

Professorship
Artificial Intelligence
Prof. Dr. Fred Hamker

TITEL

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CHEMNITZ UNIVERSITY
OF TECHNOLOGY



Outline

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Goals

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- Enhance object recognition by neuro-computational concepts.
- Concept of visual attention can solve the problem of parallel segmentation and recognition.
- Combine the concept of attention with shape-based object recognition.
- Use a stereoscopic input to be applicable to robots with two cameras.



Concept of attention - key ideas

Concept of visual attention (Hamker, 2005):

Focus processing on a spatial part of the image or at a subset of features.

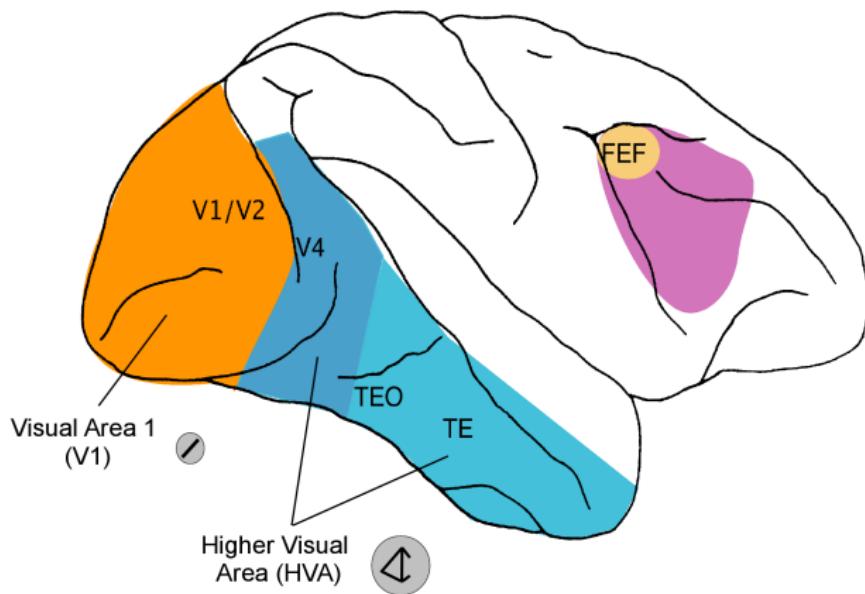
Key ideas:

- ① Parallel processing over all hierarchical areas in the visual stream.
- ② Selection of cells: first spatial, and second feature-based.



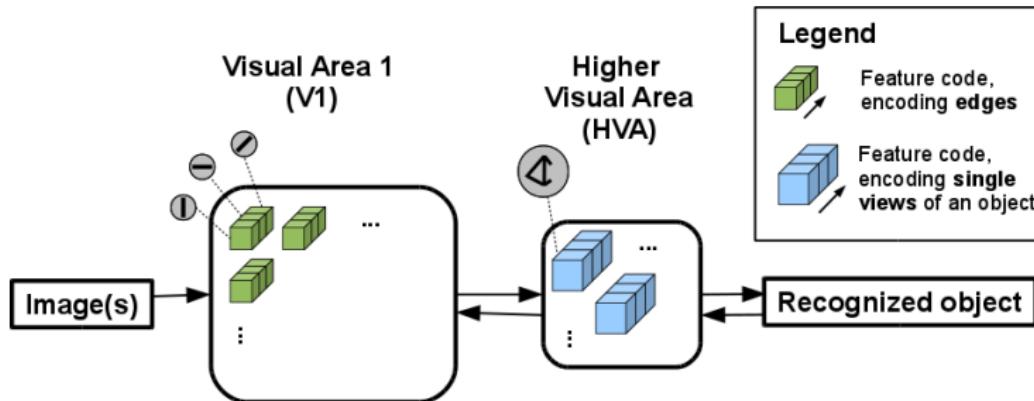
Visual Cortex

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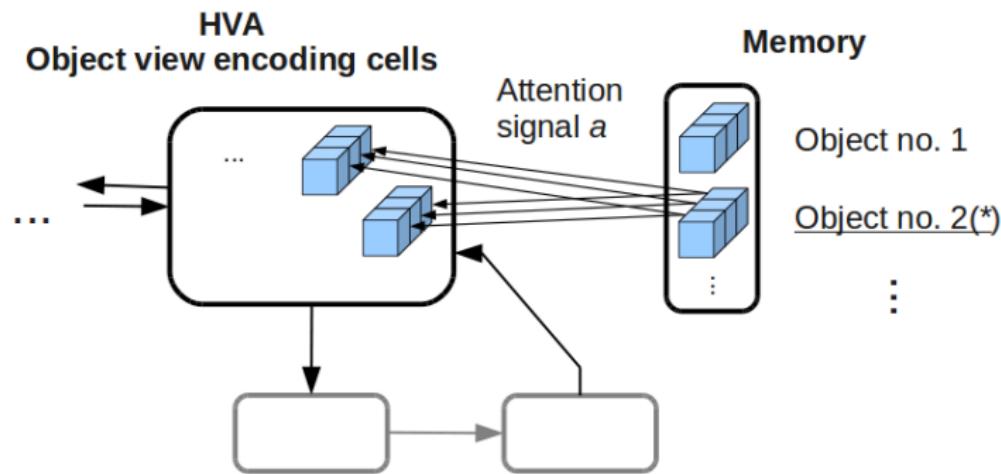
Parallel processing



- Bottom-up processing, driven by conspicuous image points like edges, corners, ...
- Top-down processing, hence which object is expected.



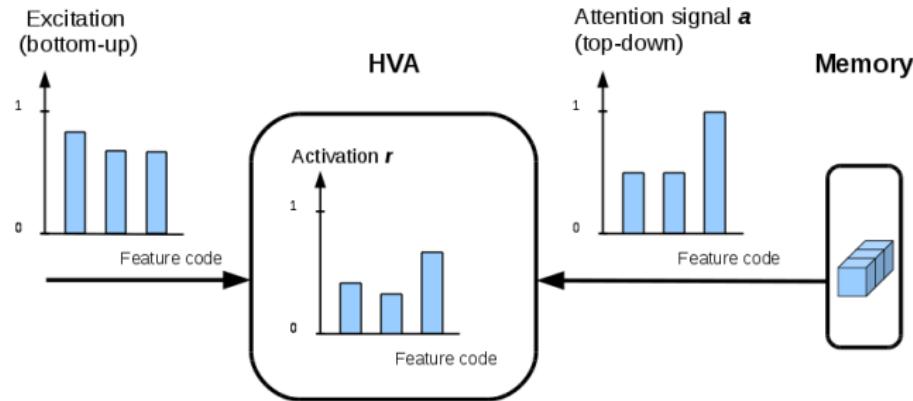
Feature-based selection of cells





Information integration

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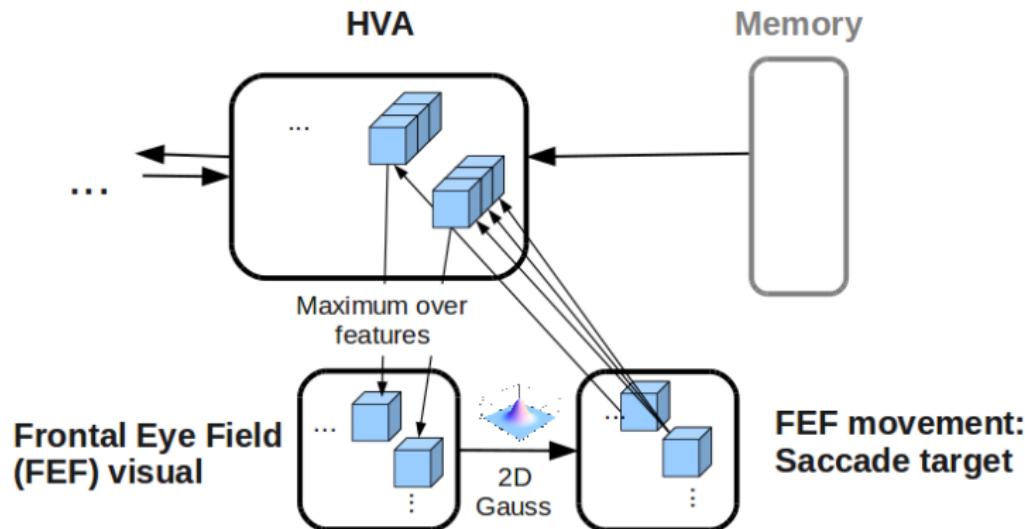
Activation r_j for cell j :

$$\tau \frac{\Delta r_j}{\Delta t} = (\sum_i w_{i,j} \cdot r_i) \cdot (1 + a_j - \max\{a\})$$



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Spatial selection of cells





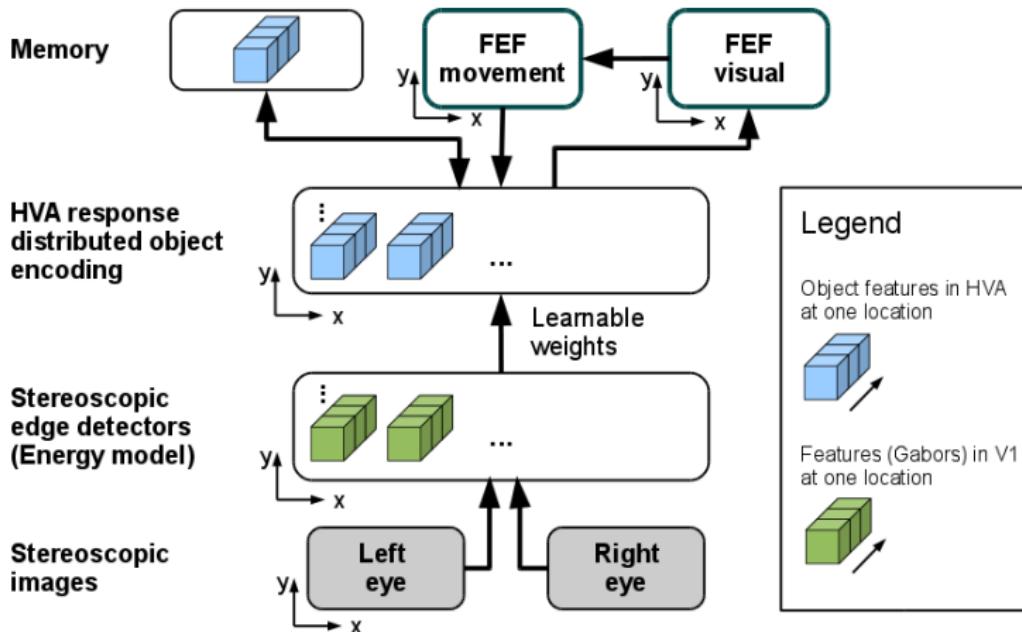
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Model

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- Idea: A following image belong probably to the same object then the last image.
- Present a slowly in depth moving object as input.
- Use a Oja like trace learning rule (simplified form):

$$\tau \frac{\Delta w}{\Delta t} = r^{\text{HVA}}(\textit{trial} - 1) \cdot r^{\text{V1}}(\textit{trial}) - \alpha \cdot (r^{\text{HVA}})^2 \cdot w$$

- Achieve view encoding cells with scaling and depth invariances.



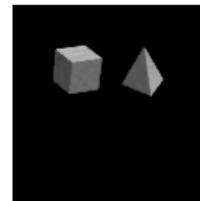
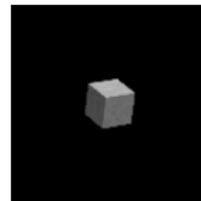
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Experiment:

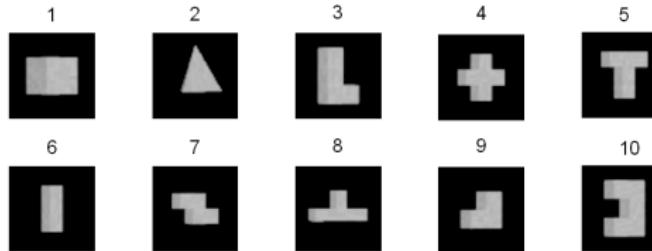
- ① Present an object alone and memorize it.
- ② Search the object in a complex scene.





Object recognition

Recognition of 10 different Objects:



- ① Present each object alone at a random position and memorize it.
- ② Search and recognize the object in a complex scene.



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- Demonstrate the psychological concept of attention in connection with learned shape-based detectors.
- The concept will also work well with other descriptors.
- Model is able to recognize and localize an object in parallel.



Future work

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- Area HVA is an abstraction of V2, V4 and TEO/TE.
- The attention signal is not applied at V1.
- The stereoscopic edge detector does not work with huge disparities.



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Acknowledgments



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