Lossless Image Compression Based on Contextual Adaptation of Predictor Blends

First Croatian Computer Vision Workshop 2012

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CBPC – Contents

- Introduction
- CBP predictor
- Results
- Conclusion

Introduction

Predictive image coding:

1. Prediction $\hat{I} = f(\Omega(I))$
2. Contextual probability model
3. Entropy coding

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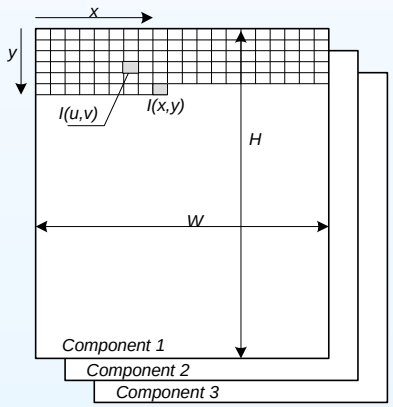

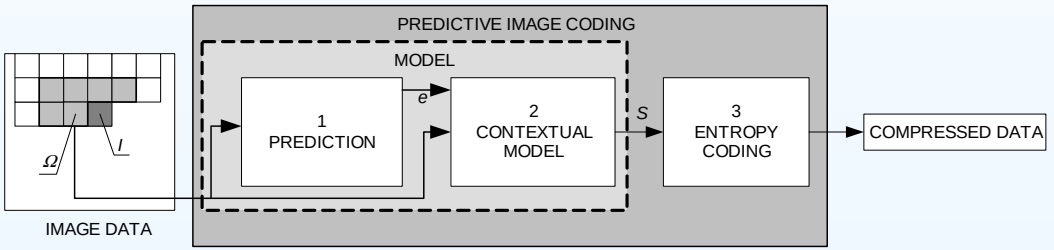

Figure 1: Predictive image coding

$$\hat{I}(x,y) = f(\Omega(x,y)) = \sum_{I(i,j)\in\Omega} a_{i,j} \cdot I(i,j)$$

$$e(x,y) = I(x,y) - \hat{I}(x,y)$$

CBP predictor

Typical image regions:

CBP predictor

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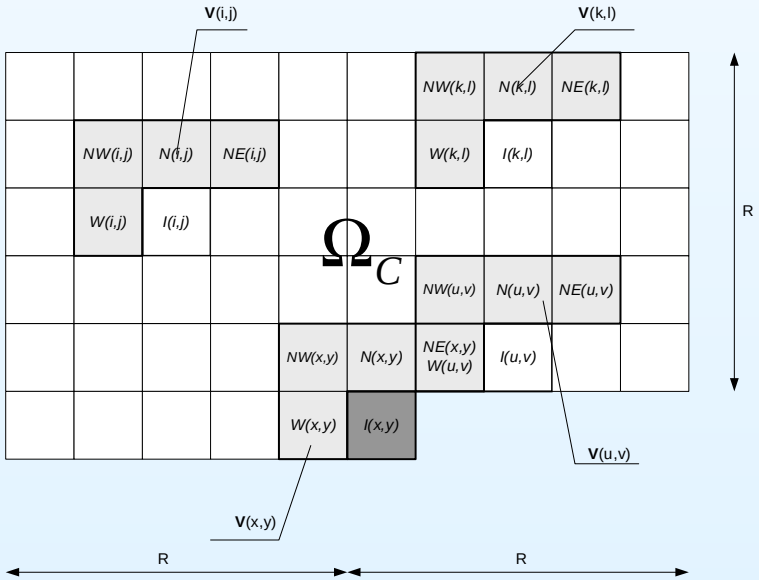
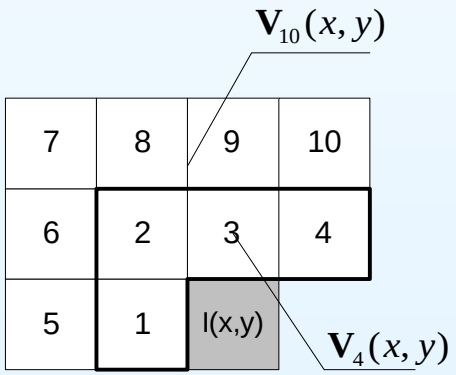
Proposed predictor: *Classification and Blending Predictor – CBP*





CBP predictor

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1. **Classification:**
   $D(i,j) = ||v(i,j) - v(x,y)|| = ||w - v|| = \sum_{k=1}^{d} |w_k - v_k|^2$
   Find M pixels with the smallest distances to the current pixel's vector $v(x,y)$ = *Current cell* Ω_B.

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2. **Blending:** For every $f_k \in \mathcal{F}$ determine penalty term G_k

$$G_k = \frac{1}{M} \sum_{I(i,j) \in \Omega_B} (f_k(i,j) - I(i,j))^2 \qquad \forall f_k \in \mathcal{F}$$

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4. **Error correction:**

$$\bar{e}(\Omega_B) = \frac{1}{M} \sum_{I \in \Omega_B} (F(i,j) - I(i,j)$$

$$\dot{I}(x,y) = \hat{I}(x,y) + e(\bar{\Omega}_B)$$

CBP parameters

- Radius R
- Cell population M
- Vector size d (Set to 5).
- Set of predictors $\mathcal{F} = \{f_N, f_W, f_{NW}, f_{NE}, f_{GW}, f_{GN}, f_{PL}\}$

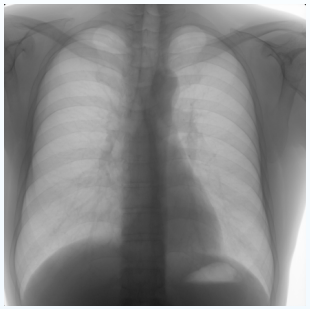
$$f_N = I(x, y-1) \qquad f_W = I(x-1, y)$$
$$f_{NW} = I(x-1, y-1) \qquad f_{NE} = I(x+1, y-1)$$
$$f_{GW} = 2 \cdot I(x, y-1) - I(x, y-2) \qquad f_{GN} = 2 \cdot I(x-1, y) - I(x-2, y)$$

$$f_{PL} = I(x, y-1) + I(x-1, y) - I(x-1, y-1)$$

Selected settings for CBP predictor

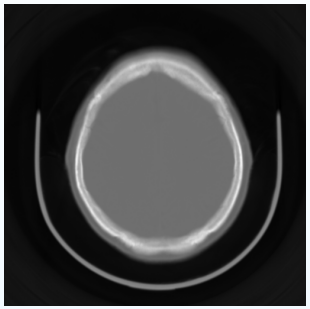
Radius *R*	Population *M*	Vector size *d*
5	7	4

Test images



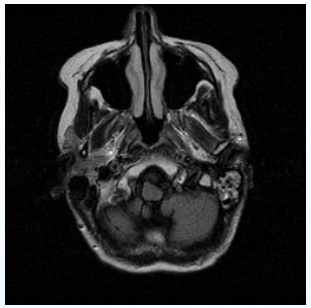
(a) CR-chest

(b) CT-abdo

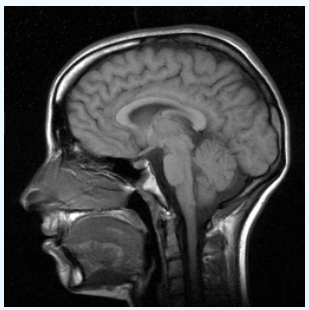


(c) CT-brain

(d) CT-lomb



(e) MR-head



(f) MR-head1

(g) MR-knee

(h) OT-an7

(i) OT-colon

CBPC Results

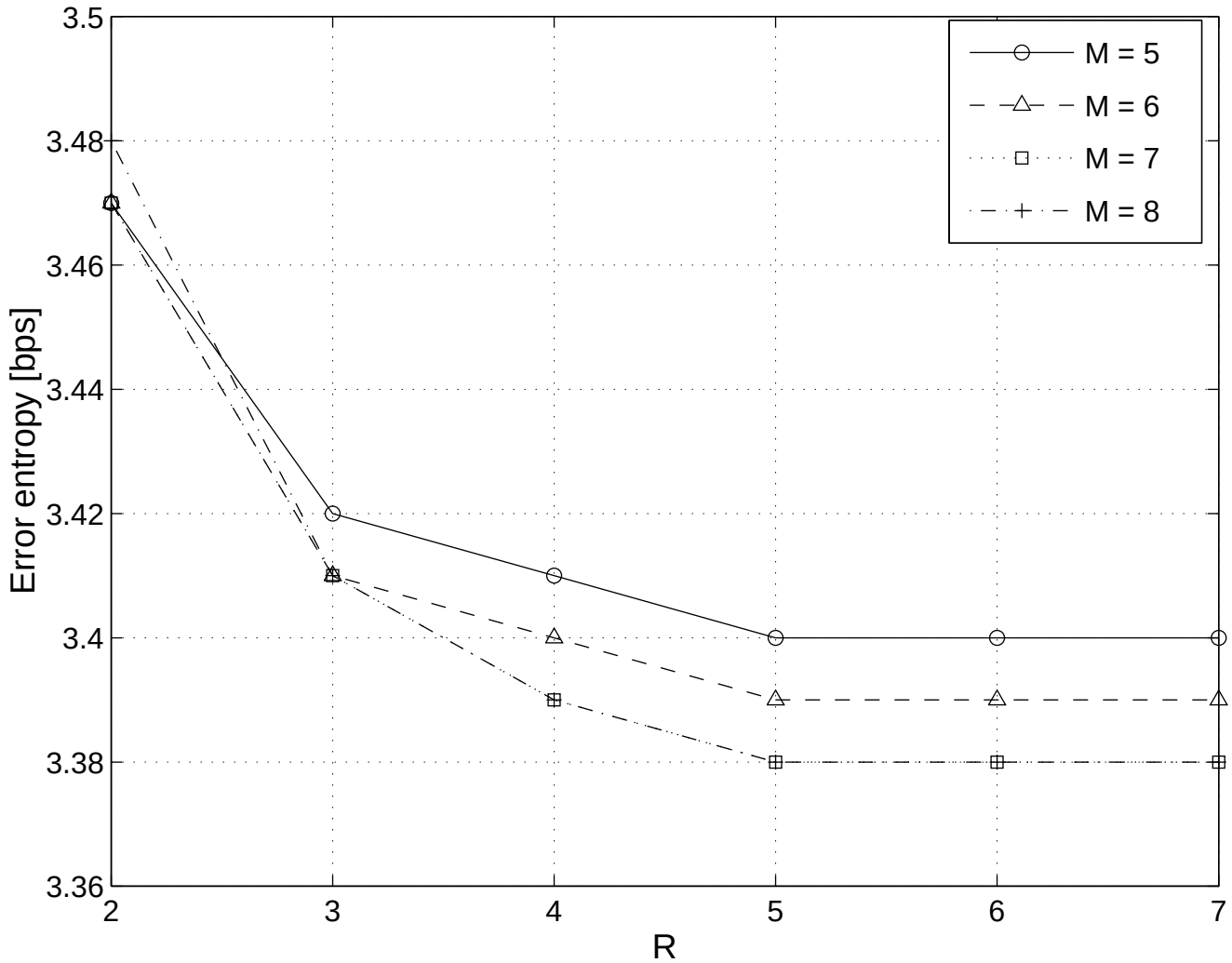


Figure 2: Average zero–order entropy vs. radius *R*

CBP Results

Zero-order entropy of the prediction error (bps)

Image	MED	GAP	CBP
CR-chest	2.52	2.49	**2.28**
CT-abdo	2.67	2.73	**2.72**
CT-brain	1.79	1.93	**1.17**
CT-lomb	2.46	2.59	**2.19**
MR-head	4.80	4.75	**4.55**
MR-head1	4.85	4.82	**4.51**
MR-knee	5.24	5.20	**5.12**
OT-an7	4.20	4.28	**4.17**
OT-colon	3.84	3.91	**3.75**
Average	3.60	3.63	**3.38**

CBPC Results

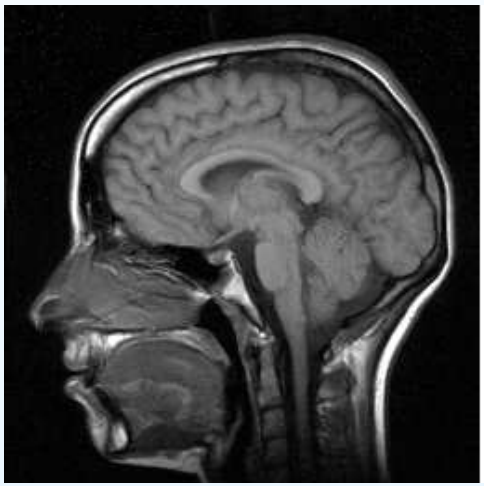
Contextual model from CALIC algorithm (Ref. [4] in the article.)

Bit-rate of a complete coder (bps)

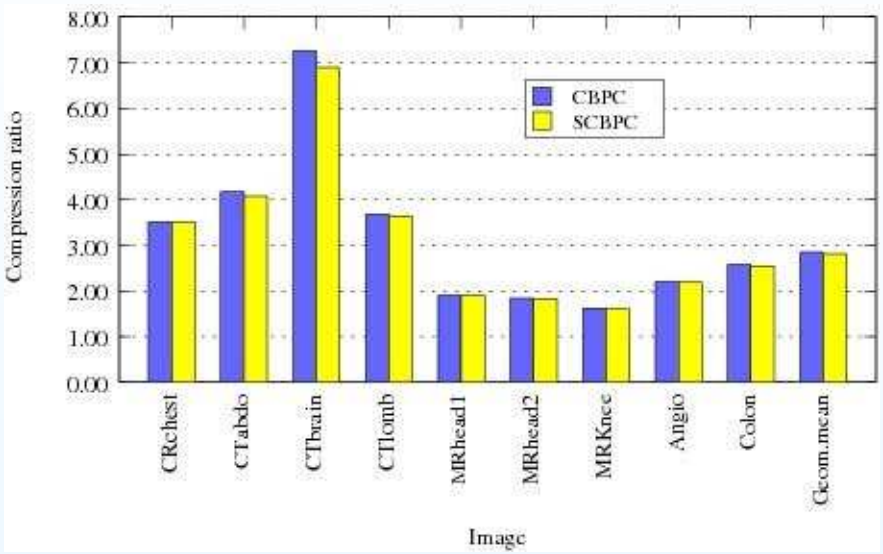
Image	CALIC	JPEG-LS	JPEG2000R	**CBPC**
CR-chest	2.35	2.39	2.52	**2.27**
CT-abdo	2.27	1.89	2.59	**1.92**
CT-brain	1.24	1.29	1.42	**1.10**
CT-lomb	2.21	2.34	2.38	**2.17**
MR-head	4.27	4.44	4.47	**4.18**
MR-head1	4.44	4.62	4.71	**4.33**
MR-knee	4.98	5.08	5.11	**4.92**
OT-an7	3.70	3.67	3.97	**3.62**
OT-colon	3.21	3.20	3.45	**3.10**
Average	**3.18**	**3.21**	**3.40**	**3.07**

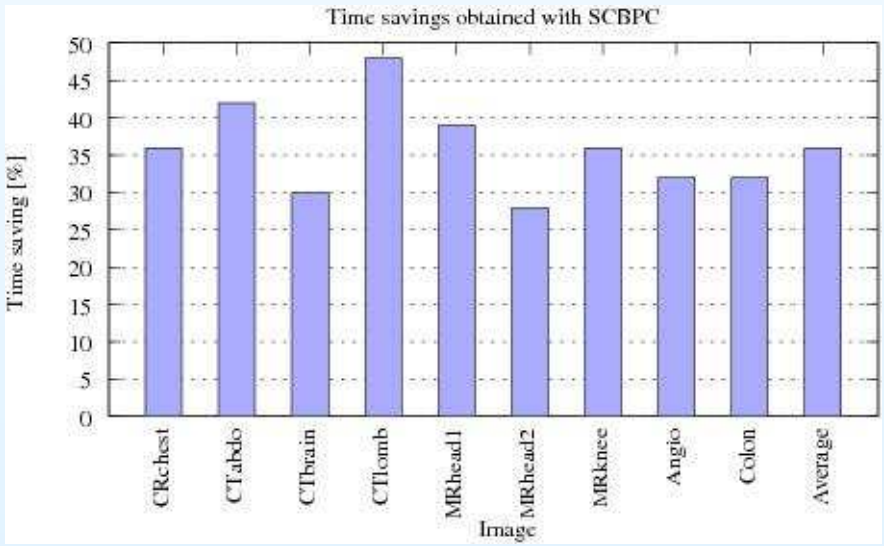
SCBPC Selective Computation

1. Reduce the number of penalty computation
2. Threshold T for penalty recomputation



SCBPC Performance Results





Software System

- CBPC – Contents
- Introduction
- CBP predictor
- CBP parameters
- Test images
- CBPC Results
- SCBPC Selective Computation
- SCBPC Performance Results
- Software System

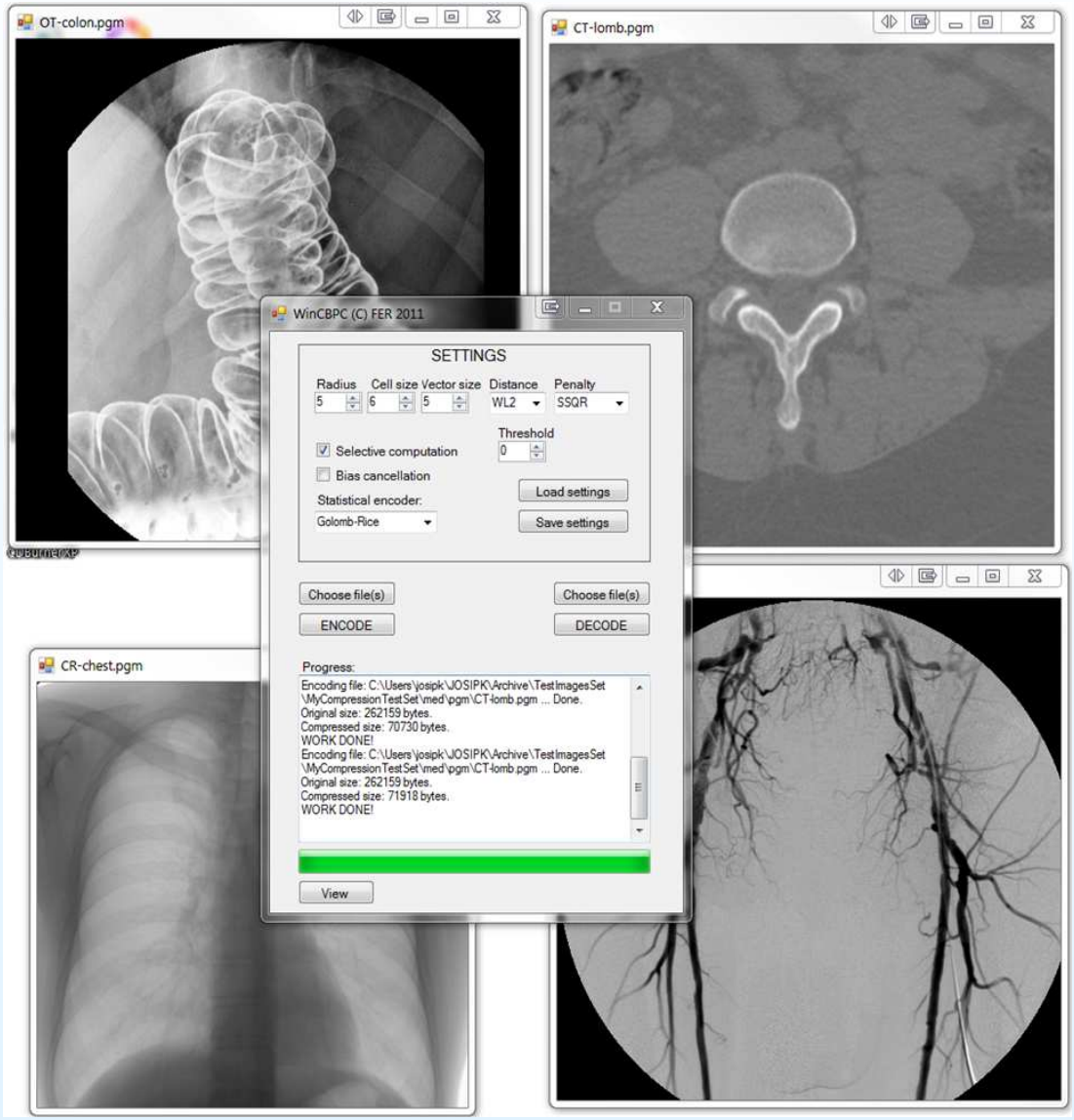


Figure 3: CBPC and SCBPC

THANK YOU!