Joint compressive autoencoders for full-image-to-image hiding

Xiyao Liu[1], Ziping Ma[1], Xingbei Guo[1], Jialu Hou[1], Lei Wang[1], Jian Zhang[1], Gerald Schaefer[2], Hui Fang[2]

[1]School of Computer Science and Engineering
Central South University

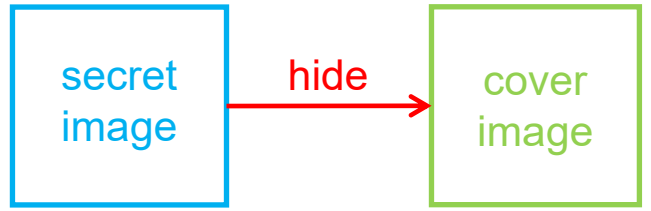
[2]Department of Computer Science
Loughborough University

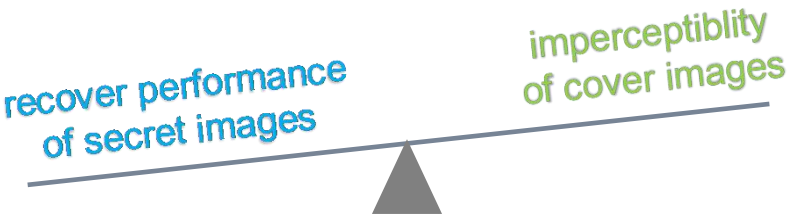
- Background
- Motivation & Key Contribution
- Proposed Algorithm & Implemention Details
- Experimental Results
- Conclusion

Background

- Image hiding:
  - a information hiding technology to embed secret messages in images
- Classical image hiding methods:
  - embed messages into insignificant components of cover images.
  - low hidden capacity

- DL-base full-image-to-image hiding methods:
  - hide same-sized images in to cover images
  - neither of the errors can be minimised
  - security problems



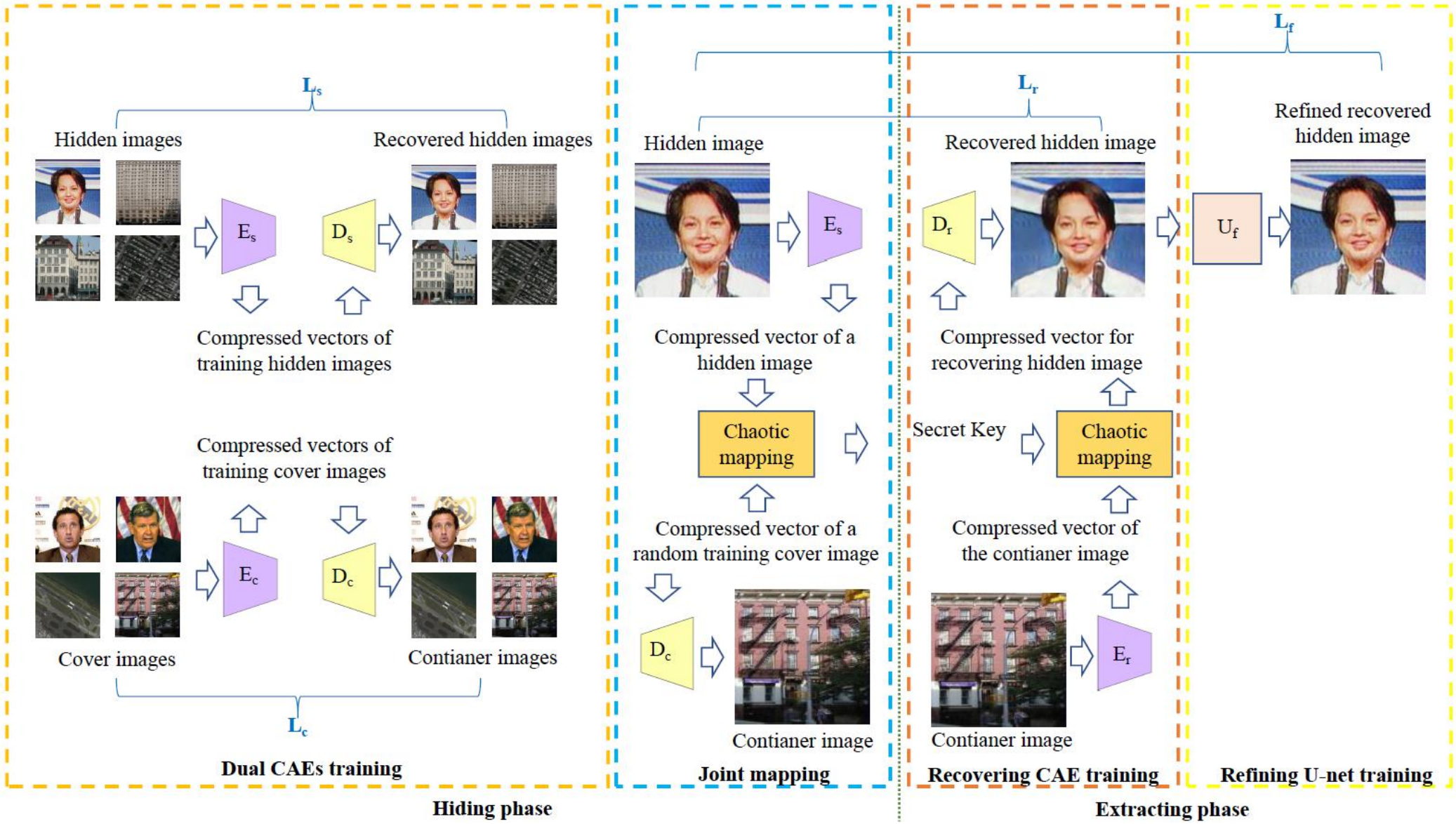


Motivation & Key Contribution

- Hidden capacity to achieve full-image-to-image hiding
- Trade-off problem in DL-based full-image-to-image hiding methods
- Security in the process of image hiding

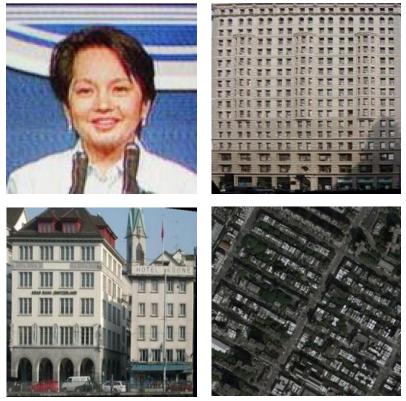
- J-CAE for full-image-to-image hiding
  - fundamentally avoids the quality trade-off problem
    - the first trial to solve the quality trade-off problem for effective full-image-to-image hiding
  - high quality recovery of the hidden image
  - employ logistic-logistic chaotic mechanism to enhance the image hiding security.

Proposed Algorithm



Dual CAEs Training

secret images

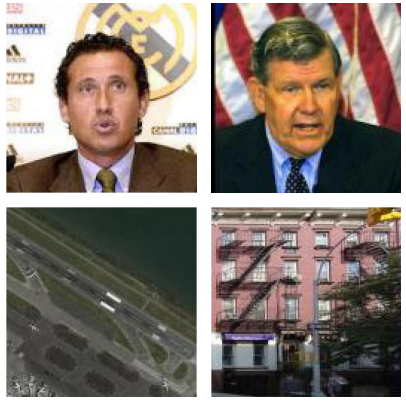


E_s

Compressed vectors of training secret images

D_s

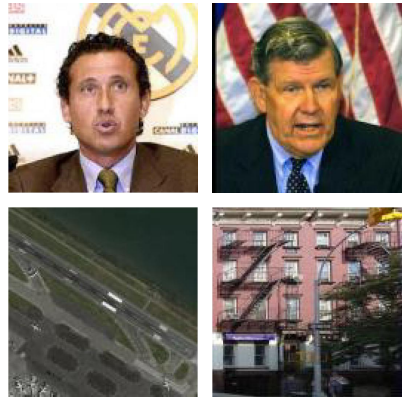
recovered secret images



E_c

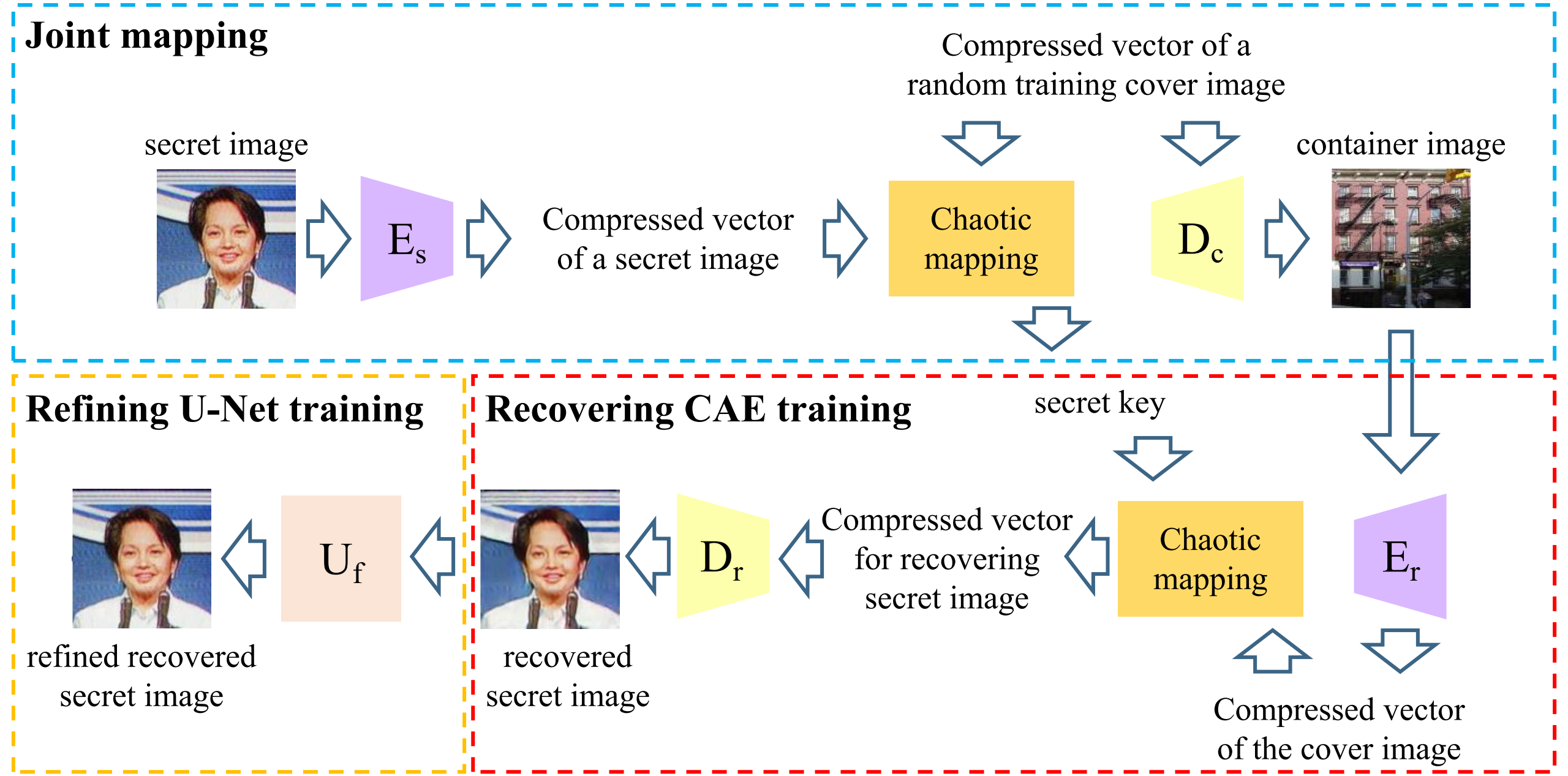
Compressed vectors of training cover images

D_c



cover images

recovered cover images


Joint mapping
Compressed vector of a random training cover image
secret image
container image
E_s
Compressed vector of a secret image
Chaotic mapping
D_c
Refining U-Net training
Recovering CAE training
secret key
U_f
D_r
Compressed vector for recovering secret image
Chaotic mapping
E_r
refined recovered secret image
recovered secret image
Compressed vector of the cover image

Implemention Details

- **The Chaotic Mapping System (Section III.A)**
- **Loss Functions (Section III.A and B)**
- Dataset Settings (Section IV.A)
- Training Parameters (Section IV.B)

Implemention Details (Chaotic Mapping System)

Eq.1 $$F = V_s \oplus V_c$$

Eq.2 $$H = \{h_n, t+1 \le n \le t+512\}$$

Eq.3 $$h_{n+1} = E_{cha}(u, h_n)T(v) - floor(E_{cha}(u, h_n)T(v))$$
where $T(v) = 2^v$ and $E_{cha}(u, h_n) = h_{n+1} = uh_n(1-h_n)$

Eq.4 $$BH = \{bh_n, 1 \le n \le 512\} \text{ as } bh_n = \begin{cases} 1 & \text{if } h_{n+t} > T \\ 0 & \text{otherwise} \end{cases}$$

Eq.5 $$K = F \oplus BH$$

Implemention Details (Loss Functions)

Eq.1

$$L_i = \left\| x - D_i[E_i(x)] \right\| - \alpha \log_2 Q[E_i(x)]$$

where $i \in (s,c)$

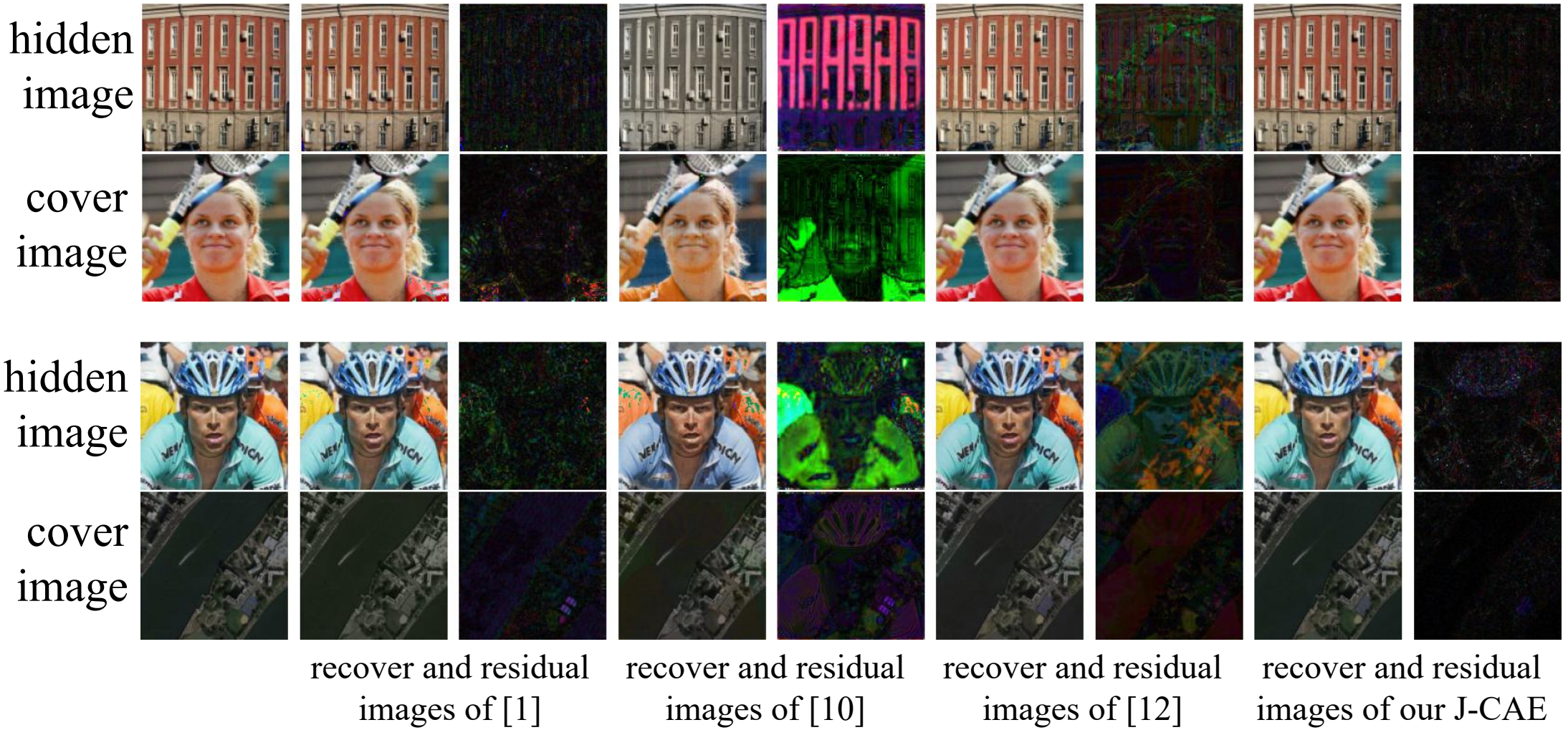
Eq.2

$$L_r = \left\| x_s - D_r[E_r(x_c)] \oplus K \oplus BH \right\| - \alpha \log_2 Q[E_r(x_c)]$$

Eq.3

$$L_f = \left\| x_s - x'_s \right\|$$

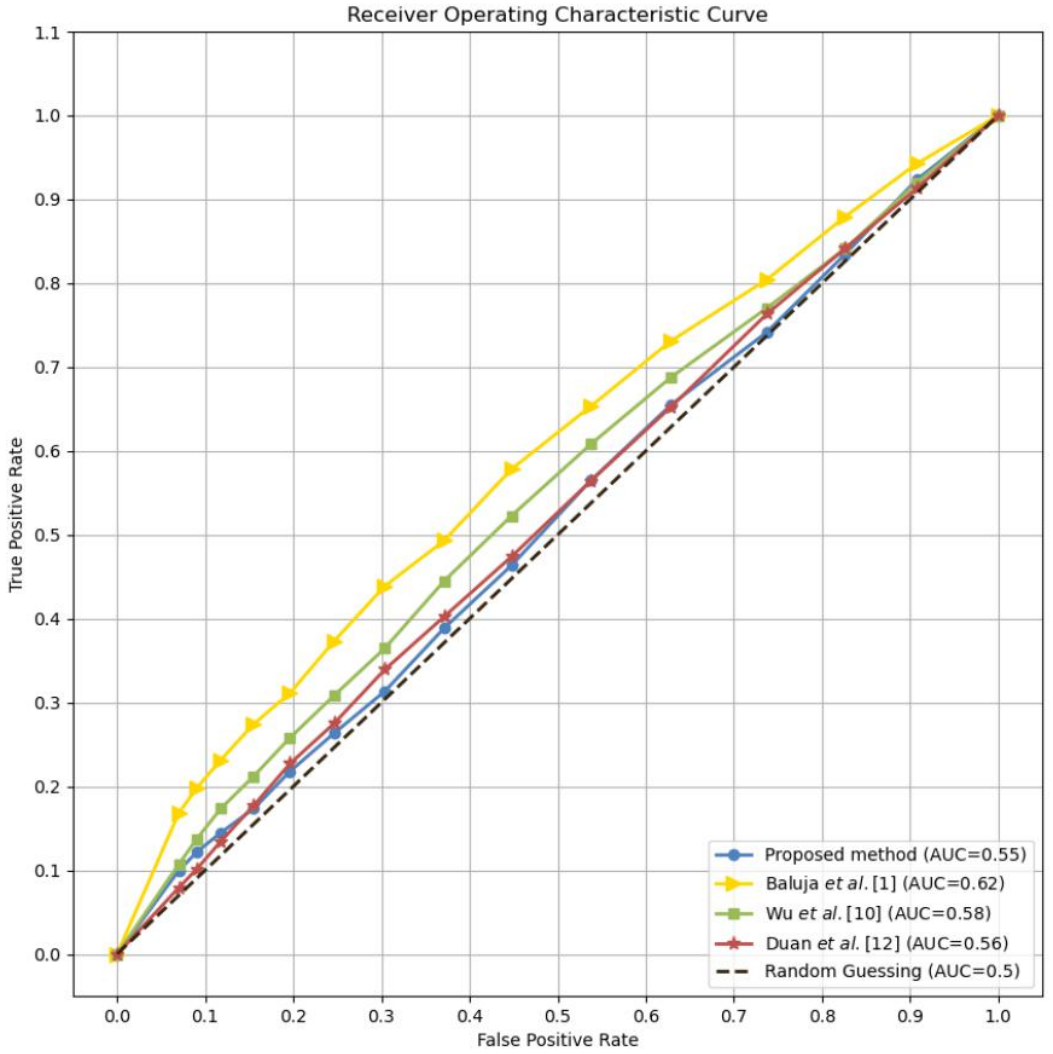
Experimental Results (Subjective Evaluation)



[1] S. Baluja, "Hiding images within images," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 42, no. 7, pp. 1685–1697, 2019.
[10] P. Wu, Y. Yang, and X. Li, "Stegnet: Mega image steganography capacity with deep convolutional network," Future Internet, vol. 10, no. 6, p. 54, 2018.
[12] X. Duan, K. Jia, B. Li, D. Guo, E. Zhang, and C. Qin, "Reversible image steganography scheme based on a u-net structure," IEEE Access, vol. 7, pp. 9314–9323, 2019.

Experimental Results (Objective Evaluation & Security Analysis)

	cover image			
	Baluja *et al.* [1]	Wu *et al.* [10]	Duan *et al.* [12]	J-CAE
pixel error	3.1012	4.4224	2,8302	**1.7881**
PSNR	31.7526	29.7046	37.3406	**40.4039**
SSIM	0.9704	0.9653	0.9893	**0.9921**
	hidden image			
	Baluja *et al.* [1]	Wu *et al.* [10]	Duan *et al.* [12]	J-CAE
pixel error	2.9329	7.4876	5.5404	**1.9547**
PSNR	34.2448	27.2817	31.9353	**39.5338**
SSIM	0.9731	0.9458	0.9728	**0.9890**



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Conclusion

- J-CAE, a novel DL-based full-image-to-image hiding algorithm
  - based on Joint Compressive Autoencoders
- achieves high hidden capacity and recover hidden images with smaller errors
- achieves significantly better visual imperceptibility
  - by mapping feature representations
- outperforms three state-of-the-art image hiding algorithms
  - on both subjective and objective comparasion

Thanks For Listening

If you have any questions, you can email us.

lxyzoewx@csu.edu.cn

h.fang@lboro.ac.uk