Implementation of an Unequal Error Protection Scheme for Scalable Foveated Image Communication

Embedded Software Systems Course Project

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Problem Statement

- To provide Unequal Error Protection (UEP) against the channel noise, for real-time scalable image communication.
- **Embedded Foveation Image Coding (EFIC)**
  - Bits with greater contribution to the foveated visual distortion are encoded and transmitted first.
- **Scalable Image Communication**
  - Bitstream can be truncated at any point to provide different compression ratios.
- **Tradeoff**
  - Decrease protection as the importance of bits decreases, in order to obtain high raw data transmission rate.

UEP using Punctured Turbo codes

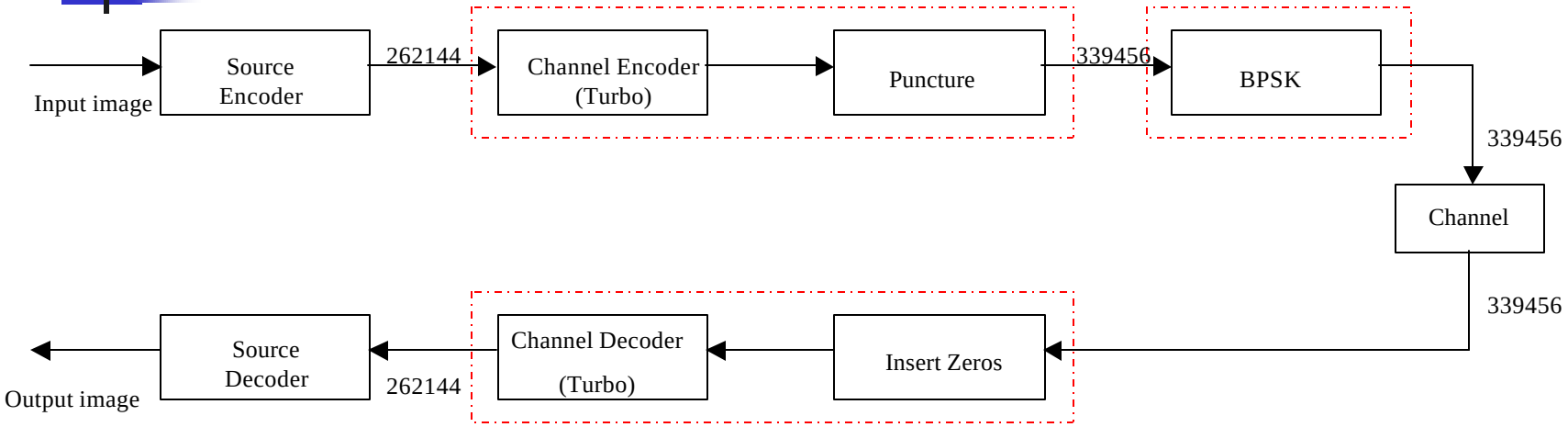
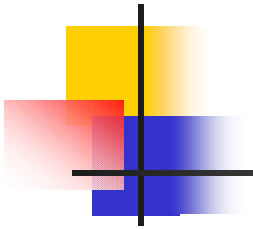


Fig. 1: Block diagram for unequal error protection using turbo codes

- Use rate compatible punctured turbo codes to provide different level of error protection to different portions of the bitstream.

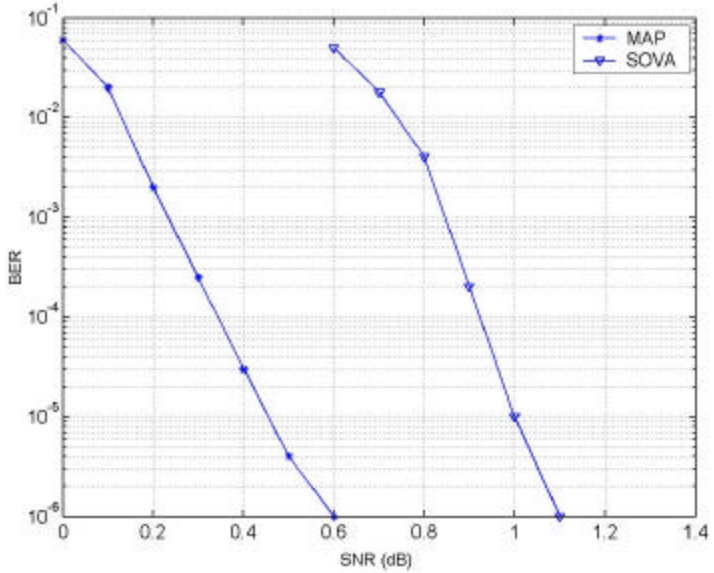


Implementation

- Each block in the system is modeled as an SDF actor.
- **Punctured Turbo Encoder:**
  - Rate 1/3 encoder with 16 states.
  - 8 different levels of puncturing for different portions of the bitstream.
  - Fixed point implementation.
- **Turbo Decoder:**
  - Uses Soft Output Viterbi Algorithm (SOVA).
    - 3 times lower complexity as compared to Maximum A posteriori Probability (MAP) algorithm.
  - Allows low complexity decoding.
  - Floating point implementation.

Implementation contd.

- Comparing MAP and SOVA performance



- Modules have been written in C.
- System is being implemented on TMS320C6701 floating-point DSP.

Results

- Encoder has been optimized.
- Decoder has been optimized with respect to memory.
- **Optimization Statistics:**

Encoder

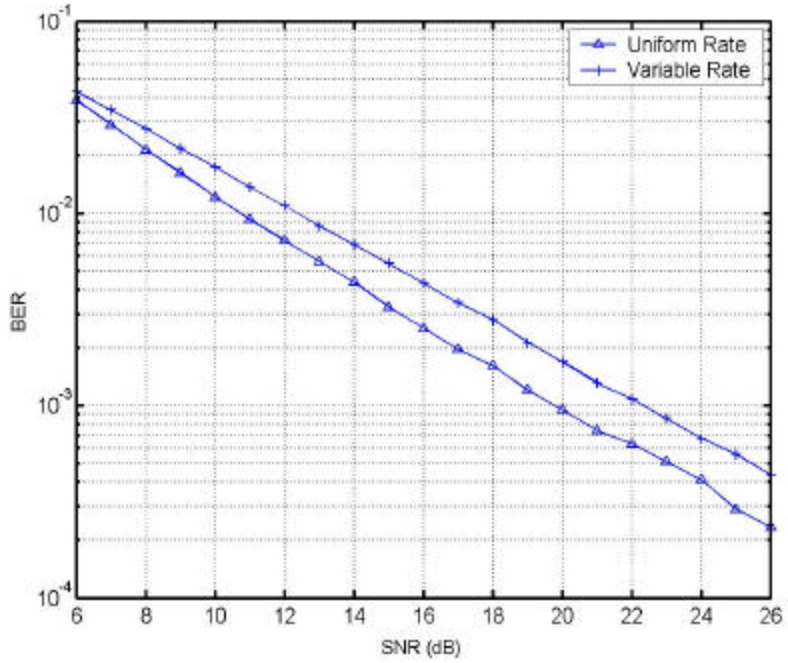
Optimization Stage	No. of Instruction Cycles (in Millions)
Without any optimization	11.18
After Level 3 optimization	5.23
After memory optimization (code & data)	1.81
After loop unrolling	1.09
After coding in assembly	0.48

Decoder

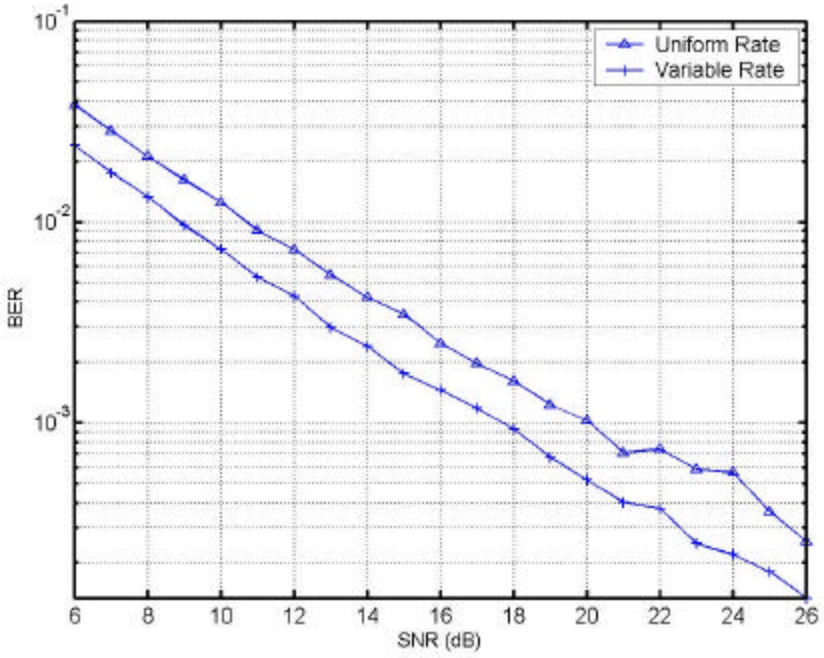
Optimization Stage	No. of Instruction Cycles (in Millions)
Without any optimization	170
After Level 3 optimization	119
After memory optimization (data)	62
After memory optimization (code)	21
After loop unrolling	18

Results contd.

- Comparison between Uniform (rate 2/3) and Unequal (overall rate 3/4) Error Protection.



BER vs. SNR for EFIC at compression ratio of 8:1



BER vs. SNR for EFIC, truncated to give a compression ratio of 32:1

Conclusions

- An unequal error protection scheme for EFIC compressed images using Punctured Turbo Codes
  - Written in C and implemented on TMS320C6701 DSP processor.
  - Optimized with respect to memory and computation time.
- **Presently working on**
  - Optimization of ‘Puncture’ and ‘Insert Zeros’ blocks.
  - Assembly level optimization of the decoder.
- **Future Work**
  - Fixed point implementation of the decoder.
  - Implementation of unequal error protection employing spatial diversity, as a real-time embedded system.