Wireless Network systems
Project report

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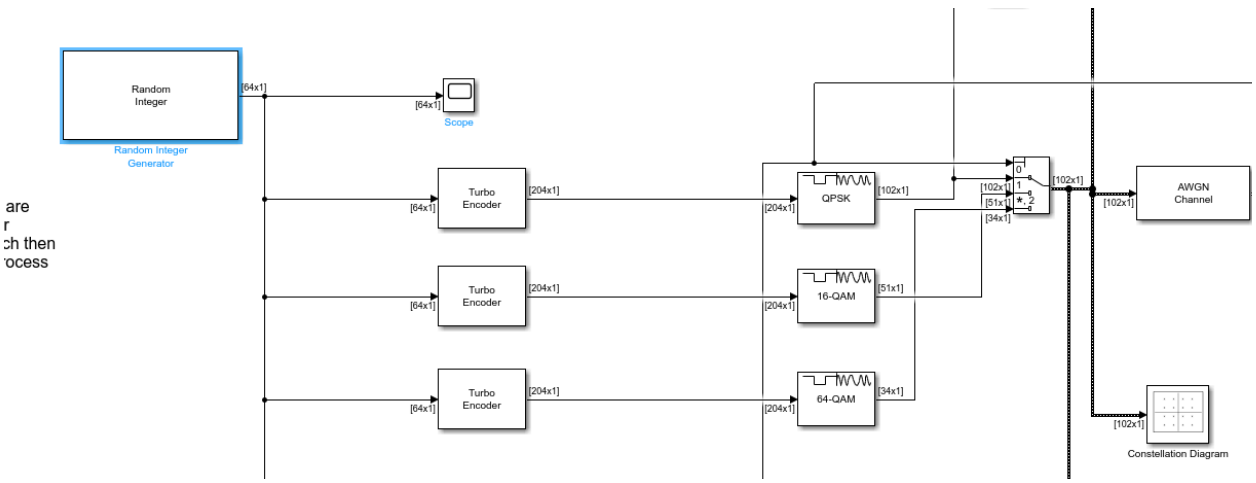
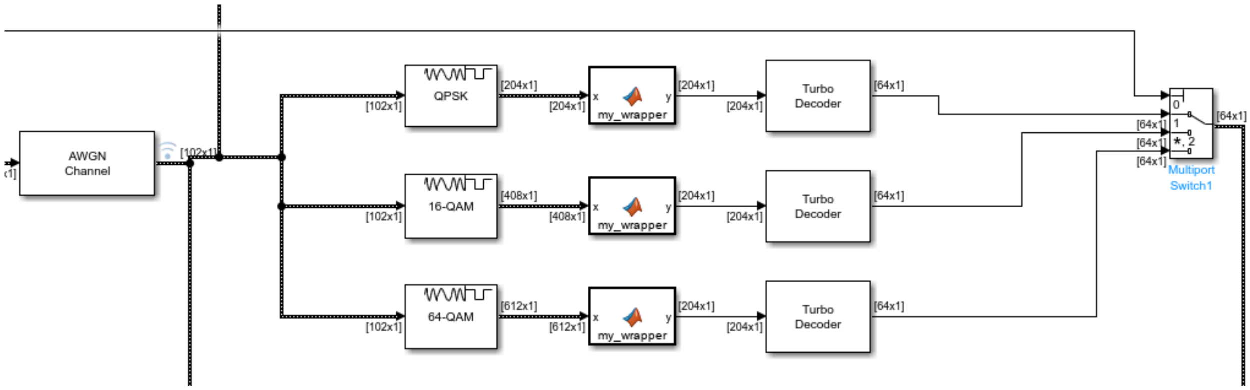
Adaptive Modulation in AWGN, Rayleigh and Rician Channels Under Realistic Propagation Effects: MATLAB-Based KPI Analysis

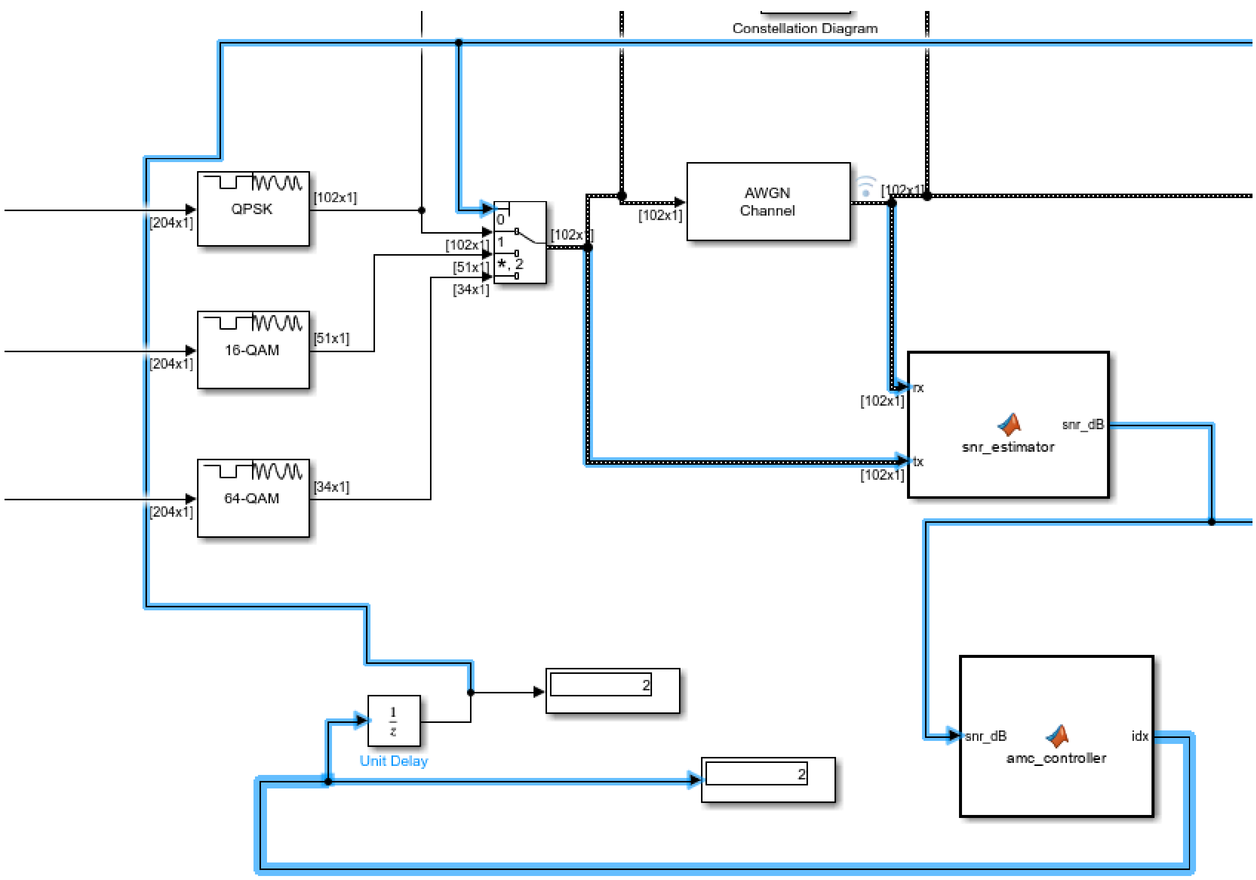
This project implements adaptive modulation in MATLAB/Simulink to compare its performance against fixed-modulation schemes.



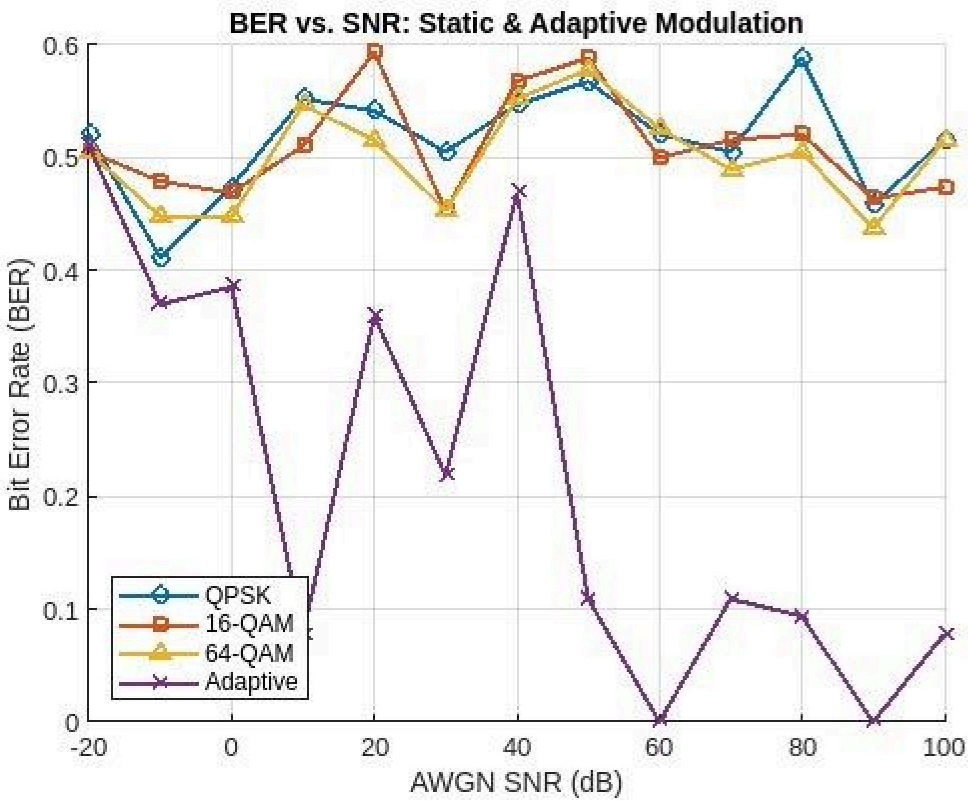
We begin by generating a random binary sequence and feeding it through a Turbo Encoder for forward-error correction. The encoded bits are then split into three parallel branches—QPSK, 16-QAM, and 64-QAM—each producing its own complex baseband waveform. A real-time SNR estimator continuously measures channel quality, and a simple AMC controller maps that estimate to an integer index (1, 2, or 3). A Multiport Switch uses this index to select exactly one of the three waveforms for transmission through an AWGN channel. At the receiver, the corresponding demodulator and Turbo Decoder recover the original bits, and a Packet Error Rate display, together with a constellation diagram, shows how the system “hops” between modulation formats as SNR varies. This adaptive approach allows the link to maintain robustness at low SNR while opportunistically increasing throughput when channel conditions improve.



At the receiver, the noisy baseband waveform emerging from the AWGN channel is fed in parallel to three demodulators—QPSK, 16-QAM, and 64-QAM—matching the three possible transmit constellations. Each demodulated symbol stream then passes through a small "wrapper" function that reshapes it back into a fixed-length bit vector, regardless of modulation order. Those standardized vectors are decoded by their respective Turbo Decoder blocks, producing three candidate bit-streams. Finally, a Multiport Switch—driven by the same AMC control index used at the transmitter—selects exactly one of the decoded outputs for further processing (e.g. Packet Error Rate calculation). This structure ensures that only the bits corresponding to the modulation order chosen by the SNR-based controller are passed on, while the other branches remain idle.



The SNR Estimator block measures the instantaneous signal-to-noise ratio by comparing the received waveform after the channel against the known transmit waveform before the channel.. The delayed SNR value is then fed into our `amc_controller` MATLAB-Function, which converts it into a one-based integer index (1 → QPSK, 2 → 16-QAM, 3 → 64-QAM). Its output is passed through a Unit Delay block to break the algebraic loop This same index drives the Multiport Switches at both transmitter and receiver, keeping the modulation format in sync on each packet.



These are the results. We took the error rate of every modulation scheme as we were doing every modulation/demodulation and selected from that the best one based on the channel conditions so we used those static schemes error rates from our simulation and ran a matlab code taking those error rates as data to plot these graphs. As we can see from this that at a given SNR the BER of Adaptive modulation is far less than the static schemes hence this shows us adaptive modulation performs better.