Strategic Preys Make Acute Predators: Enhancing Camouflaged Object Detectors by Generating Camouflaged Objects

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Introduction

Motivation:

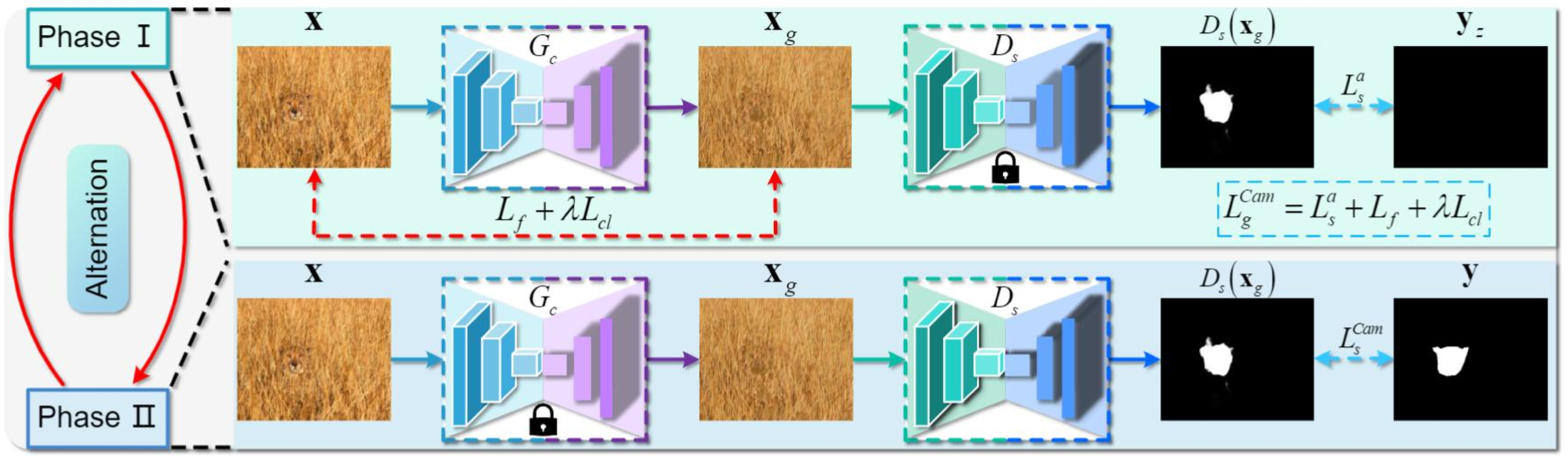
We are inspired by the prey-vs-predator game, where preys develop more deceptive camouflage skills to escape predators, which pushes the predators to develop more acute vision systems to discern the camouflage tricks. This game leads to ever-strategic preys and ever-acute predators. With this inspiration, we propose to address COD by developing algorithms on both the prey side that generates more deceptive camouflage objects and the predator side that produces complete and precise detection results.

Contribution:

1. We design an adversarial training framework, Camouflageator, for the COD task. Camouflageator employs an auxiliary generator that generates more camouflaged objects that are harder for COD detectors to detect and hence enhances the generalizability of those detectors. Camouflageator is flexible and can be integrated with various existing COD detectors.
2. We propose a new COD detector, ICEG, to address the issues of incomplete segmentation and ambiguous boundaries that existing detectors face. ICEG introduces a novel CFC module to excavate the internal coherence of camouflaged objects to obtain complete segmentation results, and an ESC module to leverage edge information to get precise boundaries.
3. Experiments verify that Camouflageator can promote the performance of existing COD detectors and ICEG significantly outperforms existing COD detectors.

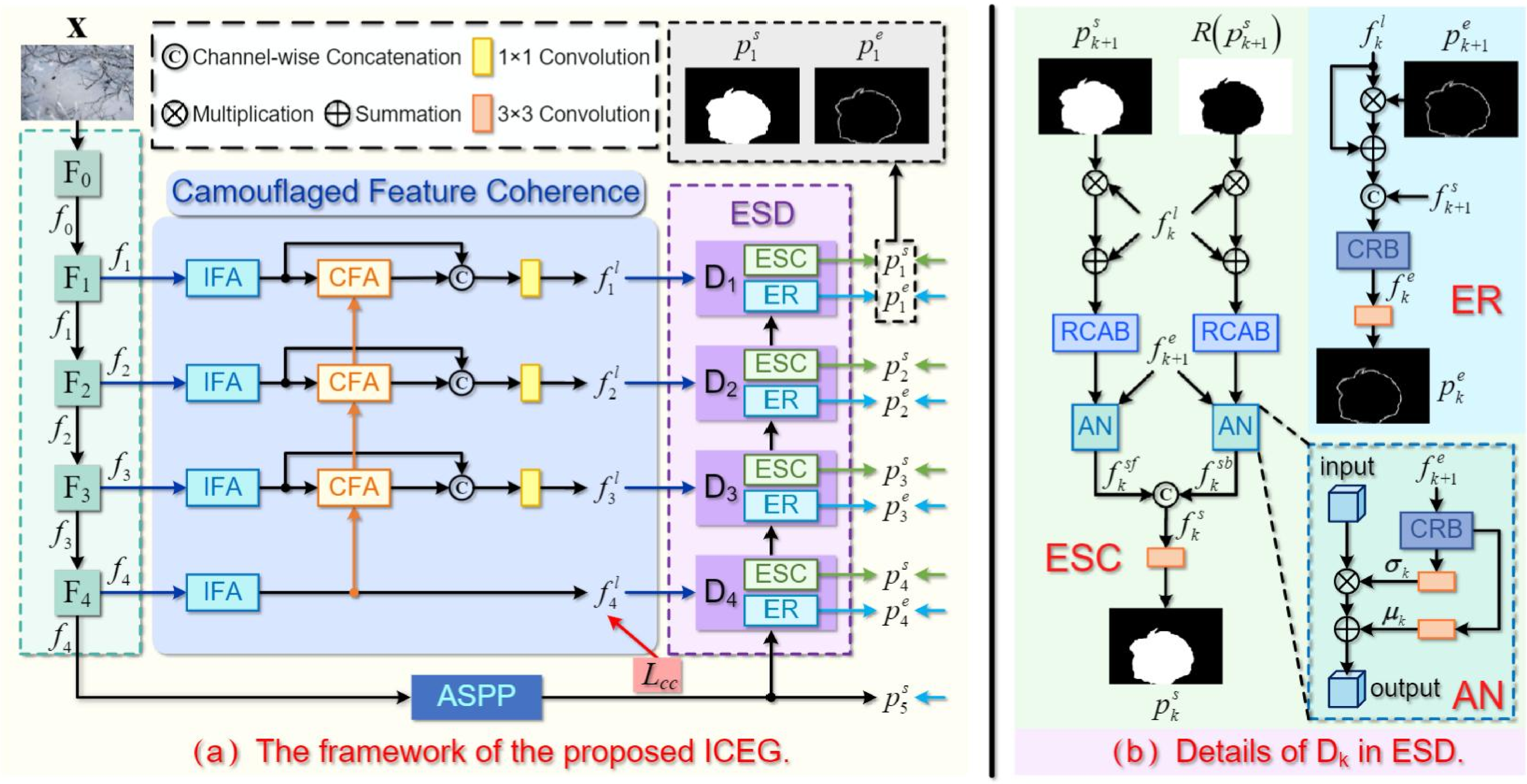
Network architecture

Overall framework



In Phase I, we fix detector Ds and update generator Gc to synthesize more camouflaged objects to deceive Ds. In Phase II, we fix Gc and train the detector Ds to segment the synthesized image.

Architecture of our detector

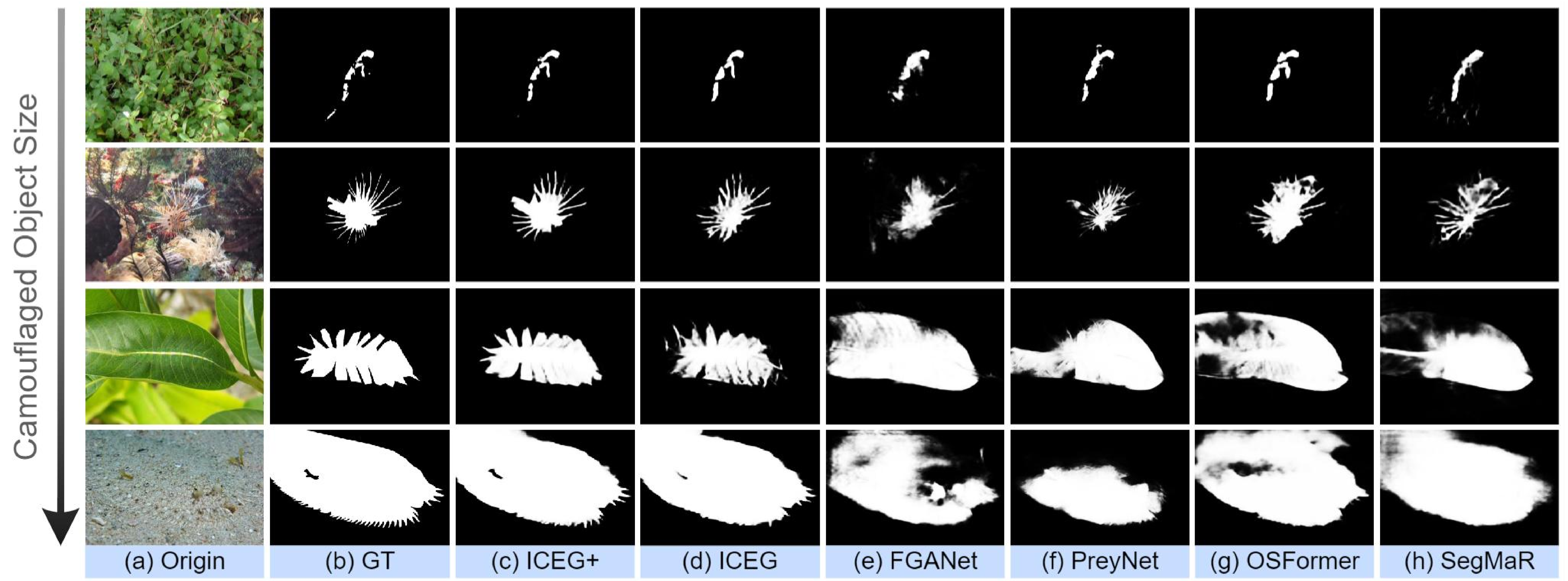


Framework of ICEG. CRB is the Conv-ReLU-BN structure.

Experiment

Qualitative and quantitative comparisons

Methods	Backbones	CHAMELEON $M\downarrow$	CHAMELEON $F_\beta\uparrow$	CHAMELEON $E_\phi\uparrow$	CHAMELEON $S_\alpha\uparrow$	CAMO $M\downarrow$	CAMO $F_\beta\uparrow$	CAMO $E_\phi\uparrow$	CAMO $S_\alpha\uparrow$	COD10K $M\downarrow$	COD10K $F_\beta\uparrow$	COD10K $E_\phi\uparrow$	COD10K $S_\alpha\uparrow$	NC4K $M\downarrow$	NC4K $F_\beta\uparrow$	NC4K $E_\phi\uparrow$	NC4K $S_\alpha\uparrow$
Common Setting: Single Input Scale and Single Stage																	
SegMaR-1 (Jia et al., 2022)	ResNet50	0.028	0.828	0.944	0.892	0.072	0.772	0.861	0.805	0.035	0.699	0.890	0.813	0.052	0.767	0.885	0.835
PreyNet (Zhang et al., 2022)	ResNet50	0.027	0.844	0.948	0.895	0.077	0.763	0.854	0.790	0.034	0.715	0.894	0.813	0.047	0.798	0.887	0.838
FGANet (Zhai et al., 2022)	ResNet50	0.030	0.838	0.944	0.896	0.070	0.769	0.865	0.800	0.032	0.708	0.894	0.803	0.047	0.800	0.891	0.837
FEDER (He et al., 2023c)	ResNet50	0.028	0.850	0.944	0.892	0.070	0.775	0.870	0.802	0.032	0.715	0.892	0.810	0.046	0.808	0.900	0.842
ICEG (Ours)	ResNet50	**0.027**	**0.858**	**0.950**	**0.899**	**0.068**	**0.789**	**0.879**	**0.810**	**0.030**	**0.747**	**0.906**	**0.826**	**0.044**	**0.814**	**0.908**	**0.849**
PreyNet+ (Ours)	ResNet50	0.027	0.856	0.954	0.901	0.074	0.778	0.869	0.808	0.031	0.744	0.908	0.833	0.044	0.821	0.912	0.859
FGANet+ (Ours)	ResNet50	0.029	0.847	0.948	0.899	0.069	0.781	0.877	0.814	0.030	0.735	0.911	0.823	0.045	0.814	0.905	0.854
FEDER+ (Ours)	ResNet50	0.027	0.855	0.947	0.895	0.068	0.793	0.883	0.820	0.030	0.739	0.905	0.831	0.043	0.820	0.910	0.845
ICEG+ (Ours)	ResNet50	0.026	0.863	0.952	0.903	0.066	0.805	0.891	0.829	0.028	0.763	0.920	0.843	0.041	0.835	0.922	0.869
SINet V2 (Fan et al., 2021)	Res2Net50	0.030	0.816	0.942	0.888	0.070	0.779	0.882	0.822	0.037	0.682	0.887	0.815	0.048	0.792	0.903	0.847
BGNet (Sun et al., 2022)	Res2Net50	0.029	0.835	0.944	0.895	0.073	0.744	0.870	0.812	0.033	0.714	0.901	0.831	0.044	0.786	0.907	0.851
ICEG (Ours)	Res2Net50	**0.025**	**0.869**	**0.958**	**0.908**	**0.066**	**0.808**	**0.903**	**0.838**	**0.028**	**0.752**	**0.914**	**0.845**	**0.042**	**0.828**	**0.917**	**0.867**
ICEG+ (Ours)	Res2Net50	0.023	0.873	0.960	0.910	0.064	0.826	0.912	0.845	0.026	0.770	0.925	0.853	0.040	0.844	0.928	0.878
ICON (Zhuge et al., 2022)	Swin	0.029	0.848	0.940	0.898	0.058	0.794	0.907	0.840	0.033	0.720	0.888	0.818	0.041	0.817	0.916	0.858
ICEG (Ours)	Swin	**0.023**	**0.860**	**0.959**	**0.905**	**0.044**	**0.855**	**0.926**	**0.867**	**0.024**	**0.782**	**0.930**	**0.857**	**0.034**	**0.855**	**0.932**	**0.879**
ICEG+ (Ours)	Swin	0.022	0.867	0.961	0.908	0.042	0.861	0.931	0.871	0.023	0.788	0.934	0.862	0.033	0.861	0.937	0.883
Other Setting: Multiple Input Scales (MIS)																	
ZoomNet (Pang et al., 2022)	ResNet50	0.024	0.858	0.943	0.902	0.066	0.792	0.877	0.820	0.029	0.740	0.888	0.838	0.043	0.814	0.896	0.853
ICEG (Ours)	ResNet50	**0.023**	**0.864**	**0.957**	**0.905**	**0.063**	**0.802**	**0.889**	**0.833**	**0.028**	**0.751**	**0.913**	**0.840**	**0.042**	**0.827**	**0.911**	**0.873**
Other Setting: Multiple Stages (MS)																	
SegMaR-4 (Jia et al., 2022)	ResNet50	0.025	0.855	0.955	0.906	0.071	0.779	0.865	0.815	0.033	0.737	0.896	0.833	0.047	0.793	0.892	0.845
ICEG-4 (Ours)	ResNet50	**0.024**	**0.870**	**0.961**	**0.907**	**0.067**	**0.802**	**0.884**	**0.823**	**0.028**	**0.755**	**0.920**	**0.843**	**0.043**	**0.824**	**0.915**	**0.860**



Information

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Code:
https://github.com/ChunmingHe/Camouflageator

WeChat

Fell free to contact me if you have any problem!