

A General Joint Source-Channel Matching Method for Wireless Video Transmission

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- There is an increasing demand for efficient and error-resilient image and video transmission systems.
- Jointly optimizing the source and the channel coder rate parameters can provide optimal performance.
- Utilizing a parametric model approach, we developed a general matching system for wireless video transmission.
- Our system has a low complexity and yields significant performance gain compared with fixed-parameter systems.

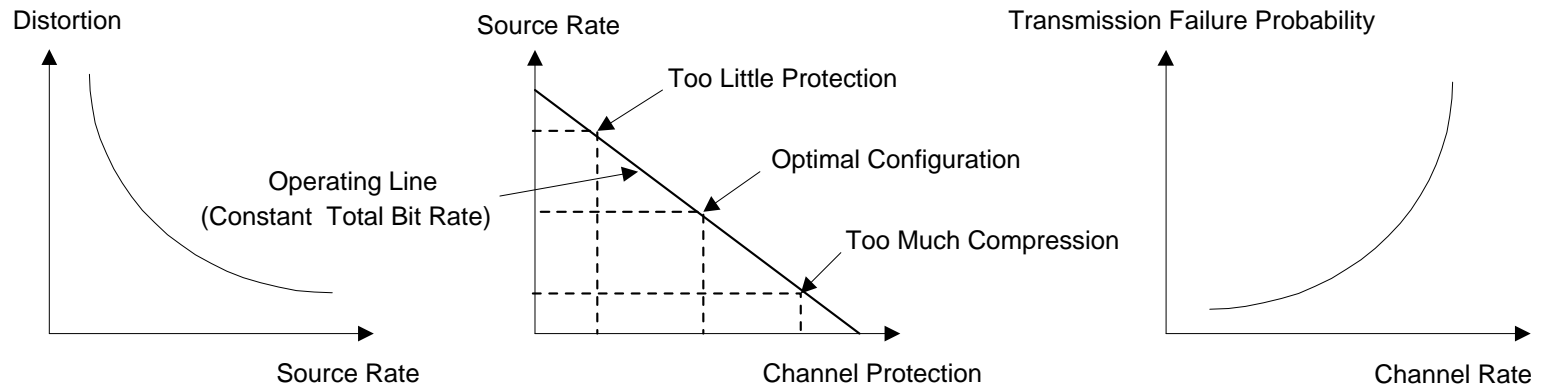
System Details

- We estimate source coder characteristic curves by evaluating control points followed by interpolation.
- Our system satisfies the real-time delay constraints, rate-control and constant-rate video playback requirements.
- A gradient descent algorithm with aid of penalty function is used to solve the constrained optimization problem.
- Our system has a fast convergence speed of below five iterations and is online implementable.
- Motion-JPEG and Conditional Block Replenishment coders and Reed-Solomon channel coders are used as examples.

Introduction

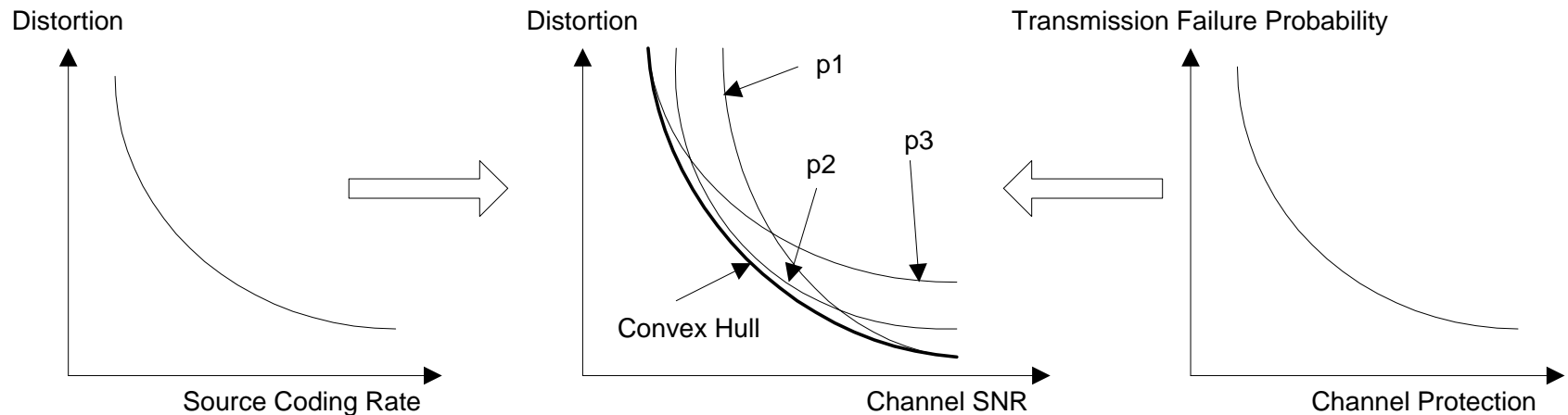
- Advantages of applying JSCM for wireless image transmission have been widely demonstrated.
- Certain difficulties arise in implementing JSCM for wireless *video* transmission:
 - Video coders are generally more complex.
 - Real-time delay constraints and rate control introduce significant new challenges.
- A general matching scheme is desirable because of real-world system implementation constraints.

Joint Source-Channel Matching



- Increasing source rate leads to less compression and reduces decoding distortion.
- Increasing the amount of channel protection reduces error and increases expected distortion.
- Limited channel capacity introduces a trade-off between the source rate and the amount of channel protection.

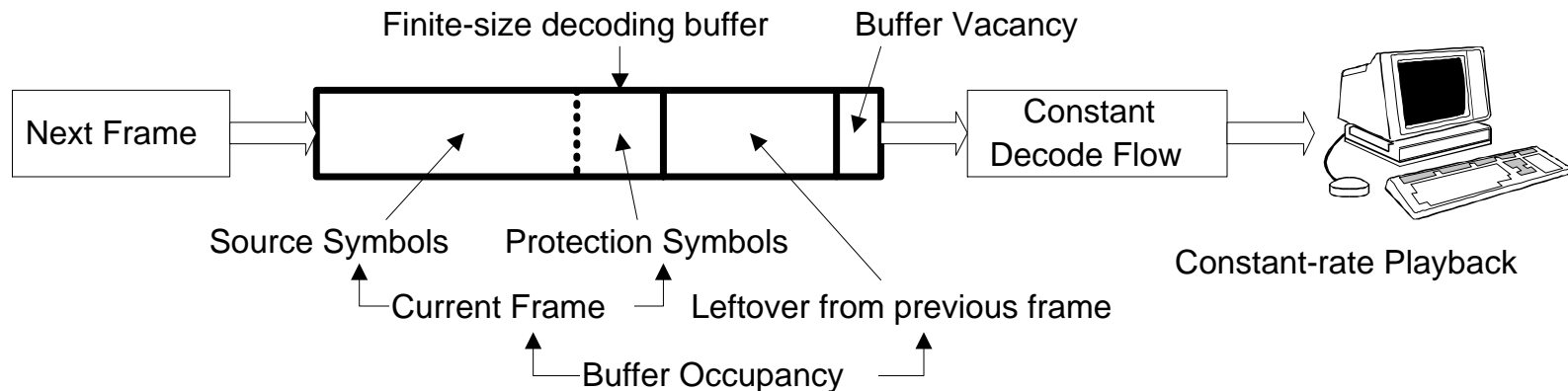
Joint Source-Channel Matching



- Fixed-parameter systems ($p1$, $p2$, $p3$) perform poorly under unfavorable channel situations.
- Adapting to the varying channel situation, JSCM jointly allocates source rate and channel protection.
- JSCM will always yield the optimal coding parameters, which are located on the convex hull of those curves.

Video Transmission Issues

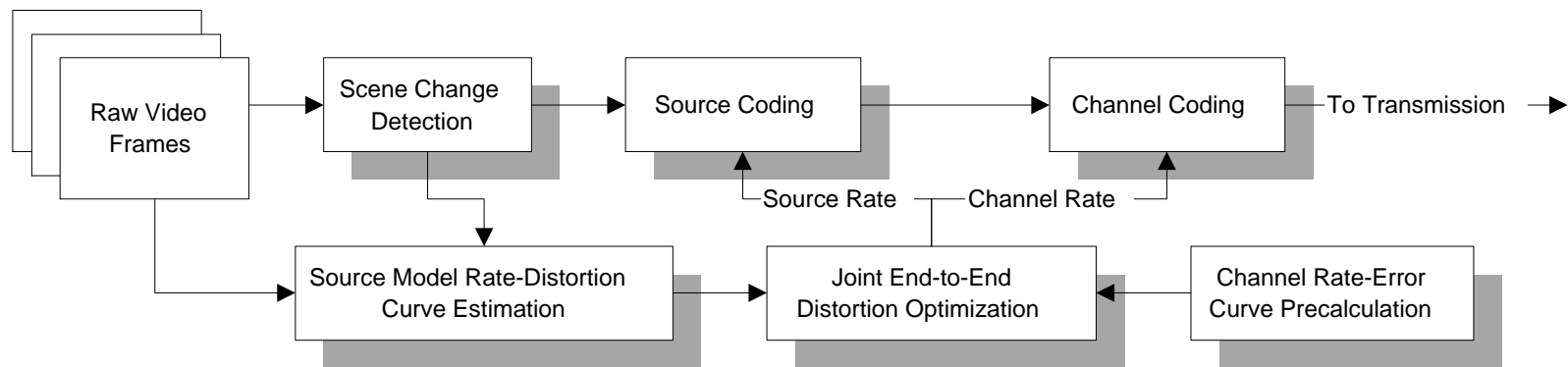
- Delay Constraint: in video transmission, only a small, finite delay is allowed.
- Rate Control: finite decoding buffer size and a constant playback rate requirement.



Problem Formulation

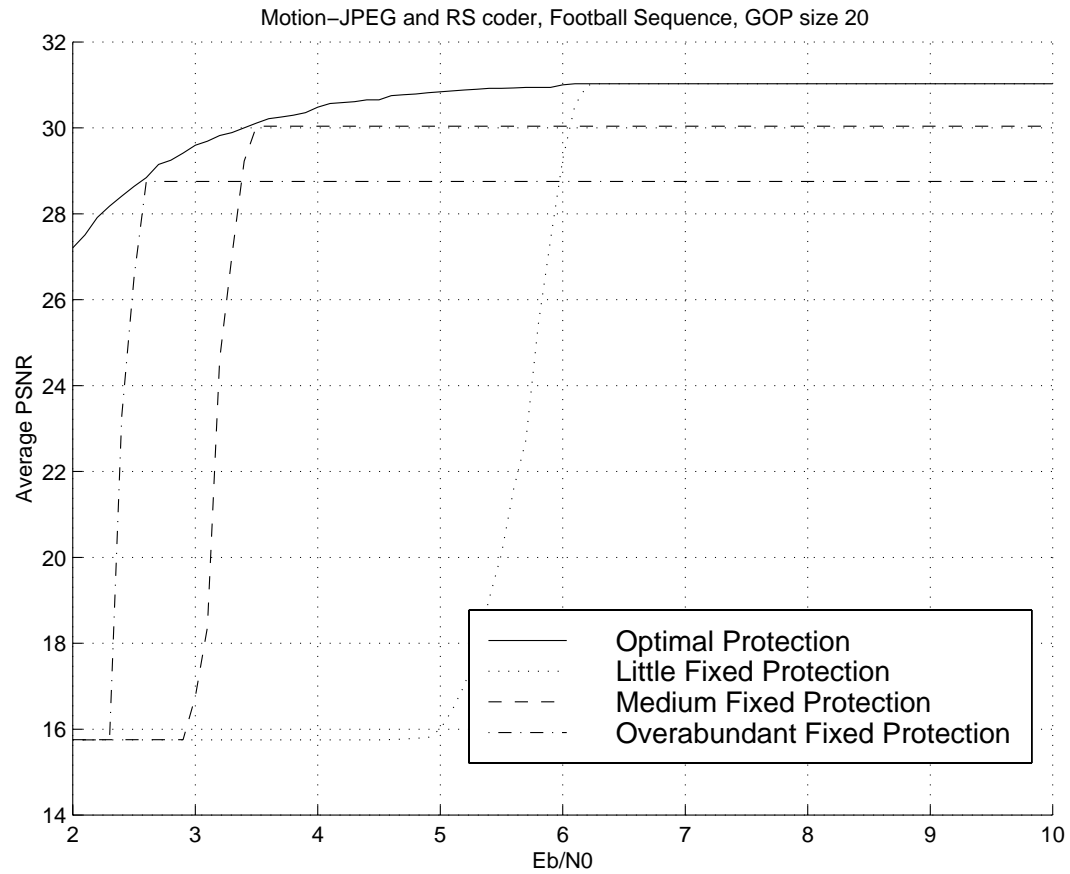
- Situation: groups of N video frames need to be source and channel coded, and then transmitted.
- Goal: minimize pre-defined cost function with respect to source and channel rate parameters.
- Constraint: avoid decoding buffer overflow while maintaining a constant decoding rate.
- Strategy: constrained nonlinear optimization, solved using gradient descent algorithm with penalty function.

General System Diagram

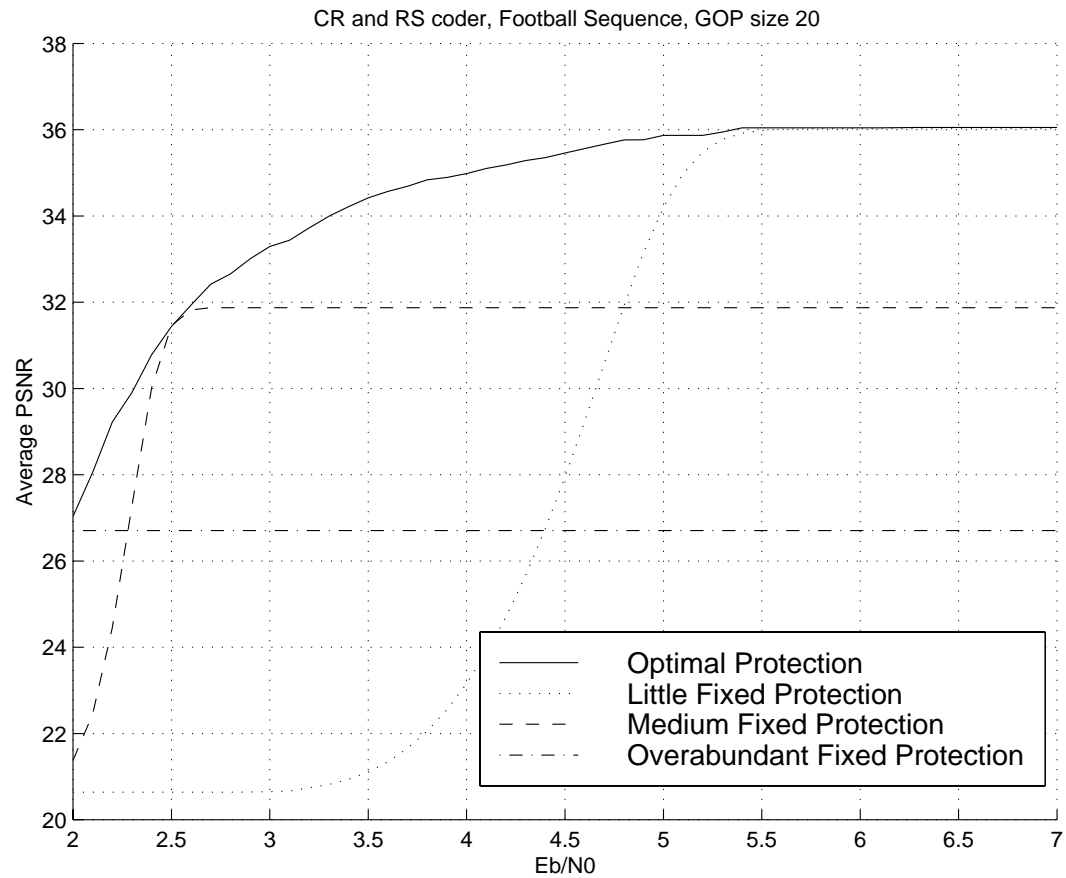


- The above general structure applies regardless of the source and channel coders being used.
- To demonstrate, we use Motion-JPEG source coder and Reed-Solomon (RS) channel coder.

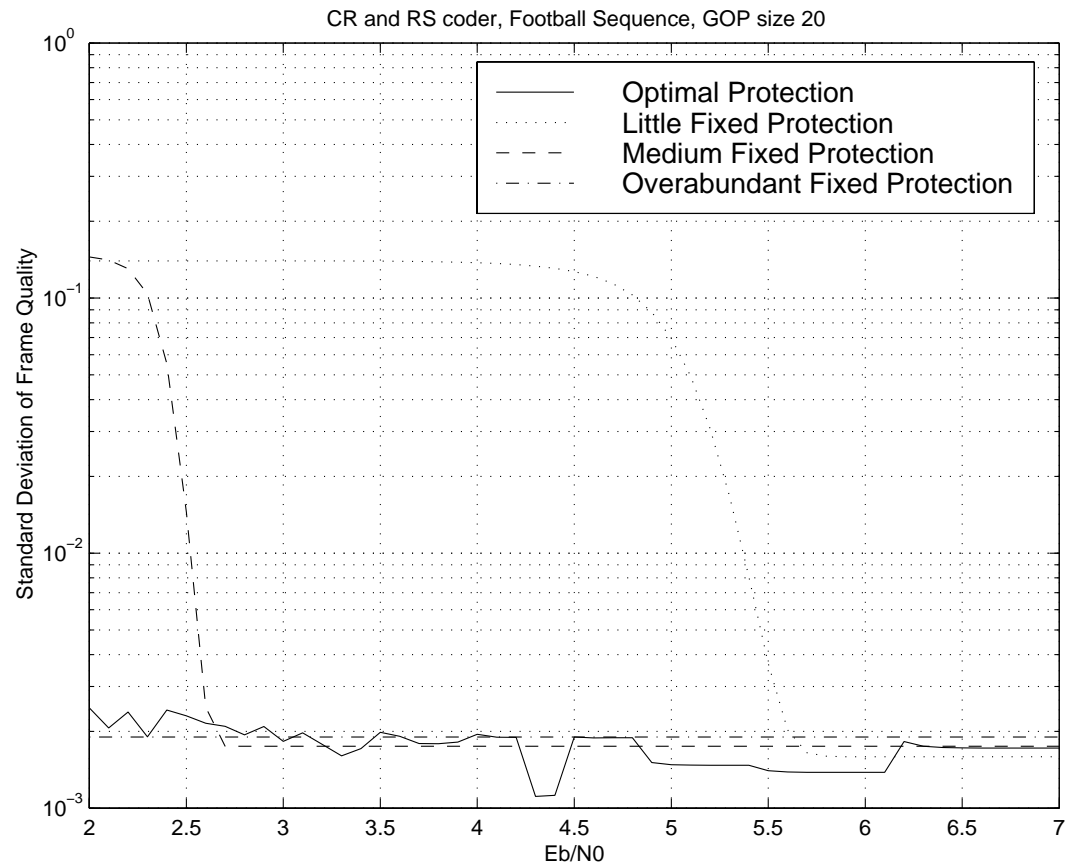
Simulation Results (MJPEG-PSNR)



Simulation Results (CBR-PSNR)



Simulation Results (CBR-VAR)



Generality Of Our System

- Inexpensive parametric-model approach for characterizing source-coder performance.
- Model parameters can be estimated online; no explicit knowledge about source coders required.
- Applicable to many coders, including standard ones.

Conclusions

- Our system yields excellent results across the entire region of channel situations.
- System generality is achieved because of the parametric-model-based approach.
- Our system has a low computational complexity and can be implemented online.
- In future work, we will test our scheme on a wider variety of source and channel coders.