

RED-Net: Residual and Enhanced Discriminative Network for image steganalysis in the Internet of medical things and telemedicine

Supplementary Material

Kai Chen, Zhengyuan Zhou, Yuchen Li, Xu Ji, Jiasong Wu, Gouenou Coatrieux, *Senior Member, IEEE*, Jean-Louis Coatrieux, *Life fellow, IEEE*, and Yang Chen, *Senior Member, IEEE*

Due to the page limitation of the main paper body, we provide the receiver operating characteristic (ROC) curves for the public dataset and private dataset, detection errors of steganography detectors in the comparison experiment and ablation experiment at payloads of 0.1bpp to 0.5bpp, the qualitative results tested on the public dataset and private dataset in the ablation experiment and algorithmic complexity in this Supplementary Material.

A. *Detection error of spatial domain steganography detector at the payload of 0.1bpp to 0.5bpp in the comparison experiment.*

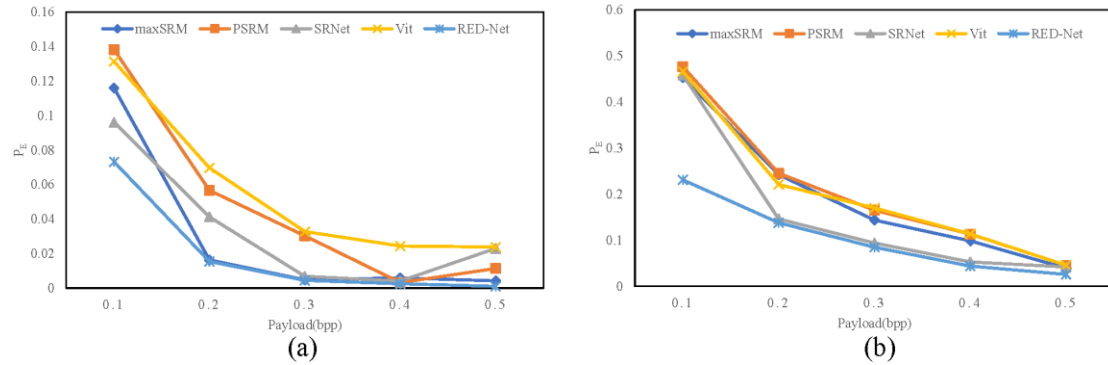


Fig. 6. Detection error of spatial domain steganography detector at the payload of 0.1bpp to 0.5bpp.(a)Detection errors of the maxSRM, PSRM,SR-Net, Vit, and RED-Net on the public dataset. (b)Detection errors of the maxSRM, PSRM, SR-Net, Vit, and the RED-Net on the private dataset.

B. *Detection error of JPEG domain steganography detector at the payload of 0.1bpp to 0.5bpp in the comparison experiment.*

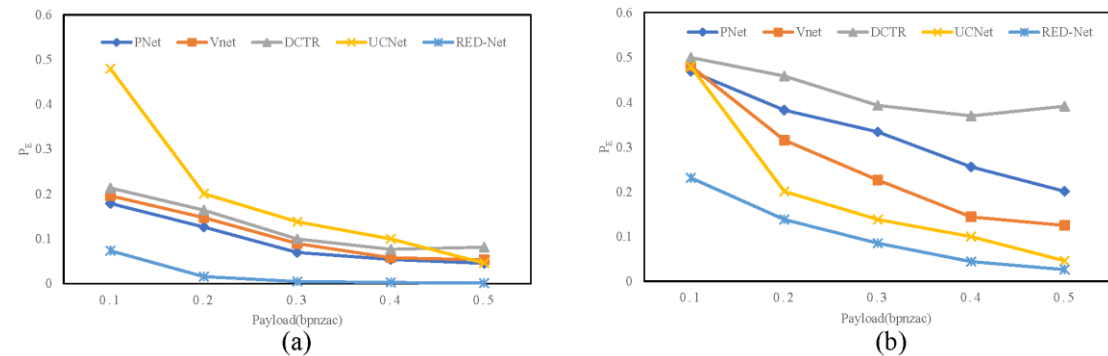


Fig. 7. Detection error of JPEG domain steganography detector at the payload of 0.1bpnzac to 0.5bpnzac.(a)Detection errors of the

DCTR, PNet, VNet, UCNet, and the RED-Net on the public dataset. (b) Detection errors of the DCTR, PNet, VNet, UCNet, and the RED-Net on the private dataset.

C. Comparison of ROC curves for deep learning-based methods on the public dataset.

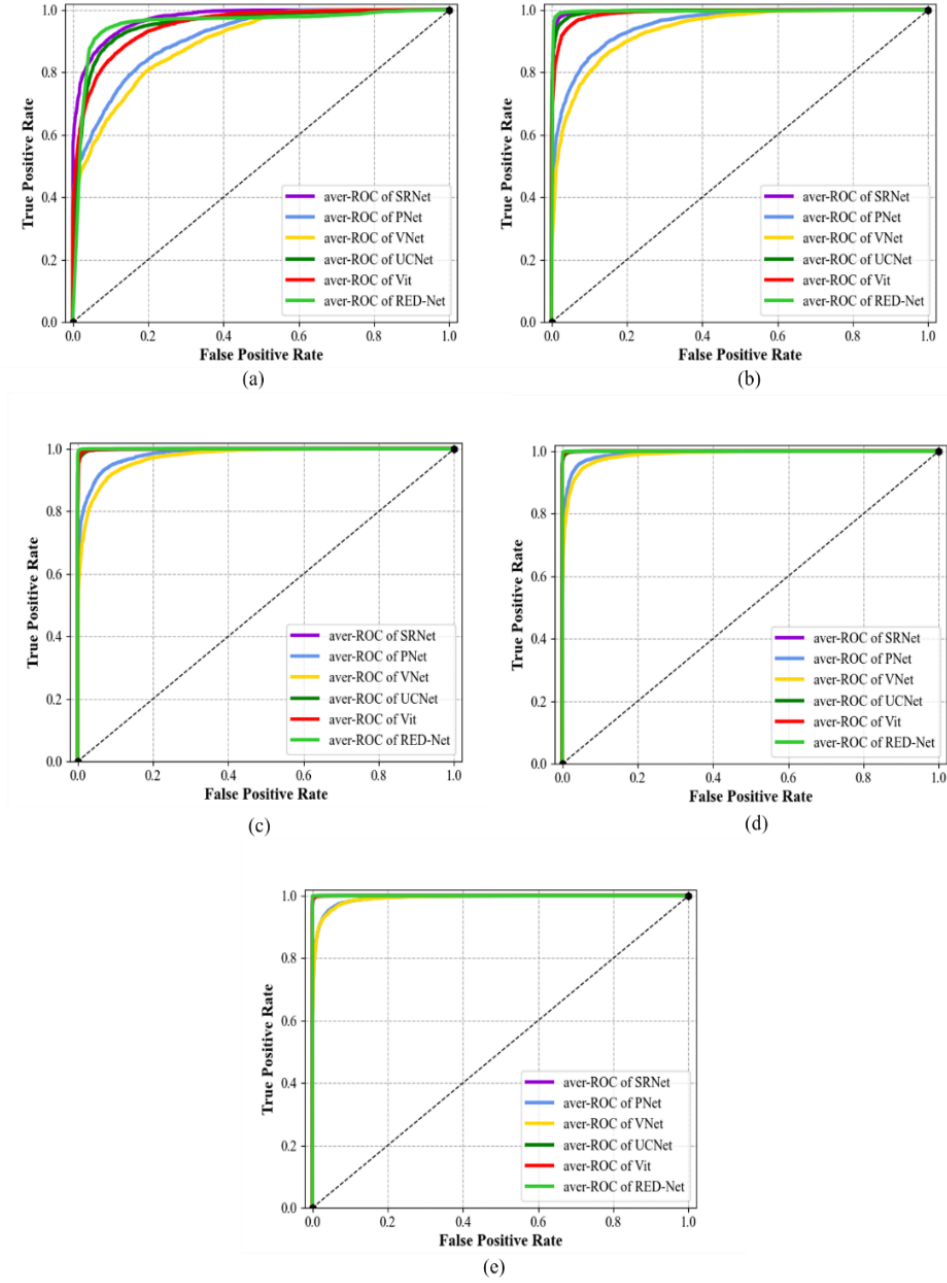


Fig. 8. Comparison of ROC curves for deep learning-based methods on the public dataset. (a) Test accuracy of RED-Net with SRNet, PNet, VNet, UCNet, and Vit at 0.1bpp/bpnzac payload. (b) Test accuracy of RED-Net versus SRNet, PNet, VNet, UCNet, and Vit at 0.2bpp/bpnzac payload. (c) Test accuracy of RED-Net with SRNet, PNet, VNet, UCNet, and Vit at 0.3bpp/bpnzac payload. (d) Test accuracy of RED-Net with SRNet, PNet, VNet, UCNet, and Vit at 0.4bpp/bpnzac payload. (e) Test accuracy of RED-Net with SRNet, PNet, VNet, UCNet, and Vit at 0.5bpp/bpnzac payload.

D. Comparison of ROC curves for deep learning-based methods on the private dataset.

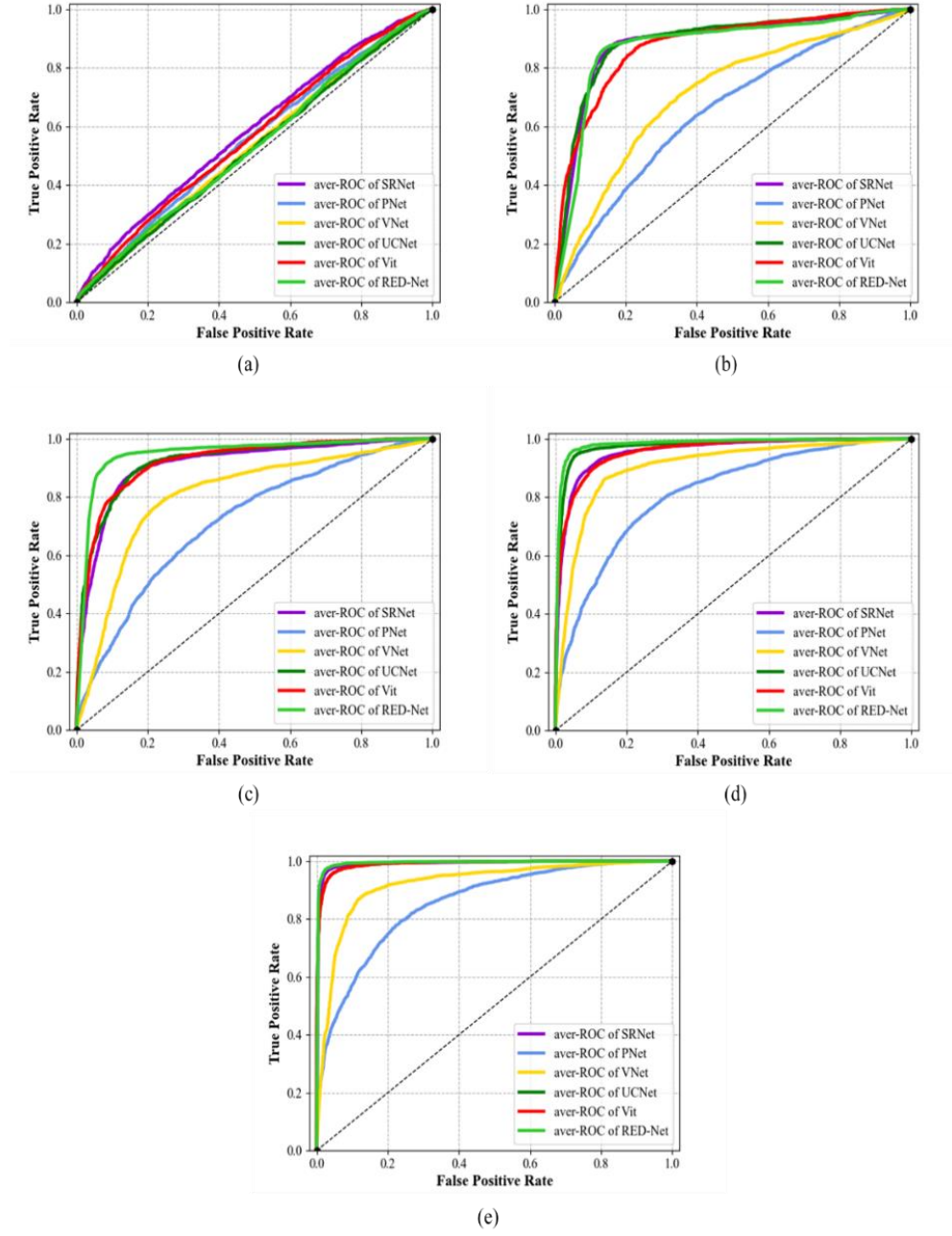


Fig. 9. Comparison of ROC curves for deep learning-based methods on the private dataset. (a) Test accuracy of RED-Net with SRNet, PNet, VNet, UCNet, and Vit at 0.1bpp/bpnzac payload. (b) Test accuracy of RED-Net versus SRNet, PNet, VNet, UCNet, and Vit at 0.2bpp/bpnzac payload. (c) Test accuracy of RED-Net with SRNet, PNet, VNet, UCNet, and Vit at 0.3bpp/bpnzac payload. (d) Test accuracy of RED-Net with SRNet, PNet, VNet, UCNet, and Vit at 0.4bpp/bpnzac payload. (e) Test accuracy of RED-Net with SRNet, PNet, VNet, UCNet, and Vit at 0.5bpp/bpnzac payload.

E. The qualitative results tested on the public dataset and private dataset in the ablation experiment.

TABLE V
RESULTS OF ABLATION EXPERIMENTS ON THE PUBLIC DATASET

Model	Evaluation index	0.1bpp	0.2bpp	0.3bpp	0.4bpp	0.5bpp
DS-Net	P_{FA}	12.06%	7.14%	1.32%	1.2%	0.84%
	P_{MD}	7.68%	0.4%	1.02%	0.24%	0.12%
	P_E	0.0987	0.0377	0.0117	0.0072	0.0048
DS-Net+SIEM	P_{FA}	10.98%	4.14%	1.4%	0.06%	0.14%
	P_{MD}	7.94%	0.78%	0.26%	1.02%	0.18%
	P_E	0.0946	0.0246	0.0083	0.0054	0.0016
DS-Net+SIDM	P_{FA}	12.66%	5.02%	1.08%	0.46%	0.32%
	P_{MD}	4.72%	0.92%	0.3%	0.44%	0.06%
	P_E	0.0869	0.0297	0.0069	0.0045	0.0019
DS-Net+SIEM+SIDM (RED-Net)	P_{FA}	8.88%	2.12%	0.3%	0.32%	0.16%
	P_{MD}	5.76%	0.96%	0.6%	0.2%	0.04%
	P_E	0.0732	0.0154	0.0045	0.0025	0.0010

TABLE VI
RESULTS OF ABLATION EXPERIMENTS ON THE PRIVATE DATASET

Model	Evaluation index	0.1bpp	0.2bpp	0.3bpp	0.4bpp	0.5bpp
DS-Net	P_{FA}	35.76%	10.8%	7.24%	12.4%	2.80%
	P_{MD}	54.24%	27.6%	20.3%	6.92%	3.68%
	P_E	0.450	0.193	0.138	0.096	0.033
DS-Net+SIEM	P_{FA}	51.84%	12.88%	8.68%	4.48%	2.96%
	P_{MD}	37.96%	14.76%	9.06%	7.32%	3.28%
	P_E	0.449	0.139	0.088	0.059	0.032
DS-Net+SIDM	P_{FA}	32.88%	14.24%	6.4%	5.8%	3.04%
	P_{MD}	27.48%	15.44%	9.76%	6.44%	3.20%
	P_E	0.302	0.149	0.083	0.060	0.032
DS-Net+SIEM+SIDM (RED-Net)	P_{FA}	18.2%	14.32%	8.32%	3.76%	3.40%
	P_{MD}	28%	13.32%	8.76%	5.12%	1.92%
	P_E	0.231	0.138	0.081	0.044	0.026

F. Detection error of steganography detector at the payload of 0.1bpp to 0.5bpp in the ablation experiment.

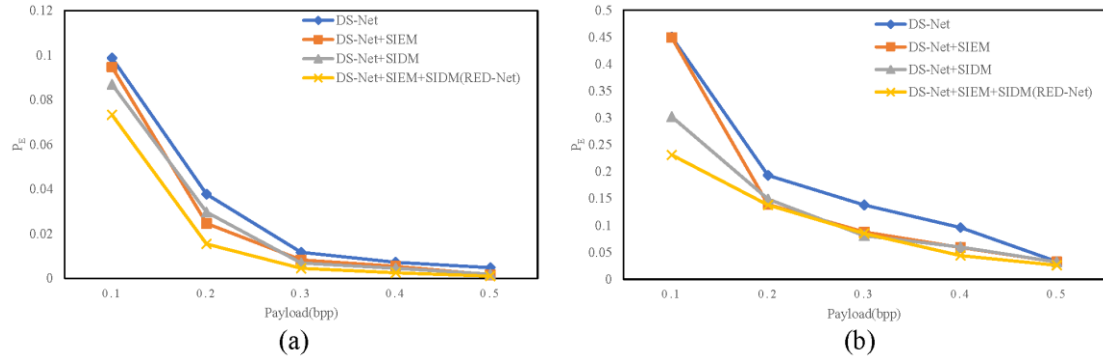


Fig. 10. Detection error of steganography detector in ablation experiment method at the payload of 0.1 to 0.5 bpp. (a) Detection errors of the DSNet, DS-Net+SIEM, DS-Net+SIDM, and DS-Net+SIEM+SIDM(RED-Net) on the public dataset. (b) Detection errors of the DS-Net, DS-Net+SIEM, DS-Net+SIDM, and DS-Net+SIEM+SIDM(RED-Net) on the private dataset.

G. Model complexity and computational time of different deep learning-based methods.

TABLE VII

MOEDL COMPLEXITY AND COMPUTATIONAL TIME OF DIFFERENT DEEP LEARNING -BASED
METHODS (G: GIGA, M: MILLION, S:SECOND)

Method	FLOPs(G)	Parameter(M)	Time(S)
SRNet	193.3596	4.779618	20.8290
PNet	12.3069	0.031882	41.4546
VNet	13.4528	0.302698	40.0894
Vit	230.1247	1.117296	21.8836
UCNet	106.9785	51.434498	16.6707
RED-Net	243.0435	4.790895	16.8874