ECE 519 - Project 2

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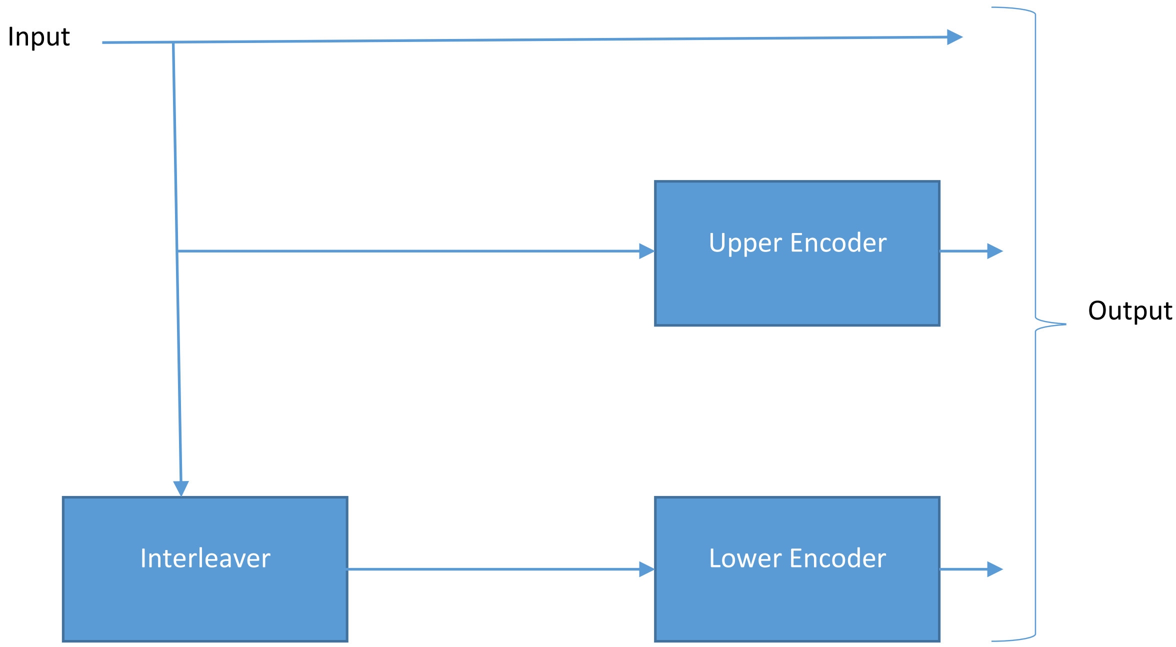
Turbo Codes:

Turbo codes are a variant of the concatenated encoding scheme. It is constructed using two or more codes that uses different interleaved version of the same information sequence. Now the turbo codes being a concatenated code, cannot provide efficient decoding output by only making use of the hard decision. The decoding is more efficient if the decoding algorithm makes use of the soft decisions (exchanging data from the soft decisions made by each decoder unit). This procedure is iterated over many rounds in order to obtain a more reliable output.

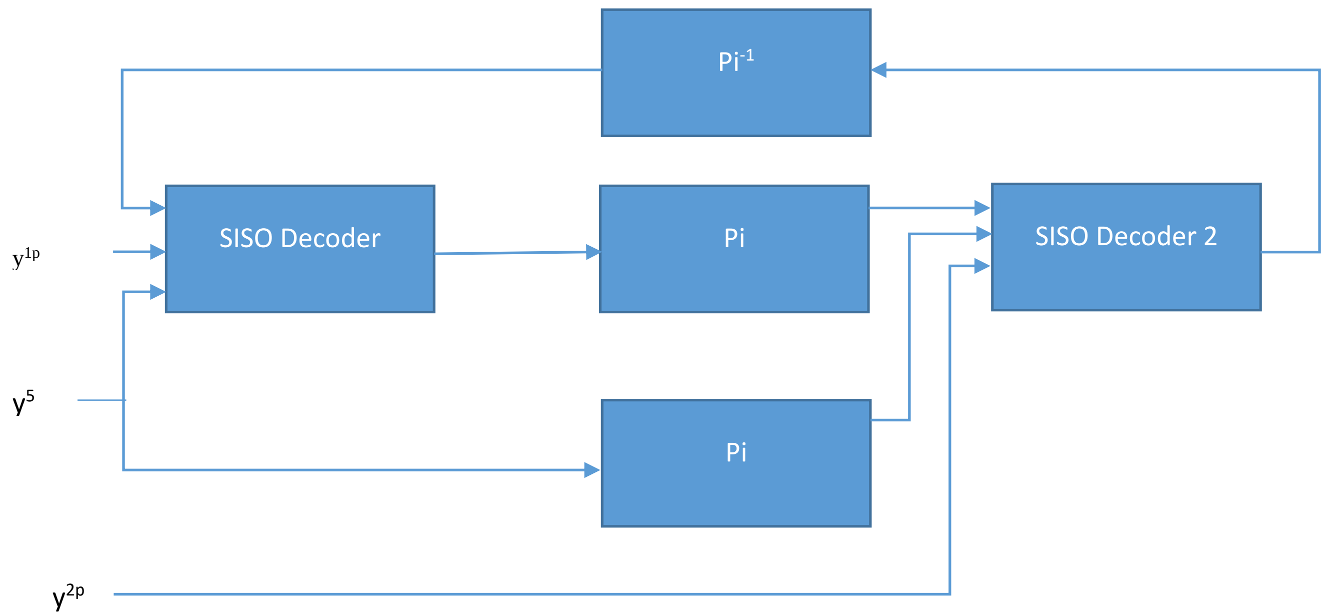
Turbo Encoder:

A turbo code is formed from the parallel concatenation of two codes separated by an interleaver. The two encoders used are normally identical. The code is in a systematic form. The main purpose of the interleaver is to randomize burst error patterns so that it can be correctly decoded. It also helps to increase the minimum distance of the turbo code. We can also use puncturing techniques in order to increase the rate of the code.



Turbo Decoder:

The decoding of turbo codes are usually done with MLD (max likelihood detector).A decoder consists of two single soft-in soft out (SISO) decoders that work iteratively. The output of one is fed into the other thereby forming a Turbo decoding iteration. The decoders process the signal, and depending on the signal amplitude they produce a soft decision output. By using the soft decision output and also the a priori probabilities we can calculate the bits to a certain degree of reliability which is then iterated again to find the final value. We either use a MAP or a LLR (Log Likelihood Ratio).



Problem 1:

It took Five Iterations, before the output converges.

Iteration 1:

$L_h(d)$		$L_v(d)$		$L(d)$	
-0.1	-1.5	0.1	-0.1	1.5	-1.5
-0.3	-0.2	-1.4	1.0	-1.5	1.1

Iteration 2:

$L_h(d)$		$L_v(d)$		$L(d)$	
-0.0	-1.6	1.1	-1.0	2.6	-2.5
-1.3	1.2	-1.5	1.0	-2.6	2.5

Iteration 3:

$L_h(d)$		$L_v(d)$		$L(d)$	
0.9	-2.5	1.1	-1.0	3.5	-3.4
-1.3	1.3	-2.4	1.0	-3.5	2.6

Iteration 4:

$L_h(d)$		$L_v(d)$		$L(d)$	
0.9	-2.5	1.1	-1.0	3.5	-3.4
-1.3	2.0	-2.4	1.0	-3.5	3.3

Iteration 5:

$L_h(d)$		$L_v(d)$		$L(d)$	
0.9	-2.5	1.1	-1.0	3.5	-3.4
-1.3	2.0	-2.4	1.0	-3.5	3.3

Decoded output

[+1 -1 -1 +1] = [1 0 0 1]

Problem 2:

It took Three Iterations, before the output converges.

Iteration 1:

$L_h(d)$		$L_v(d)$		$L(d)$	
0.61	-0.61	-0.31	0.31	3.11	-1.53
-0.23	-0.08	-2.43	1.84	-2.12	1.53

Iteration 2:

$L_h(d)$		$L_v(d)$		$L(d)$	
0.61	-0.61	1.45	-1.3	4.87	-3.14
--1.53	1.53	-2.43	1.84	-3.88	3.14

Iteration 3:

$L_h(d)$		$L_v(d)$		$L(d)$	
0.61	-0.61	1.45	-1.3	4.87	-3.14
--1.53	1.53	-2.43	1.84	-3.88	3.14

Decoded output

[+1 -1 -1 +1] = [1 0 0 1]