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A punctured convolutional code is obtained by deleting certain bits from the code word of a given rate of mother code with an aim of improving the code rate but with the same decoding complexity as the mother code. The decoding algorithm used for the Punctured convolutional codes is the same as Convolutional codes i.e. Viterbi algorithm.

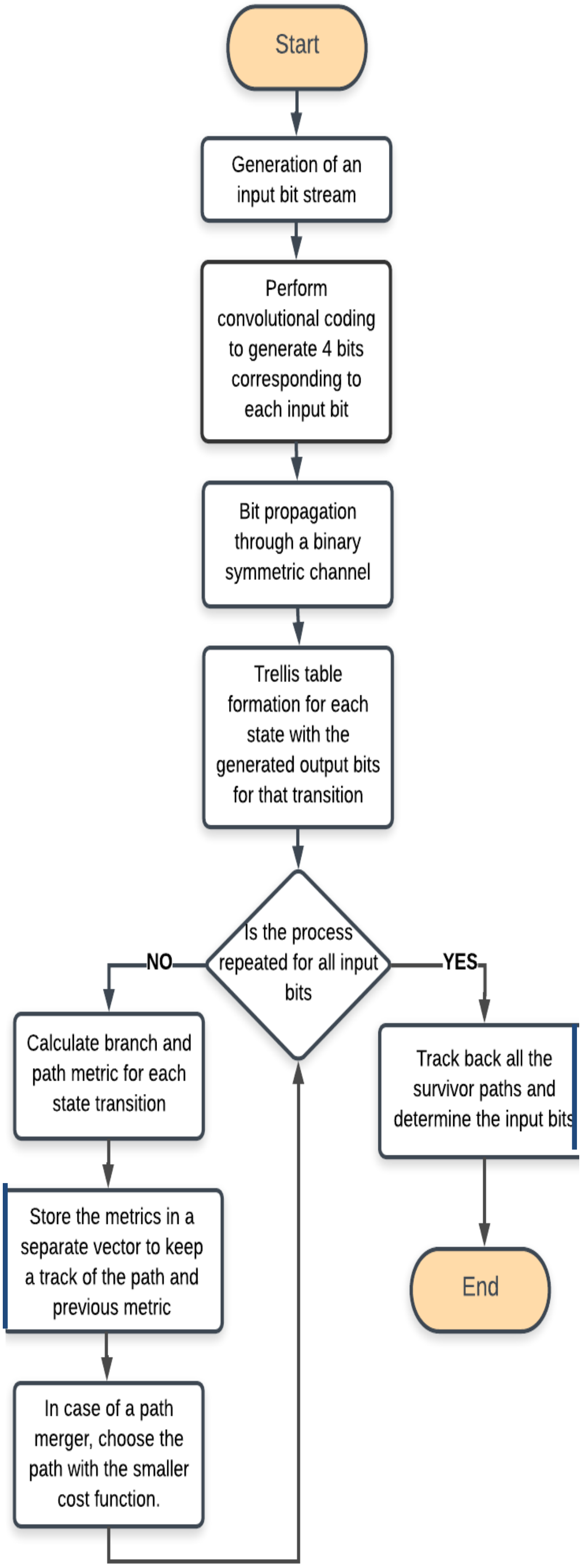
Algorithm:

1. **Encoding:**
   i. A uniform binary random source with equal probability of generating a '0' and '1' generates an 'N' bit long input stream. An additional four bits are added in the end so as to get back to the state 0.
   ii. Generator sequences of the convolutional encoder are given. Each input bit passes through 4 blocks shift register and according to the connections specified by the generator sequences, the output bits are generated.
   iii. All four bits generated at a given time are multiplexed together thereby specifying a single input bit.
   iv. With the arrival of next input bit, the previous states of the register changes and a new set of output bits are produced. The process is repeated for all the N input bits.

2. **Bit propagation through a binary symmetric channel**
   In a BSC channel, a cross over probability of 'p' is assumed which represents the probability of bit flipping while propagating through the channel. This value of 'p' varied from 0 to 0.8 throughout the simulation in order to plot a curve of bit error rate with 'p'.

3. **Decoding using Viterbi Algorithm:**
   Basis of Viterbi decoding is that in the case of a merger of two paths, one can choose a path with a smaller cost function or metric associated with it and such elimination will not affect the future metrics and the overall decoding process.

   Convolutional Codes:
   At each time instant, the value of the path and branch metric has to be determined and stored in order to keep a track of the survival path along with the associated cost function.
   i. Initial state of the system is zero. At time t=1, the two possible paths emerging from the state for both inputs '0' and '1' are considered and the corresponding hamming distance is calculated by **xor**ing the outputs generated by the two paths with the first four received bits and is stored in the matrix.
   ii. Same process has to be repeated for the first four time instants in order to have the branch and path metrics for all the 16 states of the system.
   iii. At time t = j, where j > 4, compute the partial metric for each path entering a state in the same way as above. The additional step here is to store the path (survivor) which has a lower metric and eliminating the other path. This step is concurrent with choosing the maximum likelihood



decoding.

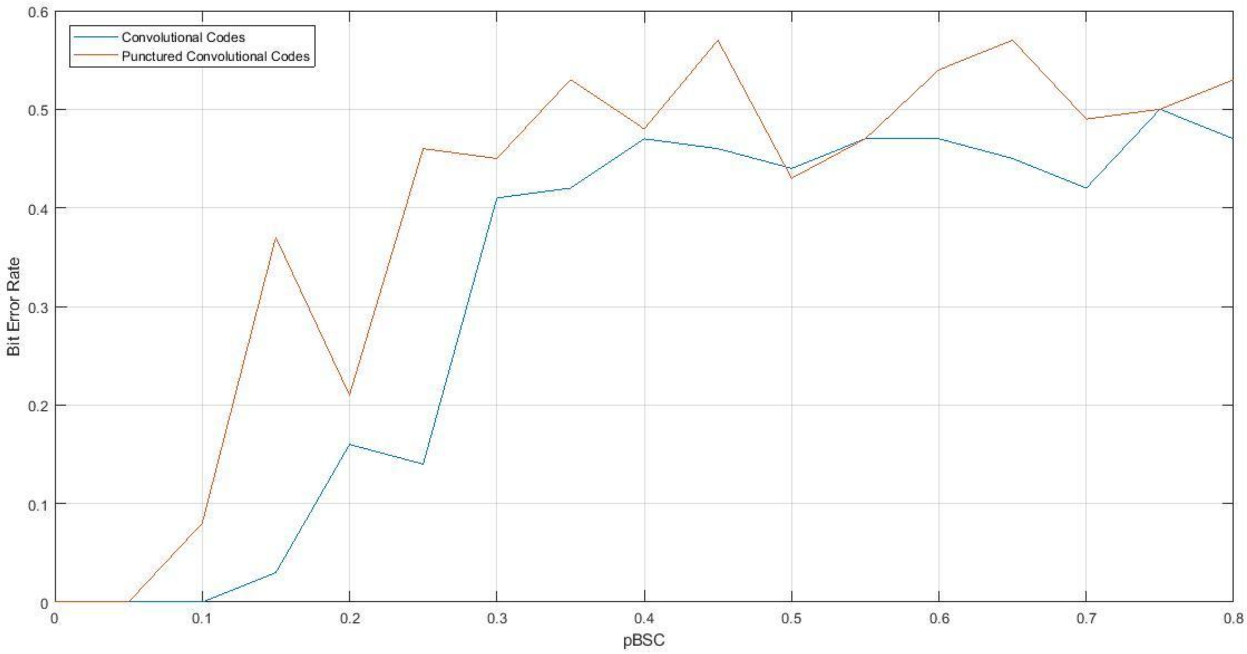
iv. Process (iii) is repeated N times so as to obtain the metrics for each state at every time instant.

v. At the end of the entire process, final state of the system will be ‘0000’. Now, the final step involves back tracing the path with the smallest metric by using the survival path matrix created during the process.

Punctured Convolutional Codes:

Decoding process for punctured code remains the same with one difference that instead of considering all the output bits to compare and calculate the hamming distance at each time instant, we consider some bits only. Puncturing matrix is used to specify the above mentioned bits. In this case, at instant 1 and 2, first three output bits are considered whereas for third and fourth time instant, only the first two output bits are taken into account. The back tracking process for determining the input bits remain the same.

<u>Simulations:</u>



Conclusion:

Bit error rate (BER) increases with an increase in the value of bit flipping probability in a binary symmetric channel for both convolutional and punctured codes. Even though the rate of the punctured codes is more as compared to the convolutional codes still convolutional codes outperforms punctured codes. Reason being that having more redundancy in the convolutional code makes it more robust to the channel’s noise. Therefore, the BER for convolutional codes is less as compared to its punctured counterpart for all the values of bit flipping probabilities.