# A Self-Validation Network for Object-Level Human Attention Estimation

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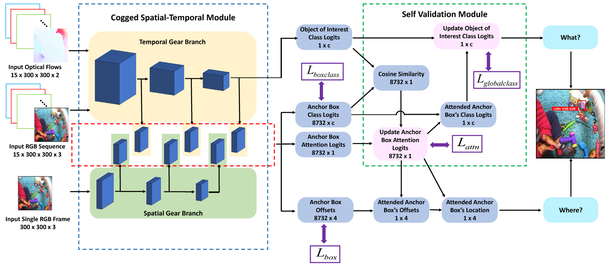
http://vision.soic.indiana.edu/mindreader/

## Introduction

- Due to the foveated nature of the human vision system, people can focus their visual attention on a small region of their visual field at a time.
- Our goal is to jointly identify and locate the attended object among many others in first-person videos.
- Various applications:
  - ❑ Applied in VR/AR devices, driver assistance systems
  - ❑ Auxiliary information for other computer vision tasks


## Model

- We propose a novel unified model to enforce and leverage the visual consistency of our foveated visual system.




- Double self validation:
  - ❑ What→Where

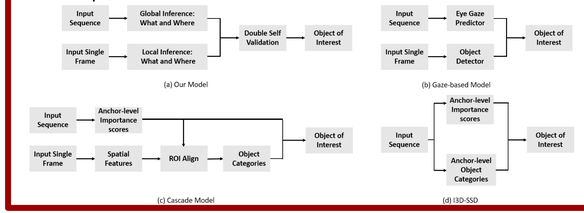
$$A' = R(A) + V_{attn} = \frac{A - (max(A) + min(A))/2}{max(A) - (max(A) + min(A))/2} + V_{attn}, \quad V^i_{attn} = \frac{C_{global} C^T_{box_i}}{||C_{global}|| \times ||C_{box_i}||}.$$

  - ❑ Where→What

$$V_{class} = C_{box_m} \quad C'_{global} = R(C_{global}) + R(V_{class})$$

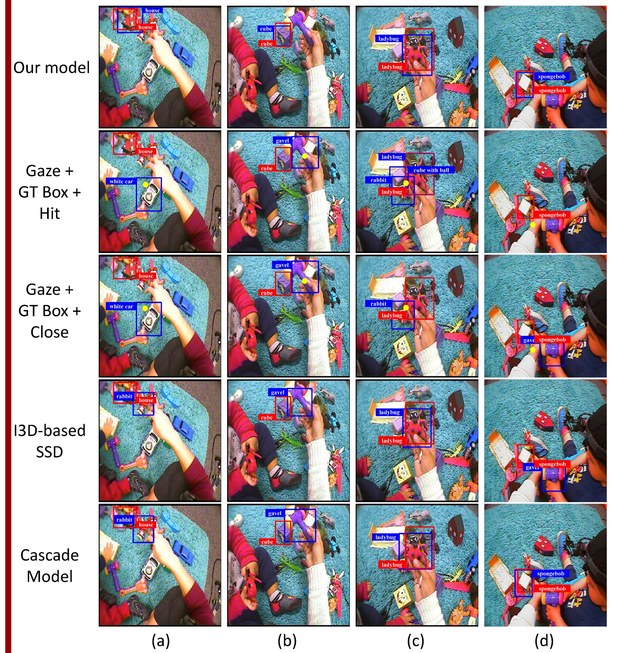
$$\hat{V}_{class} = \sum_{i=1}^{a} \tilde{A}'_i C_{box_i} \quad \tilde{A}'_i = \frac{e^{A'_i}}{\sum_{j=1}^{a} e^{A'_j}} \quad C'_{global} = R(C_{global}) + R(\hat{V}_{class})$$

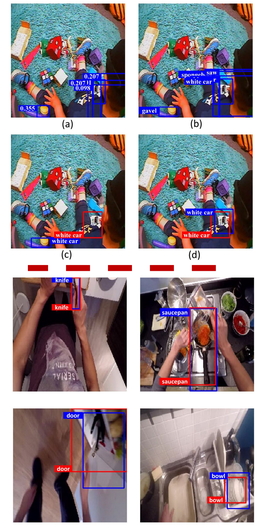
- Comparison with other baselines:




## Experiments

- Evaluate on ATT dataset and Epic-Kitchens dataset
- Report Acc_0.5, Acc_0.75 and mAcc
- To create stronger baselines, we directly use ground truth object bounding boxes and classes as well as ground truth objects in hands in several implementations of the baselines.




| Method | $Acc_{0.5}$ ↑ | $Acc_{0.75}$ ↑ | $mAcc$ ↑ |
|---|---|---|---|
| Our Mr. Net | **74.27** | **46.78** | **44.78** |
| Gaze [68] + GT Box + Hit | 25.26 | 25.26 | 25.26 |
| Gaze [68] + GT Box + Closest | 35.86 | 35.86 | 35.86 |
| I3D [9]-based SSD [40] | **70.11** | 42.10 | 40.85 |
| Cascade Model | 66.97 | **45.10** | 41.93 |
| OIH Detectors + WH Classifier | 37.16 | 37.16 | 37.16 |
| Left Handed Model | 38.31 | 38.31 | 38.31 |
| Right Handed Model | 39.00 | 39.00 | 39.00 |
| OIH GT + WH Classifier | 40.83 | 40.83 | 40.83 |
| Either Handed Model | 42.94 | 42.94 | **42.94** |
| Center GT Box | 23.97 | 23.97 | 23.97 |

Table 1: *Accuracy of our method compared to others*, on the ATT dataset. OIH represents Object-in-Hand, while WH means Which-Hand.

| Streams | Self validation? Training | Testing | $Acc_{0.5}$ ↑ | $Acc_{0.75}$ ↑ | $mAcc$ ↑ |
|---|---|---|---|---|---|
| Two | yes | yes | **74.27** | **46.78** | **44.78** |
| Two | yes | half | — | — | 43.88 |
| Two | yes | no | 68.19 | 42.83 | 41.18 |
| Two | no | yes | 67.18 | 40.06 | 39.48 |
| Two | no | half | — | — | 37.87 |
| Two | no | no | 62.33 | 38.31 | 37.18 |
| RGB | yes | yes | 74.59 | 43.15 | 42.48 |
| Flow | yes | yes | 64.30 | 38.63 | 37.60 |
| Flow | no | yes | — | — | 25.10 |
| Flow | no | no | — | — | 18.40 |

Table 2: *Ablation results.* Testing with half means that the model is tested with only what→where validation.

| Method | $Acc_{0.5}$ ↑ | $Acc_{0.75}$ ↑ | $mAcc$ ↑ |
|---|---|---|---|
| Our Mr. Net | **57.18** | **31.00** | **31.20** |
| I3D [9]-based SSD [40] | 47.58 | 24.38 | 25.42 |
| Cascade Model | 51.20 | 28.18 | 28.36 |

Table 4: *Accuracies on the Epic-Kitchen dataset.*

| Model | $Acc_{0.5}$ ↑ | $Acc_{0.75}$ ↑ | $mAcc$ ↑ |
|---|---|---|---|
| Mr. Net | **71.34** | **38.26** | **39.04** |
| Gaze [68] + GT Boxes Hit | 26.46 | 26.46 | 26.46 |
| Gaze [68] + GT Boxes Closest | 36.81 | 36.81 | 36.81 |
| I3D [9]-based SSD [40] | 67.43 | 37.90 | 37.22 |
| Cascade Model | 65.96 | 38.01 | 37.93 |

Table 3: *Results of online detection.*

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