

DarkSeg: Infrared-Driven Semantic Segmentation for Garment Grasping Detection in Low-Light Conditions

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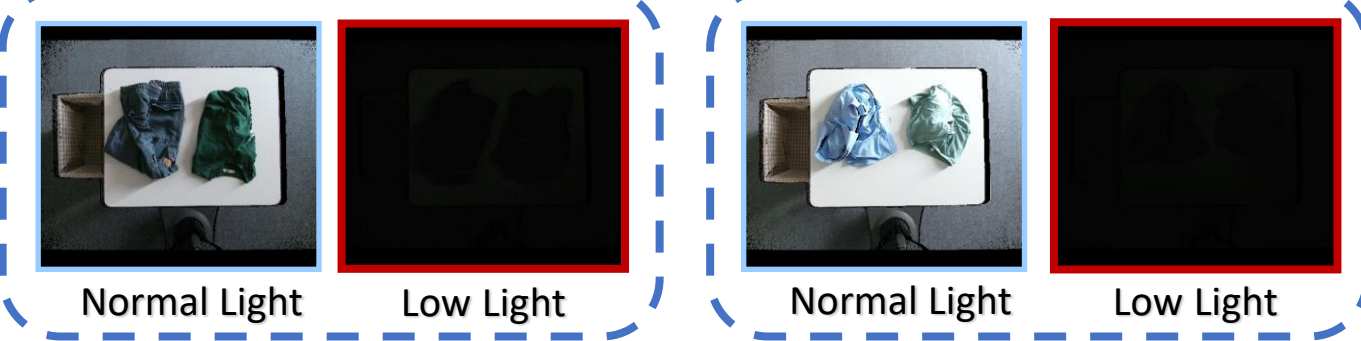
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Problem Description

Under low-light conditions, the limited light reflections captured by imaging sensors result in sparse structural features, leading to high feature similarity across different categories of garments.

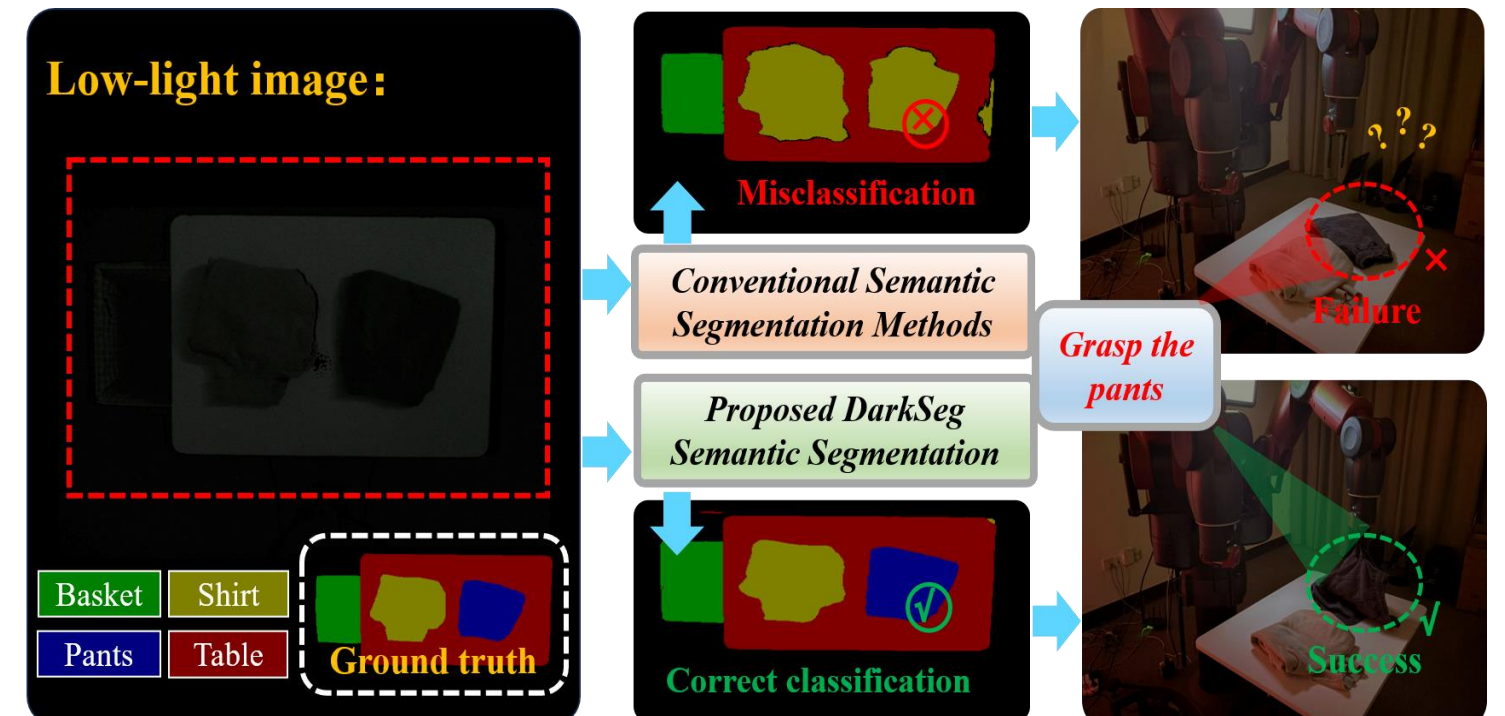


Highlights

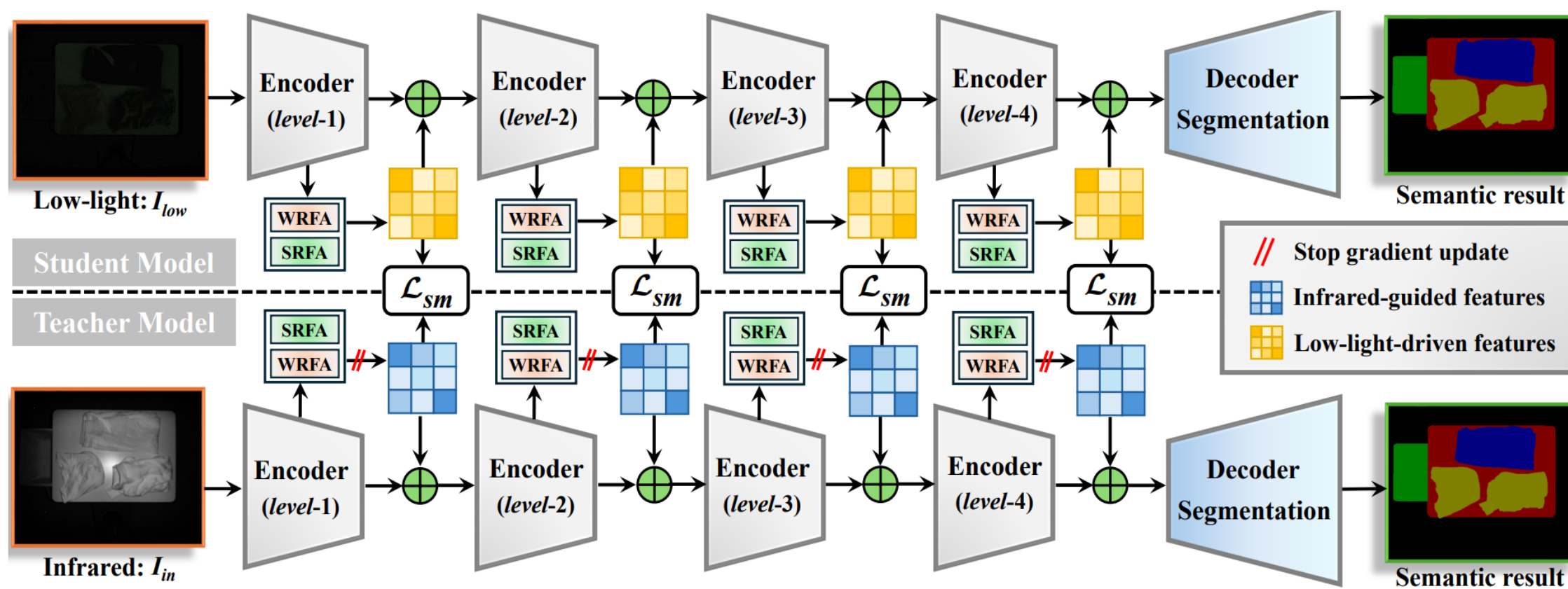
- ◆ We systematically investigate the challenges posed by low-light conditions for garment recognition and grasping, and provide new insights into low-light garment grasping from the perspective of modeling the structural complementarity between visible and infrared images.
- ◆ Our method achieves competitive performance on the DarkSeg low-light garment grasping dataset, and demonstrates promising results in real-world experiments.

Challenges of Existing Methods

Existing methods commonly employ a semantic segmentation model to perceive different categories of garments. However, under low-light conditions, the feature representations of varying garment categories become ambiguous, leading the model to make incorrect classification decisions.



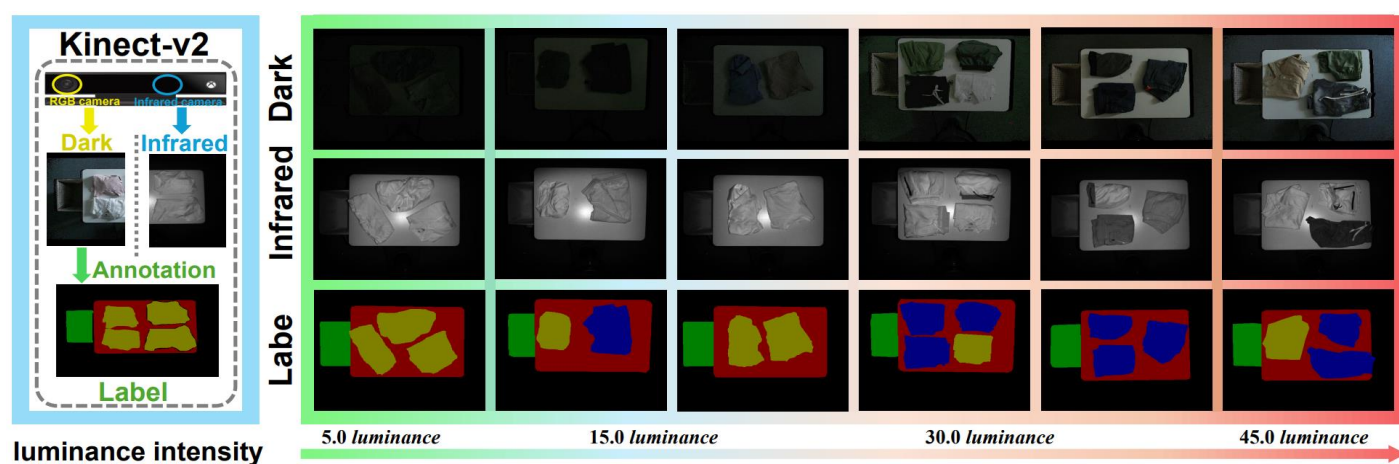
Our DarkSeg framework:



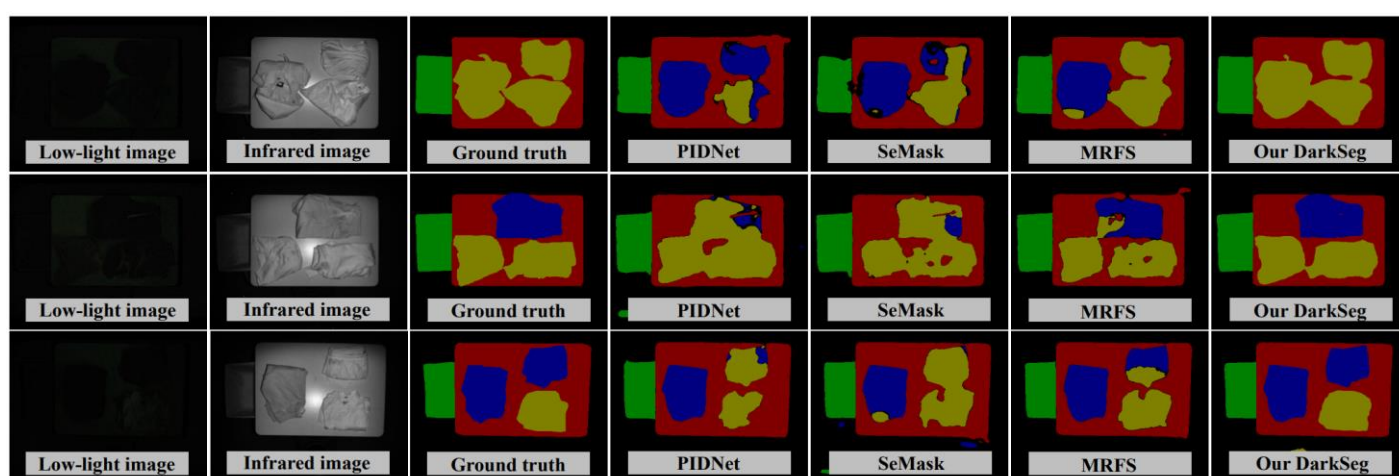
Key contributions

- ◆ We propose the DarkSeg, for low-light garment grasping, which learns illumination-invariant representations by aligning structural features between low-light and infrared modalities.
- ◆ To leverage the prominent structural features in infrared images for reinforcing low-light images, we propose a Short-Range Feature Awareness module and a Wide-Range Feature Awareness module.

Dataset and Experimental Results



The proposed **Darkclothes dataset**



Qualitative Comparison on the **Darkclothes dataset**

Method	Success Rate		
	Pants	Shirts	Average
PIDNet (RGB)	14 / 25 (64%)	18 / 25 (68%)	64%
MRFS (RGB-T)	18 / 25 (56%)	19 / 25 (72%)	74%
DarkSeg w/o TM	15 / 25 (68%)	19 / 25 (72%)	68%
DarkSeg	22 / 25 (88%)	21 / 25 (84%)	86%

Grasping Comparison on the **Darkclothes dataset**

- We compare the performance of DarkSeg with previous state-of-the-art methods on garment detection on the Darkclothes dataset.
- We conduct real-world experiments on a Baxter robot with DarkSeg to validate the effectiveness of the proposed method.
- We further analyze the complexity of our DarkSeg.