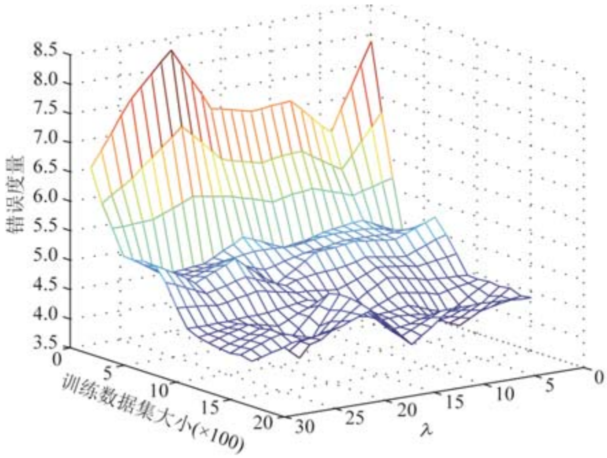
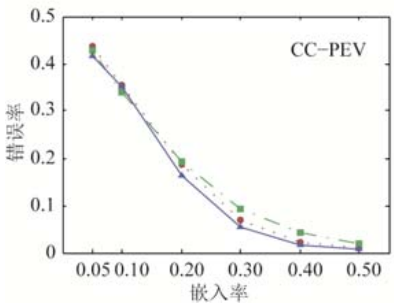
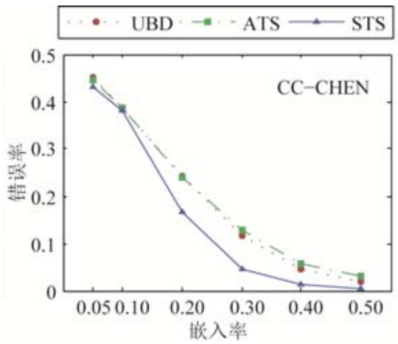


Fig.9 The relationship between the experimental parameters and the average error rate

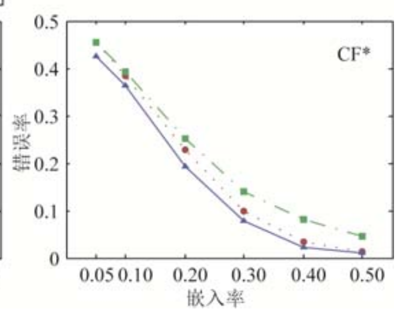
图 9 实验参数与平均错误率关系示意图



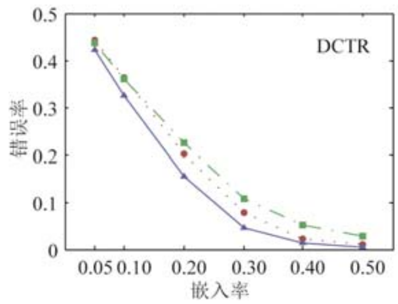
(a) CC-PEV 特征对比实验结果



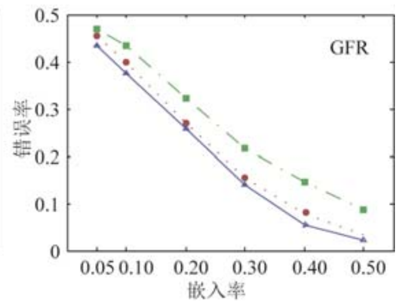
(b) CC-CHEN 特征对比实验结果



(c) CF*特征对比实验结果



(d) DCTR 特征对比实验结果



(e) GFR 特征对比实验结果

Fig.10 The comparison of experimental results between our method and other methods

图 10 本文方法与其他方法对比结果图

Table 1 The comparison of experimental results between our method and other methods

表 1 本文方法与其他方法对比结果表

隐写分析特征	分析框架	不同嵌入率(bpac)下检测错误率(%)					
		0.05	0.1	0.2	0.3	0.4	0.5
CC-PEV	UBD	43.71	35.14	18.57	6.99	2.33	1.02
	ATS	42.73	**34.03**	19.40	9.25	4.30	1.90
	STSS	**41.47**	35.12	**16.39**	**5.57**	**1.51**	**0.80**
CC-CHEN	UBD	45.05	38.62	24.13	11.71	4.57	1.84
	ATS	44.45	38.60	23.85	12.88	5.73	3.00
	STSS	**43.14**	**38.13**	**16.56**	**4.68**	**1.34**	**0.50**

Table 1 The comparison of experimental results between our method and other methods (Continued)

表 1 本文方法与其他方法对比结果表(续)

隐写分析特征	分析框架	不同嵌入率(bpac)下检测错误率(%)					
		0.05	0.1	0.2	0.3	0.4	0.5
CF*	UBD	45.42	38.31	22.74	9.77	3.41	1.44
	ATS	45.40	39.13	25.15	14.00	8.00	4.55
	STSS	**42.63**	**36.29**	**19.25**	**7.67**	**2.24**	**1.03**
DCTR	UBD	44.38	36.47	20.02	7.80	2.34	0.93
	ATS	43.60	35.95	22.60	10.85	5.08	2.80
	STSS	**42.25**	**32.50**	**15.31**	**4.53**	**1.20**	**0.43**
GFR	UBD	45.52	39.86	26.98	15.49	7.77	3.47
	ATS	46.85	43.45	32.30	21.53	14.48	8.68
	STSS	**43.39**	**37.59**	**25.71**	**13.93**	**5.46**	**2.08**

6 结 论

隐写操作在对数字图像进行修改的同时也改变了图像在特征空间中的位置,不同图像的特征在隐写作用下运动模式也会不同.以往的隐写分析工作没有充分挖掘训练数据与测试样本之间的关系,也没有充分利用测试样本本身的信息来进行分析.本文提出了“特定测试样本隐写分析(STSS)框架”,研究了影响隐写分析的两个重要因素——“特征距离”与“特征运动模式”相似度,基于这两个因素,在训练数据库中针对每个测试样本选择专用的训练集训练分类器,很大程度上解决了隐写分析中的 CSM 问题.实验结果表明,本文方法进一步挖掘了训练数据库的分析潜力,有效利用了测试样本的信息,在特定测试样本的隐写分析场景中表现出的性能优于其他方法.

当拥有大数据训练资源时,我们就有条件对特定测试样本筛选更匹配的训练集,所以,STSS 框架适用于设计大数据环境下的精准隐写分析系统.但本文对 STSS 框架仅进行了初步探索,未来还有许多问题需要进一步研究.

(1) 本文假设隐写算法与嵌入率已知,下一步可以尝试对常见隐写修改模式,如“LSB 替换”和“加减 1”进行未知嵌入率的隐写分析;

(2) 本文目前只对经典的非自适应隐写算法 nsF5 作了分析,设计了两种训练集筛选特征,取得了初步实验效果.对于使用 STC 框架的自适应隐写算法,未来可以考虑融合其他特征(如纹理特征)进行深入研究,设计更好的训练集筛选方法,以进一步拓宽 STSS 框架的应用范围,完善其性能.

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