MAPR 2025 THE 8TH INTERNATIONAL CONFERENCE ON MULTIMEDIA ANALYSIS AND PATTERN RECOGNITION

Few-Shot Instance Segmentation: An Exploration in the Frequency Domain for Camouflage Instances

Project Page

Thanh-Danh Nguyen[1,2], Hung-Phu Cao[3], Thanh Duc Ngo[1,2], Vinh-Tiep Nguyen†[1,2], and Tam V. Nguyen[4]

[1]University of Information Technology, Ho Chi Minh City, Vietnam,
[2]Vietnam National University, Ho Chi Minh City, Vietnam, [3]Endava Vietnam, Ho Chi Minh City, Vietnam, [4]University of Dayton, Dayton, OH 45469, United States
{danhnt, thanhnd, tiepnv}@uit.edu.vn, caohungphu@hotmail.com, tamnguyen@udayton.edu, †corresponding author

INTRODUCTION

Motivation: Color space domain-based augmentation fails to capture the full range of visual camouflage characteristics; the derivative frequency domain supports revealing the minor differences.

Main contribution: **FS-CAMOFreq**, a novel framework addressing few-shot camouflage instance segmentation (CIS) via the instance-aware frequency-based augmentation.

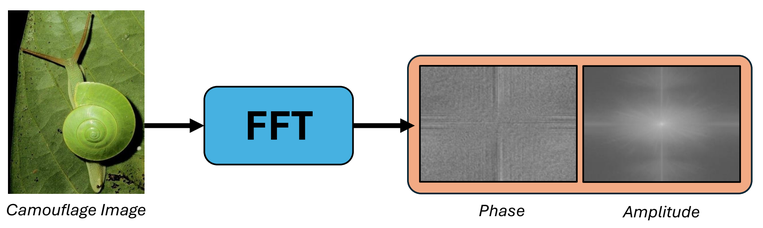
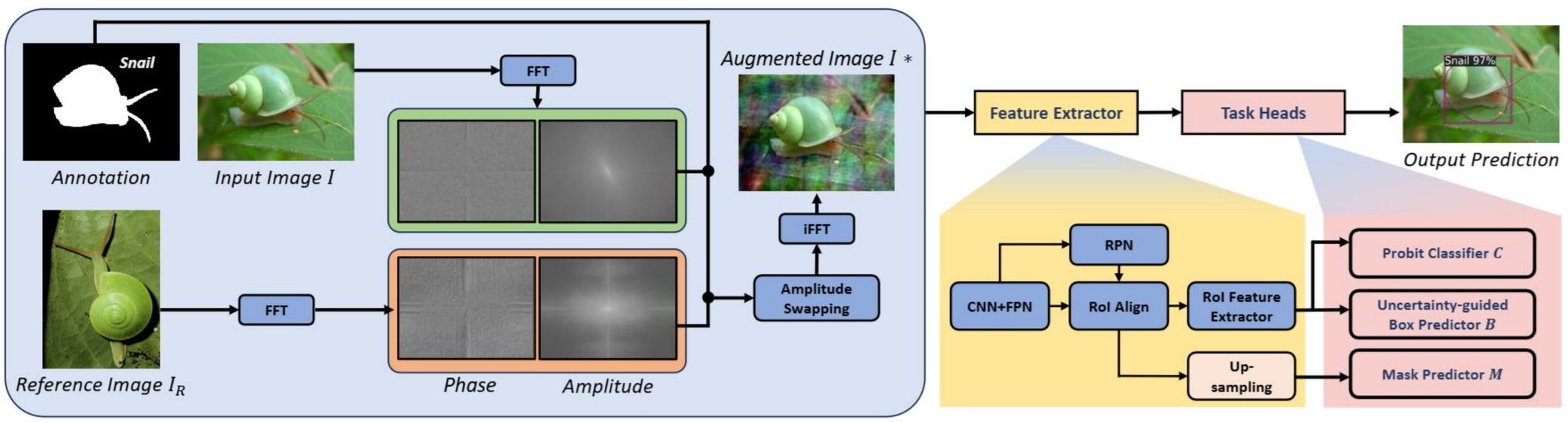


Fig. 1. Breaking a camouflage image into the frequency domain by a phase and an amplitude component via Fast Fourier Transform FFT.

METHOD



Our **FS-CAMOFreq** exploits the frequency domain to enhance few-shot CIS task.

Fig. 2. Overview of our FS-CAMOFreq framework exploiting the instance-ware frequency-based enhancement in few-shot camouflage instance segmentation.

Few-shot Fine-tuning CIS: The CIS model is presented in two phases:

- **Base phase**: training with abundant annotated training data C_{base}.
- **Novel phase**: fine-tuning on a disjoint set of novel classes C_{novel} containing a few samples per each class of novel data.

In our case, the few-shot fine-tuning relies on *a few annotated samples*, enhanced by our proposed instance-aware frequency-based method.

Instance-Aware Frequency-Based Data Enhancement:

The frequency-based transformations are applied to the non-instance regions, leaving the target object unaltered. The referenced image I_R is chosen from the same semantic class:

- **Frequency-based amplitude component swapping**: the amplitude component is swapped between the input image I and the referenced image I_R guided by the masked non-instance region.
- **Instance-aware augmentation**: the instance regions are kept unaltered to maintain the signature of camouflage texture.

RESULT

Tab. 2. Ablation study of our FS-CAMOFreq on instance region augmentation.

FS-CAMOFreq	Detection			Segmentation		
Num. of shots	nAP	nAP50	nAP75	nAP	nAP50	nAP75
1	5.63	8.38	6.44	5.31	8.44	5.97
2	5.64	8.10	6.56	5.65	8.36	6.49
3	4.94	7.17	5.71	5.16	7.35	5.78
5	6.12	9.01	6.59	6.84	9.64	7.53
Avg.	**5.58**	**8.17**	**6.33**	**5.74**	**8.45**	**6.44**

Tab. 1. SoTA comparison of our FS-CAMOFreq evaluated on CAMO-FS benchmark. The backbones are COCO-80 FPN-R101.

Model		nAP						nAP50					
Method	Backbone/ Num. of shots	Instance Segmentation			Object Detection			Instance Segmentation			Object Detection		
		1	5	Avg.	1	5	Avg.	1	5	Avg.	1	5	Avg.
MTFA [3]	COCO-80 ResNet-50	2.48	6.40	4.44	1.98	6.17	4.08	4.24	9.89	7.07	4.12	9.94	7.03
M-RCNN [28]		4.08	8.29	6.19	2.82	6.18	4.50	6.91	13.89	10.40	6.78	13.92	10.35
iFS-RCNN [2]		4.17	6.38	5.28	3.92	6.60	5.26	6.19	10.02	8.11	6.23	10.15	8.19
MTFA [3]	COCO-80 ResNet-101	3.66	5.95	4.81	2.93	5.84	4.39	5.37	8.67	7.02	5.86	9.13	7.50
M-RCNN [28]		4.39	10.09	7.24	3.03	7.79	5.41	7.58	15.41	11.50	7.53	15.86	11.70
iFS-RCNN [2]		4.27	7.80	6.04	3.79	8.08	5.94	5.98	11.35	8.67	5.92	11.52	8.72
FS-CDIS-ITL* [4]		5.35	9.35	7.35	4.71	10.36	7.54	7.80	14.01	10.91	7.85	14.40	11.13
FS-CDIS-IMS* [4]		2.99	9.03	6.01	2.74	8.44	5.59	4.62	12.48	8.55	4.81	13.18	9.00
		Our performance											
Baseline FS-CAMOFreq †	COCO-80 ResNet-101	5.55	8.21	6.88	5.34	8.82	7.08	8.42	12.07	10.25	8.49	12.86	10.68
FS-CAMOFreq (ours)		**5.71**	**8.31**	**7.01**	**5.56**	**8.89**	**7.23**	**8.50**	**11.72**	**10.11**	**8.56**	**12.11**	**10.34**

* *denotes the FS-CDIS results built on top of iFS-RCNN [2]*
† *denotes our reproduced baseline FS-CDIS iFS-RCNN [2], [4] on our upgraded CUDA version 12.4*