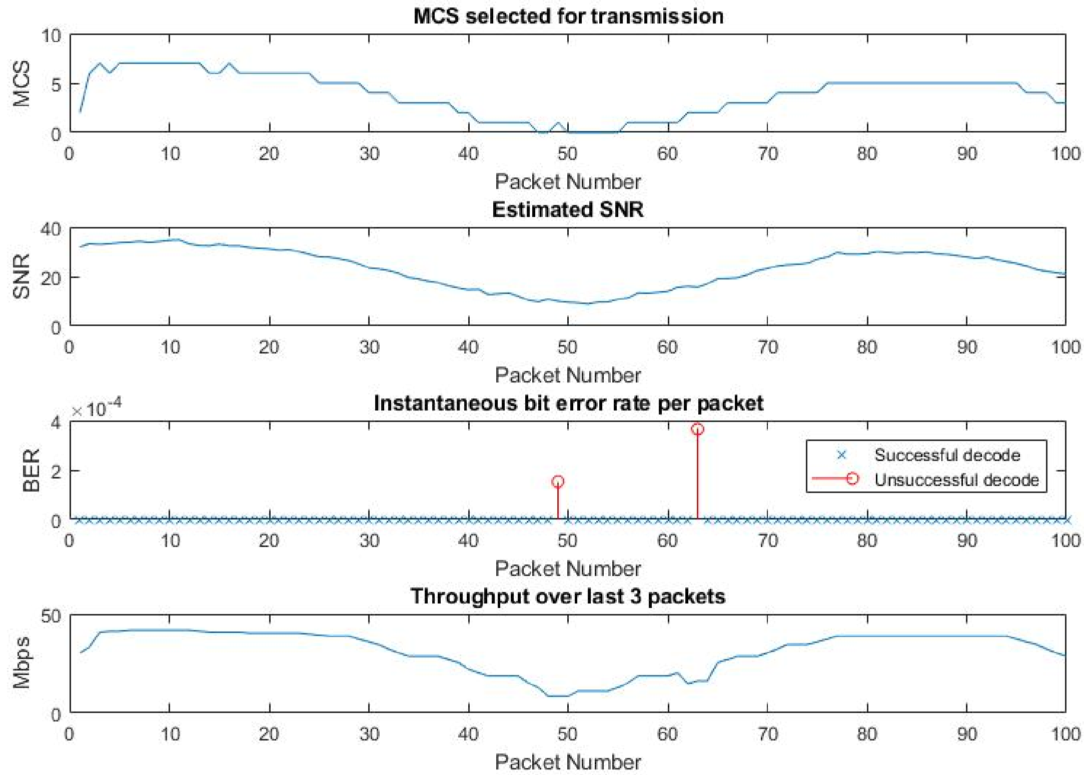

Figure 6: Performance of algorithm 2 for mean SNR = 22 and amplitude = 14

Conclusion

In this assignment two rate control algorithms using Fuzzy rule base system has been proposed and implemented. The first algorithm uses the signal to noise ratio and the bit error rate to decide on the best possible MCS. This algorithm is a corrective action which affects the throughput every time we face an error and hence a modified algorithm was devised. The second algorithm used only the signal to noise ratio to choose the most suited MCS. In both the cases the system adapts to any given SNR range and chooses a coding scheme that maintains a good balance between the bit error rate and throughput.