THROUGHPUT RETURNS DUE TO ADAPTIVE MODULATION TECHNIQUES

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ABSTRACT

Adaptive modulation is a powerful technique to increases the throughput of a wireless network by adjusting the modulation scheme to the channel status. We investigate the throughput returns due to the employments of adaptive modulation techniques (MPSK:M-ary Phase Shift Keying or MQAM:M-ary Quadrature Amplitude Modulation). In this project, the Bit Error Rate (BER) performance and spectral efficiency of a coded adaptive modulation technique over a multipath fading channel (no fading, flat fading and dispersive fading) will be implemented. By using simuation, we find out that the SNR increased because higher modulation technique is use. While SNR decrease when the lower modulation technique is use. For this case, when SNR>8dB, bit rate is 54Mbps, the 64QAM ¾ is apply and when SNR<1, bit rate is 6Mbps, the BPSK ½ is implement. This results in good data rates in the system. Therefore, Adaptive modulation systems offer a significant throughput and/or power gain compared to non-adaptive transmission, particularly when the channel conditions are slowly time varying and a reliable feedback channel is available.

Keywords: Adaptive modulation, SNR, data rates.

BACKGROUND OF STUDY

Our project is based on our study to the journal with a title of *Adaptive Power Control for Space Comunications* [1]. This paper investigates the implementation of power control techniques for crosslinks communications during a rendezvous scenario of the Crew Exploration Vehicle (CEV) and the Lunar Surface Access Module (LSAM). The crosslink will generate excess interference to the space-to-ground link as the distances between the two vehicles decreases, if the output power is fixed and optimized for the worst-case link analysis at the maximum distance range.

Power control is required to maintain the optimal power level for the crosslink without interfering with the space-to-ground link. This project has proved that by using the adaptive power control, it can optimize the crosslink communication. Besides, adaptive power control will allow for minimum interference to other receivers, maximum capacity of spectrum allocation, increased power efficient of spacecraft, and adaptability to dynamic mission & communication condition.

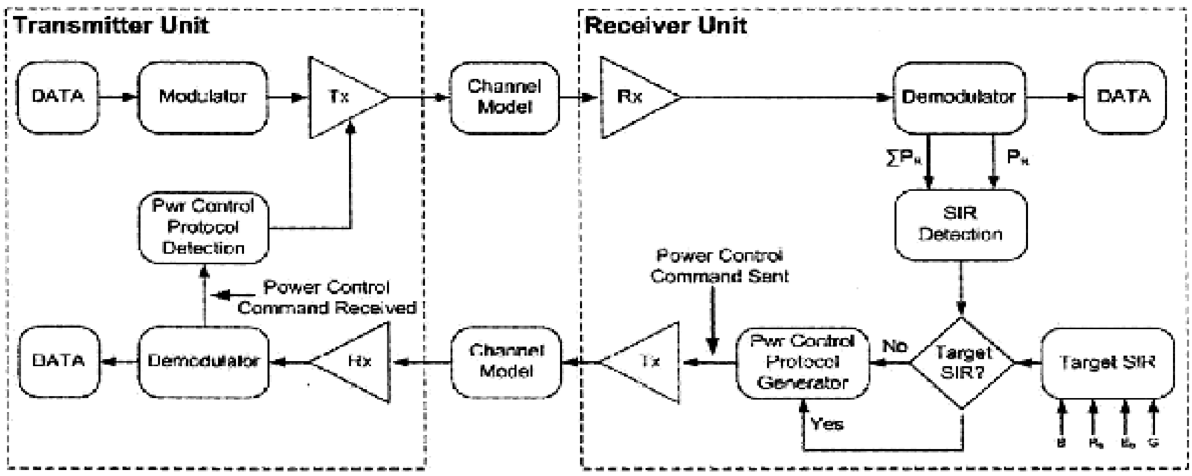

Figure 1 Function System Diagram [1]

To ensure higher network throughput in a fixed cellular broadband wireless access system incorporating the effects of shadowing, multipath fading, and multiple access interference., there are three adaptive modulations can be employed, adaptive modulation, adaptive coding, and adaptive power control [3].

PROBLEM STATEMENT

In this work, we investigate the throughput returns due to the employments of adaptive modulation techniques (MPSK:M-ary Phase Shift

Keying or MQAM:M-ary Quadrature Amplitude Modulation) have been proposed for maximizing the system throughput by adapting the modulation level and the coding rate to the channel conditions. Besides, the frequency selective fading will be discussed further in finding and discussions.

ADAPTIVE MODULATION

Adaptive modulation is a powerful technique to improve the energy efficiency and increase the data rate over a fading channel [4]. Adaptive modulation increases the throughput of a wireless network by adjusting the modulation scheme to the channel status [5]. To have more capacity and more flexibility in using adaptive modulation, our study attempts to use **few modulation schemes together with few coded rates**, which includes BPSK ½, BPSK ¾, QPSK ½, QPSK ¾, 16-QAM ½, 16-QAM ¾, 64-QAM 2/3, and 64-QAM.

SELECTIVE FADING

Selective Fading is often observed in microwave relay links. Another name is dispersive fading [6]. The cause of this type of fading is multipath with a time delay short enough to cause signal cancellation in only part of the wideband channel hence the name selective fading. This signal cancellation causes severe signal waveform distortion. Digital Radio Equipment is especially susceptible to this distortion.

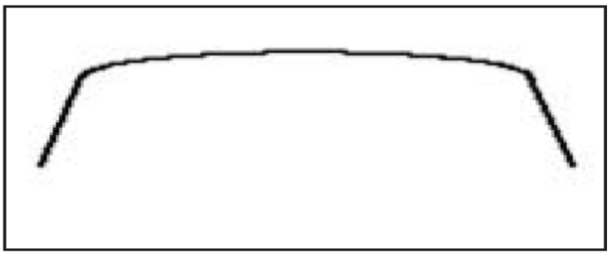

Figure 2 Normal Signal Spectrum [5]

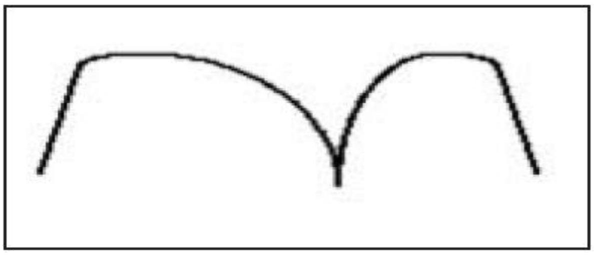

Figure 3 Distorted Signal Spectrum In-band Notch [5]

DESIGN MODULE

As in figure 4, transmitter part consists of input variable-rate data source and modulator bank consists of 8 different modulation techniques and coding states based on the SNR value at the receiver.

- SNR < 1 dB the system dynamically use BPSK (R=1\2), Bit Rate=6Mb/s.
- when 1 < SNR < 2, system dynamically use BPSK (R=3\4), Bit Rate=9Mb/s.
- when 2 < SNR < 3, system dynamically use QPSK (R=1\2), Bit Rate=12Mb/s.
- when 3 < SNR < 4, system dynamically use QPSK (R=3\4), Bit Rate=18Mb/s.
- when 4 < SNR < 5, system dynamically use 16QAM (R=1\2), Bit Rate=24Mb/s.
- when 5 < SNR < 6, system dynamically use 16QAM (R=3\4), Bit Rate=36Mb/s.
- when 6 < SNR < 8, system dynamically use 64QAM (R=2\3), Bit Rate=48Mb/s.
- when SNR >8 the system dynamically use 64QAM (R=3\4), Bit Rate=54Mb/s

The signal will transmit over the communication channel through the multipath fading (no fading, flat fading and dispersive fading) to the receiver.

The output data received at the receiver are decoded so as to reconstruct the input data. The receiver part inclusive of 8 different demodulator methods (same as the modulator), SNR estimation, and adaptive modulation control. This adaptive modulation control will give instruction for the modulator and demodulator to use which type of techniques.

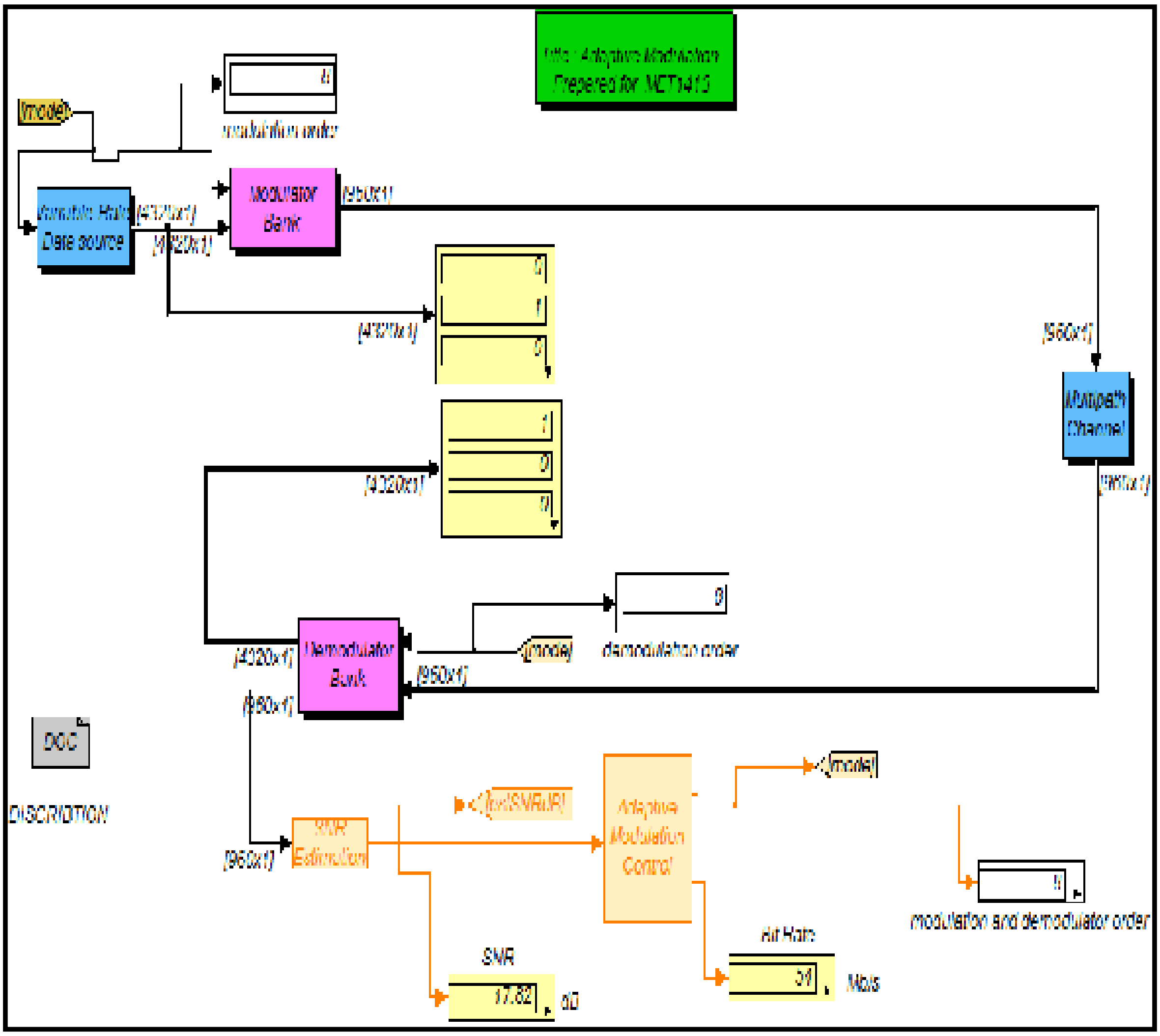

Figure 4 Function System Diagram of Adaptive Modulation

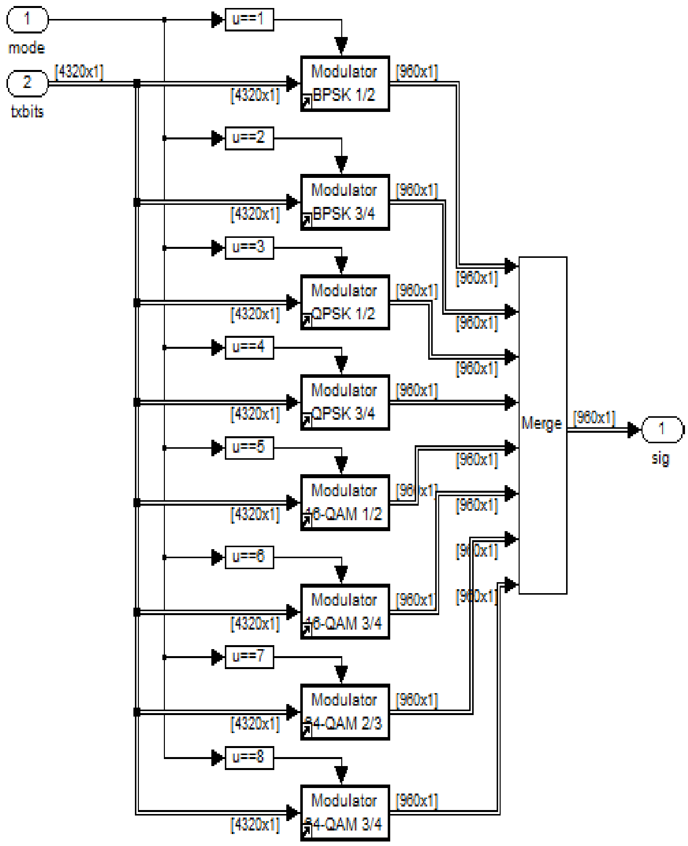

Figure 5 Modulator

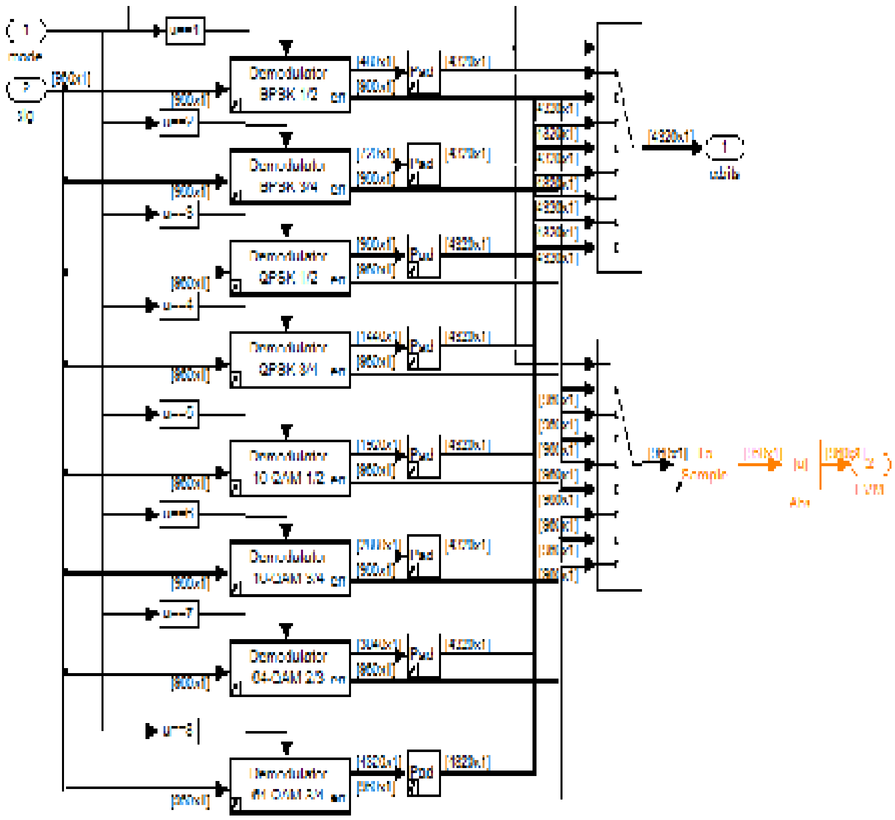

Figure 6 Demodulator

FINDINGS AND DISCUSSIONS

In this project, the Bit Error Rate (BER) performance and spectral efficiency of a coded adaptive modulation technique over a multipath fading channel (no fading, flat fading and dispersive fading) are shown. The performance of the adaptive coded modulation in a multipath fading environment has been simulated using MATLAB.

MPSK and MQAM are mean for bandwidth limited systems.

$Rb / W = \log_2 M$ [bits / Hz]

Bandwidth efficiency increases as M increases.

From the MATLAB simulink, for dispersive fading, we find out that the SNR increased because higher modulation technique is use. While SNR decrease when the lower modulation technique is use. For this case, when SNR>8dB, bit rate is 54Mbps, the 64QAM ¾ is apply and when SNR<1, bit rate is 6Mbps, the BPSK ½ is implement. This results in good data rates in the system.

This MATLAB simulation has prove that the adaptive modulation coding can improve the energy efficiency and increase the data rate over a fading channel. Besides, adaptive modulation increases the throughput of a wireless network by adjusting the modulation scheme to the channel status.

In the system model described above, the modulation and transmitted power can be chosen by the transmitter to best suit the existing channel conditions. To vary modulation type and constellation size continuously is not practical to implement. So the modulation is restricted to Mary Quadrature Amplitude Modulation (MQAM) with the constellation size is restricted to $M0 = 16$, and $M1 = 64$ and BPSK, QPSK. Square constellations are used for large M due to their inherent spectral efficiency and ease of implementation.

The power too is restricted to a finite set. Once the regions and associated constellations are fixed, a power control policy that satisfies the BER requirement and the power constraint is chosen. Each constellation is transmitted with a particular power associated with it.

CONCLUSION

Adaptive modulation systems offer a significant throughput and/or power gain compared to non-adaptive transmission, particularly when the channel conditions are slowly time varying and a reliable feedback channel is available.

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