SOME SIMULATION RESULTS FOR CONVOLUTIONAL CODES OVER A PCM/FM FADING CHANNEL

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Summary. NASA is now actively planning entry probe missions for the outer planets. Such an entry probe requires a new telemetry link design. A probable modulation for this link is a continuous phase, narrow-band FSK (or PCM/FM), and this paper reports on simulations which can be used to estimate convolutional code performance with mild fading on such a channel. Simulated decoding has been performed for a range of signal-to-noise ratios on the PCM/FM channel with various fading characteristics.

The channel itself was a digital simulation comprizing a data generator, a modulator, a noise and fading generator, a tracking receiver, and a symbol synchronizer/detector. The signal with noise and fading and the receiver tracking response were simulated as complex amplitudes which vary at subsymbol time intervals. Thus the channel simulation was felt to be an accurate representation of actual hardware performance.

A quantized detected symbol stream from the simulated receiver was recorded on magnetic tape in files of 100 k symbols or processed by the decoding simulator. The symbol files using both a Fano Sequential Decoder (k = 24, R = ½) and a Viterbi Maximum Likelihood Decoder (k = 7, R = 1/2). Although the data file was recorded with eight level quantization, it was decoded under simulated quantizations of 2, 4, and 8. The data, as generated, consisted of a repeated 63-symbol pseudo-noise sequence, but it was transformed into an all-zero sequence of longer lengths for the decoding simulation. Most decoding was done on data frames of 252 bits (504 symbols).

The effect of atmospheric turbulence was modeled assuming that the refractive index fluctuations were weak and spacially homogeneous. The amplitude and phase fluctuations were modeled as narrow-band, independent random processes with the phase being normal and the amplitude being log normal. The variance and bandwidth of each process were adjusted to give parametric decoding performance. In addition, the fading effect on the decoders was simulated under conditions of different interlace matrices.

The results presented include the decoded error rate measured for the Maximum Likelihood Decoder, and the frame deletion rate versus the number of computations for

sequential decoding. In addition, histograms are presented as an aid in characterizing the channel amplitude probability and error bursts.

These results give the communications system engineer a good basis for choosing design parameters and operating points for a PCM/FM fading channel. They also provide some interesting points of comparison with decoding performance over the more common PSK, additive Gaussian noise channel.