

UNIVERSITY OF MÜNSTER
DEPARTMENT OF INFORMATION SYSTEMS

Salient Object Detection for Social Media Images

SEMINAR THESIS

in the context of the seminar

MORE THAN MEETS THE A-EYE: REFLECTING HUMAN VISION IN ARTIFICIAL
INTELLIGENCE

submitted by

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Submission Date	5.12.2025

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1 Introduction

1.1 Motivation and Context

1.2 Research Gap

2 Theoretical Background

2.1 Image Segmentation

Image segmentation is the process of dividing an image into different regions by grouping pixels and assigning each pixel a label. This step is an important part of many computer vision applications, such as detecting tumors in medical images or identifying pedestrians in autonomous driving. According to human visual perception, the identified regions are non-overlapping and meaningful - however, defining what exactly counts as a “meaningful” region can be difficult, as human perception is subjective and object boundaries are not always clear (Yu et al., 2023).

There are three common types of segmentation:

Semantic segmentation assigns every pixel in an image a semantic label, such as “car” or “sky”. *Instance segmentation* separates individual objects within the same class, for example distinguishing several people in one image. *Panoptic segmentation* combines both approaches by providing pixel-wise class labels and also identifying individual object instances.

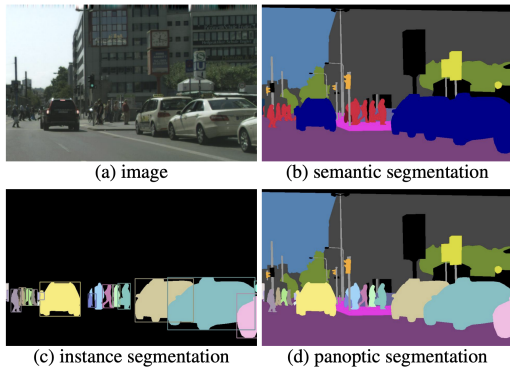


Figure 1 Types of image segmentation by Kirillov et al., 2019

Earlier approaches to image segmentation include algorithms such as k-means-clustering (Dhanachandra et al., 2015). Yet in recent years, deep learning models have significantly improved the segmentation effect and performance, therefore becoming the dominant method for solving segmentation tasks in complex environments (Minaee et al., 2022).

According to Zhou et al., 2024, the above-described image segmentation methods fall into the category of generic image segmentation (GIS). The category of promptable image segmentation (PIS) extends GIS by specifying the target to segment through a prompt. This prompt can have various forms such as text, box or points.

2.2 Salient Object Detection

The human visual system pays more attention to certain parts in an image, a property known as saliency. Inspired by this mechanism, *saliency detection* models aim to predict which regions in an image are most likely to attract human visual attention. These models typically provide saliency maps in form of heat maps, in which higher intensity values indicate regions detected to be more important (Ahmadi et al., 2018).

Salient Object Detection (SOD) – also referred to as salient object segmentation (Borji et al., 2019) or saliency segmentation (Kakanopas & Worarapanya, 2021) – goes one step further by segmenting the most salient object(s) of an image. SOD can be interpreted as a two-stage process: 1) Detection of the most salient object and 2) Accurate segmentation of the region of that object. In contrast to general image segmentation, SOD focuses on segmenting only those objects that are (or that are predicted to be) most salient (Borji et al., 2019; T. Liu et al., 2011). Figure 2 illustrates the difference between saliency detection and salient object detection.

2.3 Image Segmentation Models

Table 1 offers a structured overview of prominent and state-of-the-art image segmentation models, organized according to the segmentation tasks for which they are most suitable.

For our use case, only promptable segmentation models are suitable, as the eye-tracking data provides point inputs that will be used to im-

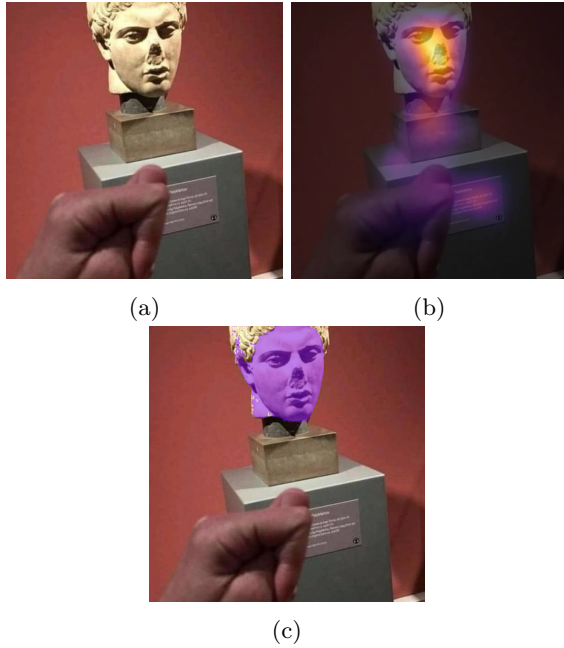


Figure 2 (a) the original image, (b) saliency map (Alexander Kroner, 2025) (c) salient object detection mask generated using SAM3 guided by the eye-tracking data

plement SOD. Among the identified promptable models, SAM and its successors are the only widely adopted models that natively support point-based prompts (Kirillov et al., 2023). In contrast, Grounded-SAM (Ren et al., 2024) and Florence-2 (Xiao et al., 2023) are limited to text prompts, and SEEM, whose last update dates back to 2023, is less actively maintained and less commonly used than SAM (Zou et al., 2023).

The Segment Anything Model (SAM) was developed by Meta AI and first introduced in mid-2023 (Kirillov et al., 2023). SAM performs object segmentation based on prompts, including points

and bounding boxes. With more than 15,000 citations, SAM has become one of the de facto standards for domain-specific applications and is already employed in several specialized salient object detection settings, such as camouflage object segmentation and medical image segmentation (Chen et al., 2025), RGB-T SOD (Z. Liu et al., 2025), and text-driven SOD (Yuan et al., 2026). The most recent version, SAM 3, was released on 20 November 2025. Its rapid adoption - reaching over 5.1k GitHub stars within two weeks - indicates strong community interest. Compared to previous versions, SAM 3 introduces the ability to detect and segment instances that match a given text description, and to further refine detections using visual examples (Carion et al., 2025).

2.4 Evaluation of Image Segmentation Models

- Subjective & Objective (Image segmentation evaluation: a survey of methods)
- SAM: IoU (SAM paper itself)
- Metrics in SOD: PR, F-measure, MAE (Salient object detection: A survey)

Generic Image Segmentation			
Instance segmentation	Semantic segmentation	Panoptic segmentation	Promptable Image Segmentation
Mask R-CNN	DeepLabV3	Mask2Former	SAM2, SAM3
YOLOv11-seg	FCN	Panoptic-DeepLab	Grounded-SAM
YOLACT	U-Net	Panoptic FPN	SEEM
Mask2Former	SegFormer	...	Florence-2
Mask DINO	LR-ASPP		...
...	...		

Table 1 Overview of prominent image segmentation models categorized by segmentation task.

3 Methodology

3.1 Experimental Design

3.2 Planned Practical Steps

The planned next steps can be divided into two main parts. The first part focuses on the optimization of the saliency object detection process, while the second part focuses on the extraction of insights from the segmented objects, based on an exploratory data analysis (Tukey, 1977).

As discussed in the previous section, the current approach offers several options for improvement. These include image preprocessing, the adjustment of threshold values, the use of box prompts instead of point prompts, and the exploration of additional clustering methods such as k means. Moreover, it is possible to add further steps between the main stages of the workflow in order to create more stable and consistent results. As a last possibility, the model can be fine-tuned, using existing scientific datasets such as WXSOD or PASCAL-S (CCVL, 2018; Quan et al., 2025), which already include saliency masks. The overall goal of this first step is to produce the best possible saliency masks for social media images. Better masks allow for a more reliable extraction of insights in the next step.

After the optimization step, the quality of the segmented masks must be evaluated. This evaluation includes three main questions. First, it must be examined if the masks truly represent the salient parts of the image. Second, the mask quality must be assessed by measuring how well the masks fit the expected important regions. Third, it must be analyzed whether certain types of images work better or worse with saliency based segmentation. This helps identify strengths and limitations of the approach for different kinds of social media content.

Furthermore, the generated masks allow for additional exploratory fields of analysis that can be grouped into three areas: user insights, content insights, and accessibility support. The user related area includes predictive user profiling,

where salient regions help identify which visual elements attract individual users. The content related area includes a deeper understanding of social media images, the detection of clickbait content, and guidance for creators who work with under optimized images. The accessibility related area focuses on focus aware alternative text generation, where the masks help identify the most important visual elements for users with visual impairments. Together, these groups show the wider potential of the approach beyond the core segmentation step.

4 Results

4.1 Current Results

Regarding the first iteration of our Saliency Object Detection Pipeline, we have successfully segmented some types of social media images. Figure TODO shows an example of a social media image, along with its generated saliency mask. The mask highlights the teacher, the computer screen and the specific area on the screen, which does represent the salient objects in this image. Also other images, showing small groups of people or single persons have been segmented quite well so far.

However, there are also several limitations, which have been observed in the current results. First, images with very complex scenes or too many objects tend to produce less accurate masks (see Figure TODO). Second, images with text overlays led to only some letters being grouped into the salient region, instead of the full text block (see Figure TODO). Third, images with landscapes or generally without clear focal points were not segmented effectively (see Figure TODO). These limitations indicate that while the current pipeline shows promise, there is still room for improvement in handling a wider variety of social media images.

4.2 Expected Results for the Planned Steps

Regarding the planned optimization steps, we expect to see significant improvements in the quality of the saliency masks. By implementing image preprocessing techniques, we anticipate that noise and irrelevant details in the images will be reduced, leading to clearer segmentation results. The other discussed optimization techniques aim to further refine the segmentation process, making it more robust across different types of images. Overall, we strive to achieve more consistently accurate saliency masks, which will enhance the reliability of subsequent analyses.

Further analyses based on the optimized masks are expected to yield valuable insights into user behavior and content characteristics on social media platforms. For instance, by examining which visual elements are most frequently highlighted in the masks, we can infer what types of content are more engaging to users. These insights can inform content creation and moderation strategies. As the second part of our planned work is mostly experimental, pivots and adjustments of the goal and scope might be necessary, which would lead to different expected results.

5 Discussion

5.1 Limitations

5.2 Future Research

6 Conclusion

A Appendix

TODO: Add result pictures and/or our code here

Bibliography

- Ahmadi, M., Hajabdollahi, M., Karimi, N., & Samavi, S. (2018, January). Context aware saliency map generation using semantic segmentation [arXiv:1801.00256 [cs]]. <https://doi.org/10.48550/arXiv.1801.00256>
- Alexander Kroner. (2025, March). Visual Saliency Prediction - a Hugging Face Space by alexanderkroner. Retrieved December 2, 2025, from <https://huggingface.co/spaces/alexanderkroner/saliency>
- Borji, A., Cheng, M.-M., Hou, Q., Jiang, H., & Li, J. (2019). Salient object detection: A survey. *Computational Visual Media*, 5(2), 117–150. <https://doi.org/10.1007/s41095-019-0149-9>
- Carion, N., Gustafson, L., Hu, Y.-T., Debnath, S., Hu, R., Suris, D., Ryali, C., Alwala, K. V., Khedr, H., Huang, A., Lei, J., Ma, T., Guo, B., Kalla, A., Marks, M., Greer, J., Wang, M., Sun, P., Rädle, R., ... Feichtenhofer, C. (2025, November). SAM 3: Segment Anything with Concepts [arXiv:2511.16719 [cs]]. <https://doi.org/10.48550/arXiv.2511.16719>
- CCVL. (2018). Pascal-S. <https://ccvl.jhu.edu/datasets/>
- Chen, T., Cao, R., Yu, X., Zhu, L., Ding, C., Ji, D., Chen, C., Zhu, Q., Xu, C., Mao, P., & Zang, Y. (2025, November). SAM3-Adapter: Efficient Adaptation of Segment Anything 3 for Camouflage Object Segmentation, Shadow Detection, and Medical Image Segmentation [arXiv:2511.19425 [cs]]. <https://doi.org/10.48550/arXiv.2511.19425>
- Dhanachandra, N., Manglem, K., & Chanu, Y. J. (2015). Image Segmentation Using K - means Clustering Algorithm and Subtractive Clustering Algorithm. *Procedia Computer Science*, 54, 764–771. <https://doi.org/10.1016/j.procs.2015.06.090>
- Kakanopas, D., & Woraratpanya, K. (2021). A Unified Framework for Saliency Segmentation. In P. Meesad, D. S. Sodsee, W. Jitsakul, & S. Tangwannawit (Eds.), *Recent Advances in Information and Communication Technology 2021* (pp. 191–200). Springer International Publishing. https://doi.org/10.1007/978-3-030-79757-7_19
- Kirillov, A., He, K., Girshick, R., Rother, C., & Dollár, P. (2019). Panoptic Segmentation. *2019 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, 9396–9405. <https://doi.org/10.1109/CVPR.2019.00963>
- Kirillov, A., Mintun, E., Ravi, N., Mao, H., Rolland, C., Gustafson, L., Xiao, T., Whitehead, S., Berg, A. C., Lo, W.-Y., Dollár, P., & Girshick, R. (2023, April). Segment Anything [arXiv:2304.02643 [cs]]. <https://doi.org/10.48550/arXiv.2304.02643>
- Liu, T., Yuan, Z., Sun, J., Wang, J., Zheng, N., Tang, X., & Shum, H.-Y. (2011). Learning to Detect a Salient Object. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 33(2), 353–367. <https://doi.org/10.1109/TPAMI.2010.70>
- Liu, Z., Wang, X., Fang, X., Tu, Z., & Wang, L. (2025, October). SAMSOD: Rethinking SAM Optimization for RGB-T Salient Object Detection [arXiv:2510.03689 [cs]]. <https://doi.org/10.48550/arXiv.2510.03689>
- Minaee, S., Boykov, Y., Porikli, F., Plaza, A., Khtarnavaz, N., & Terzopoulos, D. (2022). Image Segmentation Using Deep Learning: A Survey. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 44(7), 3523–3542. <https://doi.org/10.1109/TPAMI.2021.3059968>
- Quan, C., Xiong, Y., Rongfeng, L., Qianyu, Z., Yu, L., Xiaofei, Z., & Bolun, Z. (2025). WXSOD: A Benchmark for Robust Salient Object Detection in Adverse Weather Conditions. <https://arxiv.org/abs/2508.12250>
- Ren, T., Liu, S., Zeng, A., Lin, J., Li, K., Cao, H., Chen, J., Huang, X., Chen, Y., Yan,

- F., Zeng, Z., Zhang, H., Li, F., Yang, J., Li, H., Jiang, Q., & Zhang, L. (2024, January). Grounded SAM: Assembling Open-World Models for Diverse Visual Tasks [arXiv:2401.14159 [cs]]. <https://doi.org/10.48550/arXiv.2401.14159>
- Tukey, J. W. (1977). Exploratory data analysis. *Reading/Addison-Wesley*.
- Xiao, B., Wu, H., Xu, W., Dai, X., Hu, H., Lu, Y., Zeng, M., Liu, C., & Yuan, L. (2023, November). Florence-2: Advancing a Unified Representation for a Variety of Vision Tasks [arXiv:2311.06242 [cs]]. <https://doi.org/10.48550/arXiv.2311.06242>
- Yu, Y., Wang, C., Fu, Q., Kou, R., Huang, F., Yang, B., Yang, T., & Gao, M. (2023). Techniques and Challenges of Image Segmentation: A Review [Publisher: Multidisciplinary Digital Publishing Institute]. *Electronics*, 12(5), 1199. <https://doi.org/10.3390/electronics12051199>
- Yuan, Y., Zhang, Y., Zhang, S., & Wang, H. (2026). SaliencyCLIP-SAM: Bridging Text and Image Towards Text-Driven Salient Object Detection. In Z. Lin, L. Wang, Y. Jiang, X. Wang, S. Liao, S. Shan, R. Liu, J. Dong, & X. Yu (Eds.), *Image and Graphics* (pp. 29–41). Springer Nature. https://doi.org/10.1007/978-981-95-3393-0_3
- Zhou, T., Xia, W., Zhang, F., Chang, B., Wang, W., Yuan, Y., Konukoglu, E., & Cremers, D. (2024, November). Image Segmentation in Foundation Model Era: A Survey [arXiv:2408.12957 [cs]]. <https://doi.org/10.48550/arXiv.2408.12957>
- Zou, X., Yang, J., Zhang, H., Li, F., Li, L., Wang, J., Wang, L., Gao, J., & Lee, Y. J. (2023, July). Segment Everything Everywhere All at Once [arXiv:2304.06718 [cs]]. <https://doi.org/10.48550/arXiv.2304.06718>

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