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Reversible Data Hiding for JPEG Images Based on Quantization-Table-Modification and STC

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Abstract

Reversible data hiding (RDH) for JPEG images has attracted extensive attentions in recent years. Particularly, quantized-DCT-coefficients-modification and quantization-table-modification are two main approaches for JPEG images RDH. However, for quantization-table-modification based methods, as lack of accurate measurement for the embedding distortion, its performance is far from optimal. Then, by incorporating syndrome-trellis-code (STC) into quantization-table-modification, a novel and efficient JPEG images RDH method is proposed in this paper. Specifically, by designing diverse reversible embedding rules with STC, the corresponding capacity-distortion model is established. In this way, the embedding distortion is well controlled, and the embedding performance is enhanced. Experimental results show that the proposed method can provide better visual quality compared with some state-of-the-art methods.

Motivation

For the QTM based method, despite excellent, its performance is far from ideal due to the absence of precise measurement for the embedding distortion.

Conclusion

In this paper, a novel RDH scheme for JPEG images based on QTM and STC is proposed. Unlike the previous methods, we generalize QTM into a STC embedding framework, in which less distortion and better performance are derived. Experimental results verify that the proposed method is superior to works [11] and [6]. Additionally, incorporating reasonable block selection strategy into our method is a promising direction for future research.

Methodology

A novel RDH method for JPEG images is proposed by generalizing the embedding strategy into the STC algorithm application. The specific embedding and extraction scheme is shown in Figure. 1.

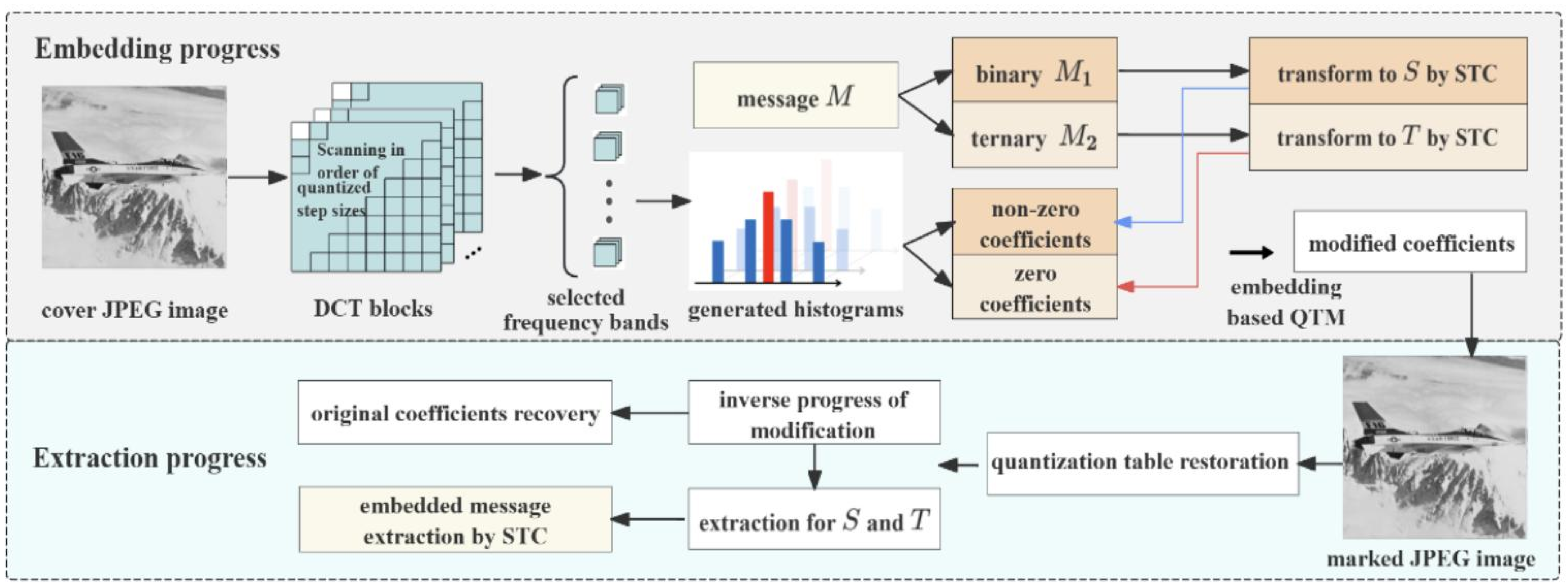
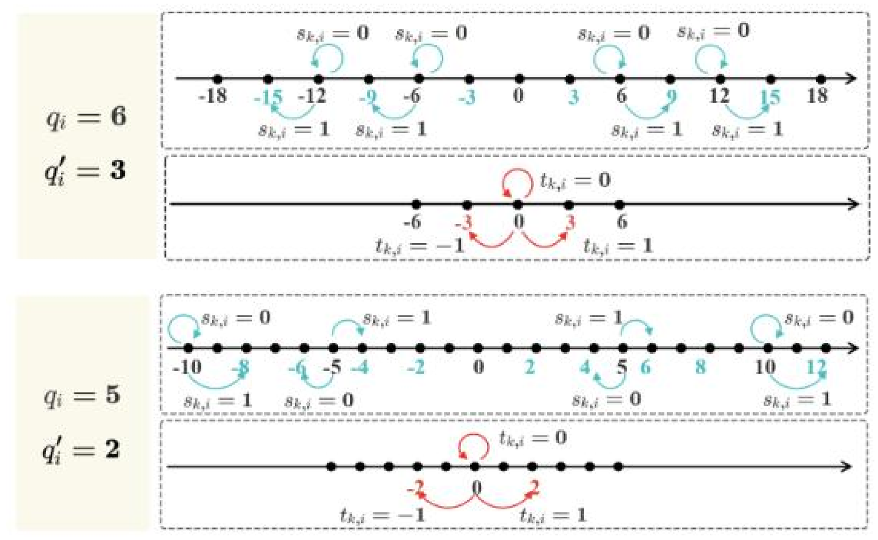


Figure 1 The proposed framework.

Embedding rules



Capacity-distortion model

$$\begin{cases} \text{minimize} & \sum\limits_{1\le k\le N, i\in I, z_{k.i}\neq 0} \lambda_{k,i} s_{k,i} \\ \text{subject to} & H_1 S = M_1 \end{cases}$$

$$\begin{cases} \text{minimize} & \sum\limits_{1\le k\le N, i\in I, z_{k.i}= 0} \mu_{k,i} \left| t_{k,i} \right| \\ \text{subject to} & H_2 T = M_2 \end{cases}$$

Experiments

Image	Method	Embedding capacity (bits) with QF=70				Embedding capacity (bits) with QF=80				Embedding capacity (bits) with QF=90			
		6,000	9,000	12,000	15,000	6,000	9,000	12,000	15,000	6,000	9,000	12,000	15,000
Airplane	[11] ($k=2$)	52.89	52.16	51.59	50.40	54.38	53.78	53.35	52.54	58.27	57.57	56.91	56.05
	[11] ($k=3$)	55.32	53.89	53.62	53.20	56.59	55.53	55.33	54.76	59.65	58.47	57.69	57.22
	[11] ($k=4$)	55.76	53.99	53.71	**53.62**	56.50	55.04	54.81	54.53	58.33	56.93	56.56	55.98
	[6]	47.71	44.69	42.16	40.10	50.68	48.15	45.81	43.70	54.54	52.43	50.88	49.30
	Ours	**56.28**	**55.13**	**54.38**	53.59	**58.92**	**57.04**	**56.20**	**55.60**	**64.58**	**62.65**	**61.30**	**60.26**
Baboon	[11] ($k=2$)	52.67	51.99	51.41	50.29	54.23	53.69	53.22	52.55	58.06	57.32	56.76	55.90
	[11] ($k=3$)	55.11	53.39	53.11	52.78	56.57	55.39	55.26	54.72	59.66	58.53	57.76	57.21
	[11] ($k=4$)	55.79	53.81	53.57	**53.50**	56.29	54.76	54.54	54.39	58.58	57.04	56.47	55.97
	[6]	44.80	42.30	40.24	38.57	46.69	44.26	42.06	40.28	49.44	46.88	44.78	43.13
	Ours	**56.12**	**55.06**	**54.28**	53.42	**58.66**	**57.07**	**56.21**	**55.54**	**64.59**	**62.55**	**61.23**	**60.11**
Barbarba	[11] ($k=2$)	52.86	52.22	51.54	50.38	54.22	53.72	53.23	52.56	58.13	57.32	56.78	55.96
	[11] ($k=3$)	55.32	53.73	53.35	53.06	56.58	55.48	55.25	54.68	59.75	58.55	57.76	57.19
	[11] ($k=4$)	55.83	53.87	53.82	**53.58**	56.24	54.85	54.59	54.37	58.57	56.93	56.49	55.92
	[6]	46.72	43.77	41.35	39.63	49.74	46.9	44.52	42.45	53.82	51.57	49.64	47.73
	Ours	**56.13**	**55.05**	**54.31**	53.52	**58.83**	**57.06**	**56.23**	**55.60**	**64.54**	**62.64**	**61.18**	**60.22**
Boat	[11] ($k=2$)	52.88	52.24	51.52	50.40	54.24	53.77	53.28	52.54	58.13	57.39	56.83	55.93
	[11] ($k=3$)	55.27	53.75	53.37	53.06	56.75	55.44	55.22	54.76	59.59	58.55	57.80	57.25
	[11] ($k=4$)	55.79	53.92	53.78	53.53	56.35	54.91	54.70	54.43	58.50	56.98	56.44	55.96
	[6]	46.23	43.79	41.90	40.35	49.32	46.68	44.80	43.18	52.81	50.57	48.86	47.45
	Ours	**56.19**	**55.09**	**54.35**	**53.55**	**58.85**	**57.06**	**56.19**	**55.58**	**64.55**	**62.63**	**61.27**	**60.20**
Elaine	[11] ($k=2$)	52.81	52.19	51.55	50.34	54.25	53.73	53.23	52.53	58.25	57.45	56.84	55.97
	[11] ($k=3$)	55.29	53.73	53.32	53.09	56.62	55.44	55.31	54.68	59.58	58.45	57.77	57.25
	[11] ($k=4$)	55.88	53.88	53.76	**53.58**	56.29	54.80	54.61	54.40	58.60	57.12	56.48	56.04
	[6]	47.34	45.34	43.73	42.34	49.44	47.35	45.76	44.54	52.23	50.08	48.49	47.34
	Ours	**56.18**	**55.06**	**54.32**	53.52	**58.84**	**57.06**	**56.17**	**55.58**	**64.56**	**62.57**	**61.27**	**60.24**
Lake	[11] ($k=2$)	52.89	52.17	51.46	50.39	54.32	53.71	53.29	52.51	58.09	57.34	56.74	55.93
	[11] ($k=3$)	55.18	53.64	53.28	53.02	56.62	55.48	55.24	54.74	59.50	58.48	57.79	57.23
	[11] ($k=4$)	55.80	53.91	53.73	**53.60**	56.19	54.84	54.62	54.41	58.45	56.97	56.44	56.01
	[6]	46.8	44.29	42.13	40.39	49.43	47.01	44.84	42.94	53.62	50.87	48.72	46.90
	Ours	**56.20**	**55.09**	**54.36**	53.52	**58.78**	**57.01**	**56.20**	**55.56**	**64.64**	**62.57**	**61.29**	**60.22**

Table 1 Comparison of PSNR values in dB for different images with different quality factors for the proposed method and the comparison methods.

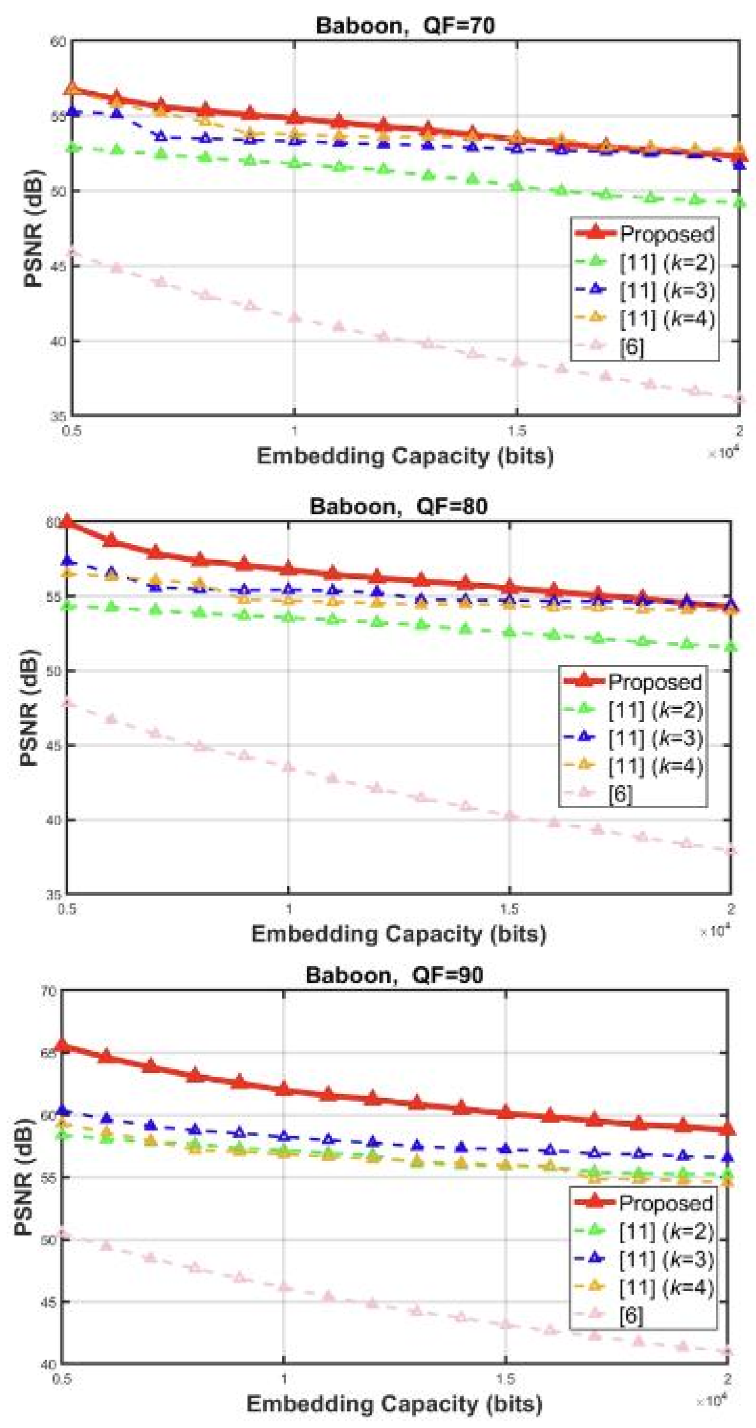


Figure 2 PSNR values corresponding to different embedding capacities for the proposed method and comparison method.