

Lehigh University Center for Optical Technologies

Robust Distributed Source Coding Using LDPC Codes

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Motivation of the Work

- Distributed Source Coding (DSC), also known as distributed compression or the Slepian-Wolf Coding
- Compression of statistically dependent signals in a **distributed** manner to the **same rate** as with a system where the signals are compressed **jointly**
- Goal: exploring robust DSC using Low Density Parity Check codes**

Why Robust?

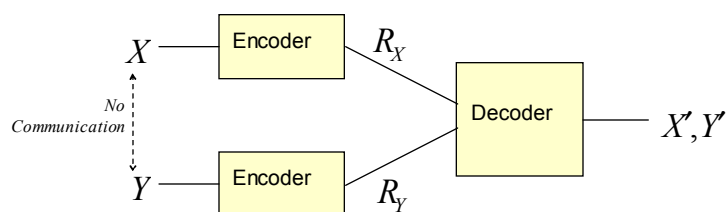
- Robust:** relatively insensitive to minor transmission errors; error resilient (even without explicit error protection)
- In real life: transmission channels are noisy and error protection is imperfect
- Errors in compressed data may cause the source decoder to fail completely

Why LDPC codes?

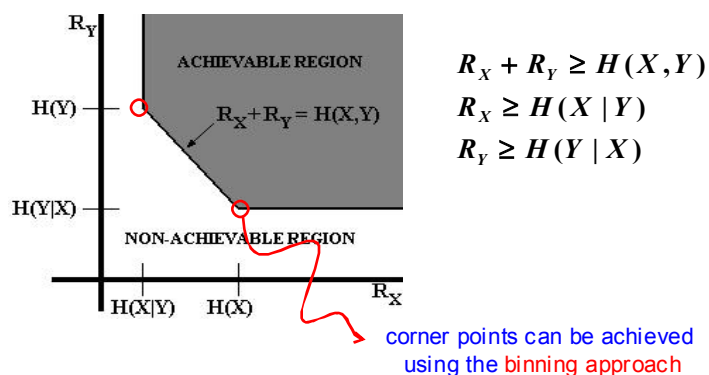
- LDPC codes are power channel codes – powerful channel codes are needed for good compression rates in DSC (Binning Theory)
- LDPC codes have potentially lower decoding complexity than turbo codes

Preliminary

The Slepian-Wolf coding problem tackles the distributed encoding of correlated discrete-alphabet sources for decoding at a common receiver



The Slepian-Wolf achievable rate region. No performance loss is seen as a result of the lack of communication between sources

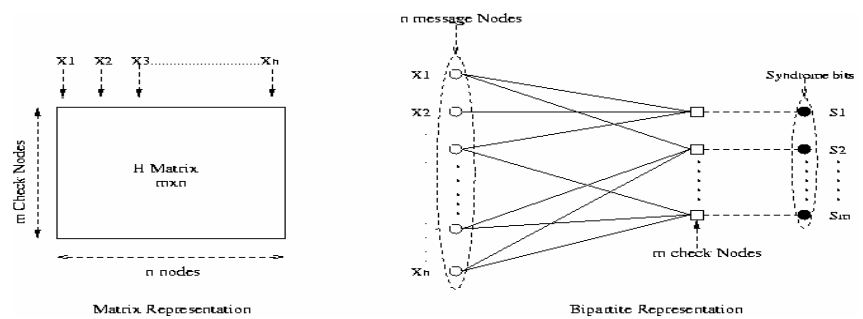


Binning Theory

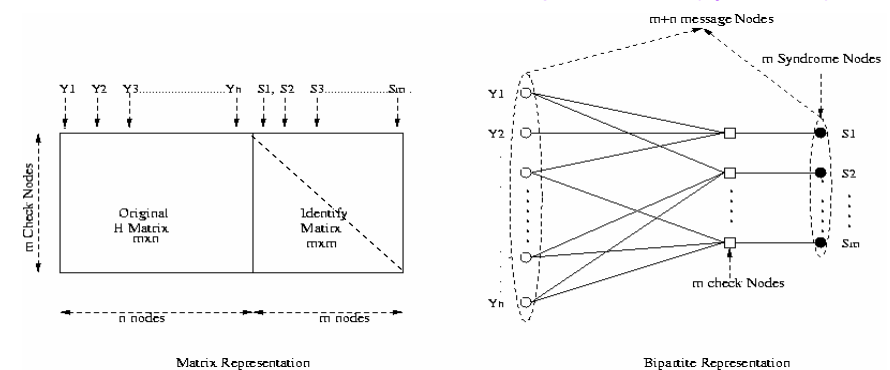
Binning refers to partitioning the space of all possible outcomes of a random source into disjoint bins. For binary i.i.d. sources, $X \in \{0,1\}^n, Y \in \{0,1\}^n$, the generic binning concept uses approximately $2^{nH(X,Y)}$ sequences to describe (X^n, Y^n) where the $2^{nH(X,Y)}$ sequences will be placed in $2^{nH(X|Y)}$ bins with $2^{nH(Y)}$ sequences in each bin. So only $nH(X|Y)$ bits are needed to specify a particular bin and $nH(Y)$ bits to specify a particular sequence in the bin. **It is straight forward to use LDPC code to take the syndrome information as the bin index.**

Conventional Approach

Source encoding: using an **conventional LDPC** code

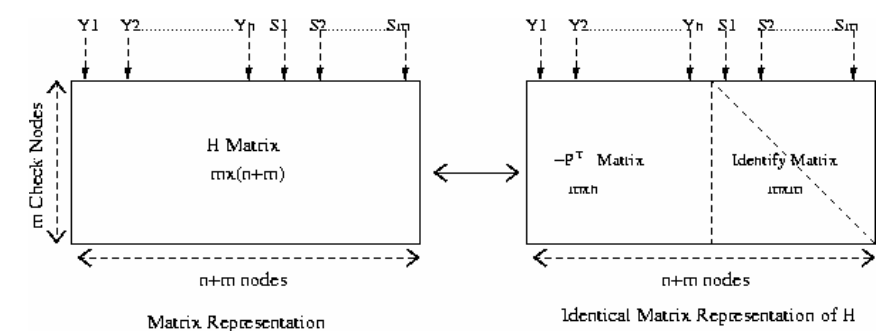


Decoding: using an **extended LDPC** code that contains an identity sub-matrix
 → The extended H matrix not suitable for message-passing decoding
 → **vulnerable to residue errors in the compressed data (syndromes)**



The Proposed Approach

Decoding: using a **conventional LDPC** code that possesses the desired weight properties/distribution
 → **well performing, robust to residue errors in syndrome bits**



Source encoding: using an **shortened LDPC** code

