Towards Active Image Segmentation: the Foveal Bounded Irregular Pyramid

Rebeca Marfil
Grupo de Ingeniería de Sistemas Integrados
Departamento de Tecnología Electrónica
Universidad de Málaga, Spain

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- Cartesian Foveal Geometries. Foveal polygon
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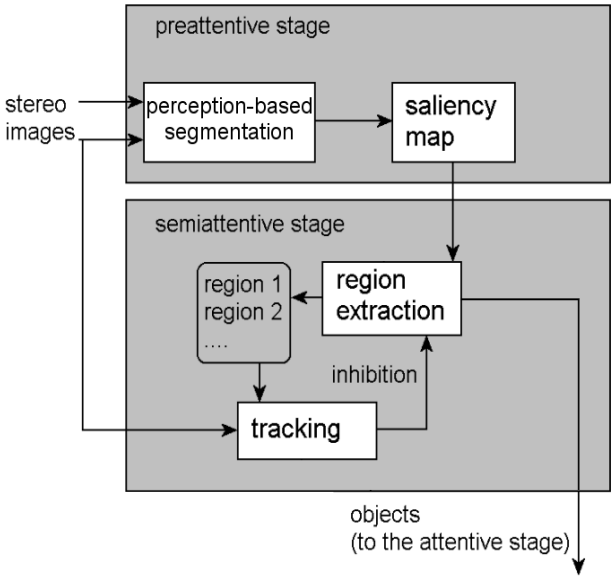
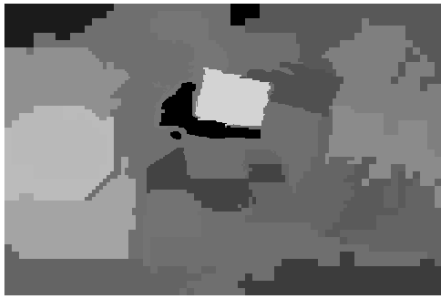
Introduction: segmentation and attention

- Segmentation in computer vision is the process to divide up an image into non-overlapping and compact regions.
- Perceptual segmentation approaches try to divide up the image into pre-attentive objects (proto-objects) in the same way that a human does.
- Problems:
  - The accuracy of a segmentation depends on the application
  - What are we looking for in the image? What is the object of interest?

Attention provides the object of interest

Introduction: segmentation and attention





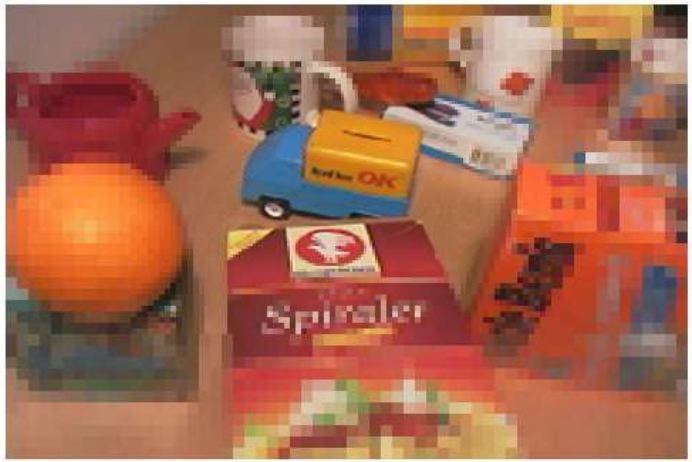
Saliency map

- In biological vision systems, attention pre-selects relevant information from the sensed field of view.
- In computer vision, attention mechanisms extract the relevant information from an image by computing saliency maps.
- Problems:
  - Most artificial systems works at pixel resolution

Segmentation provides the proto-objects as the units where the attention is deployed

Segmentation can be modulated by attention.

Introduction: goals of the presented work



Reduce the computational load associated to the segmentation process:

- Resembling the spatial geometry of the images captured by the human retina: capturing only the region of interest at high resolution (fovea) while the rest of the scene is captured at lower resolution (periphery).

FOVEAL VISION

- Performing foveal segmentation

FOVEAL BOUNDED IRREGULAR PYRAMID

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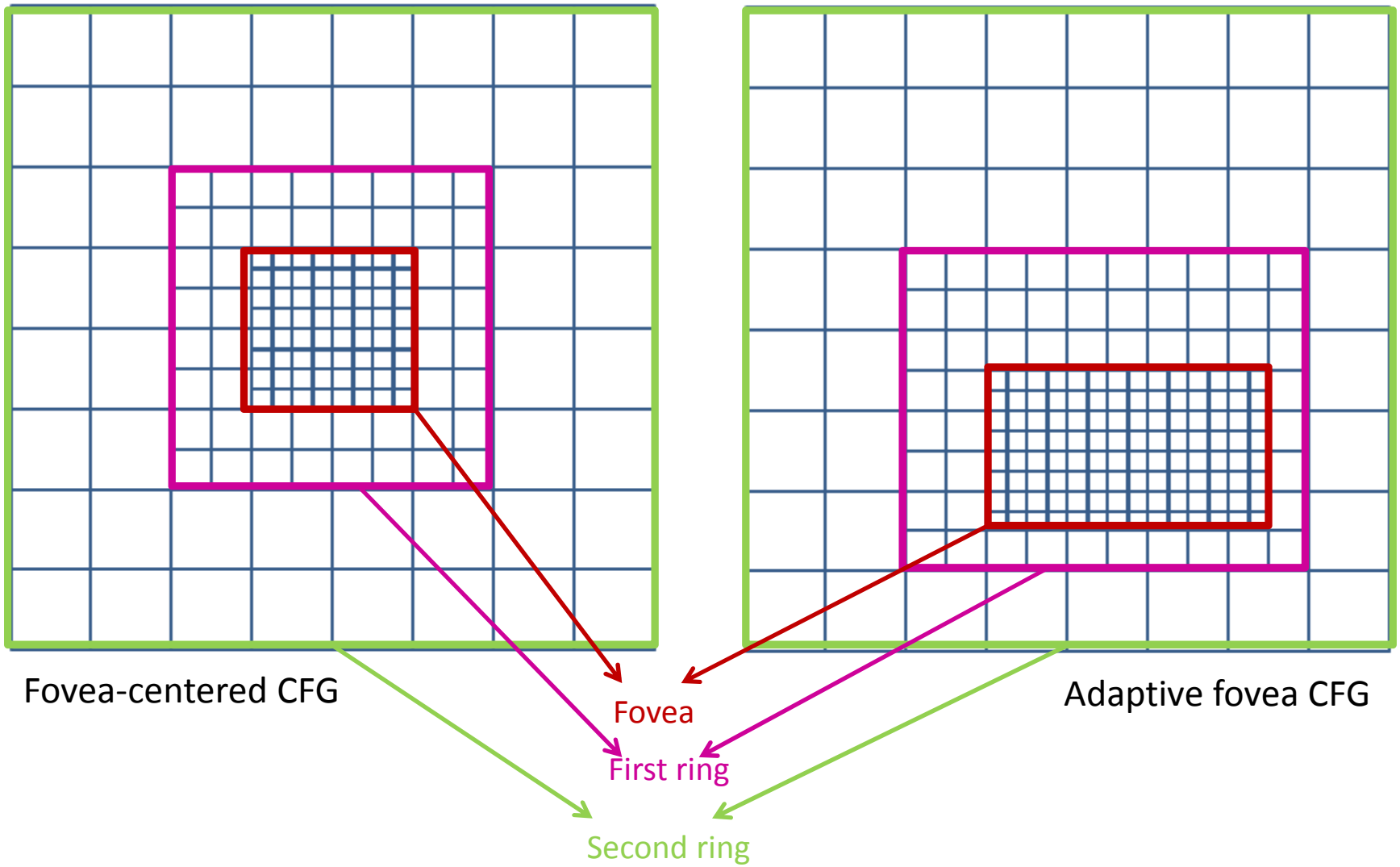
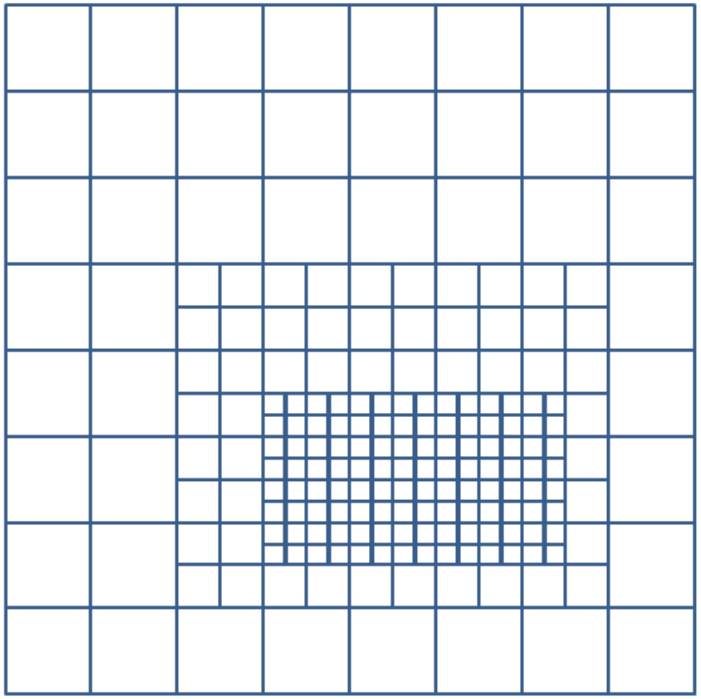
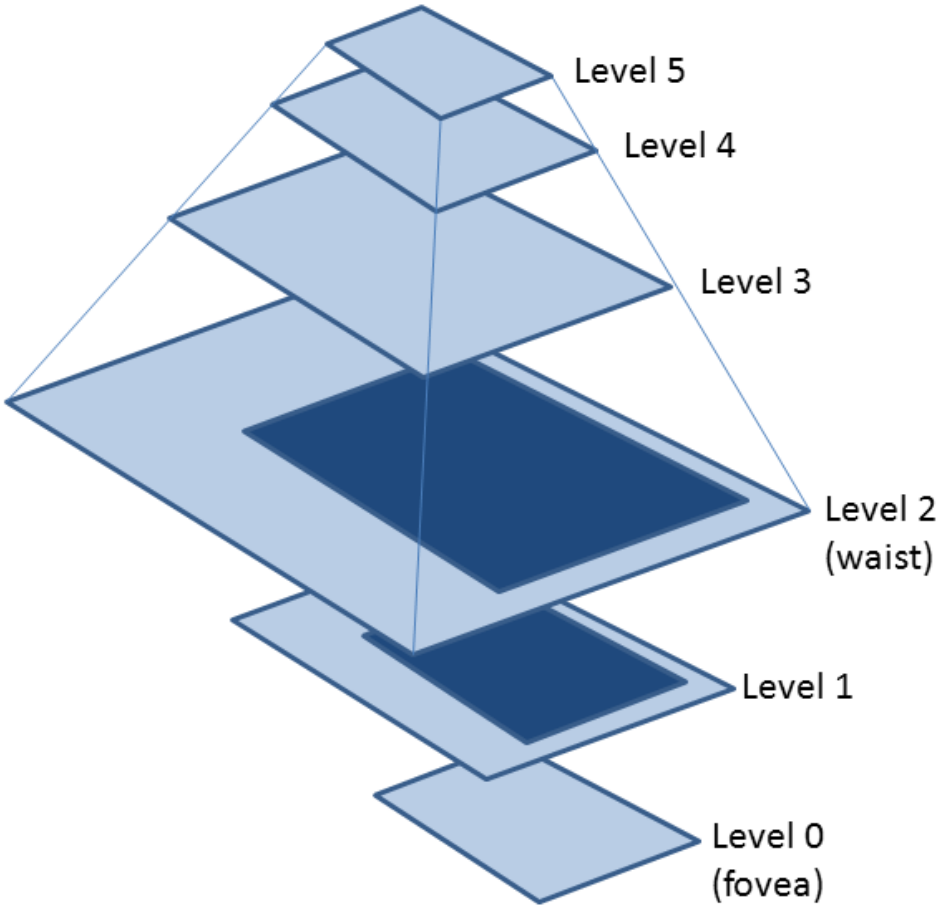
Cartesian Foveal Geometries (CFG)



Foveal Polygon





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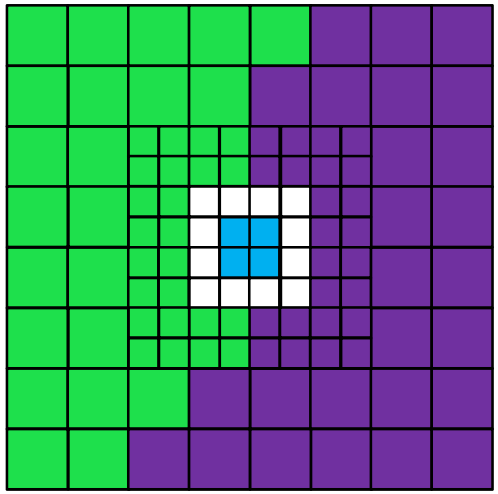
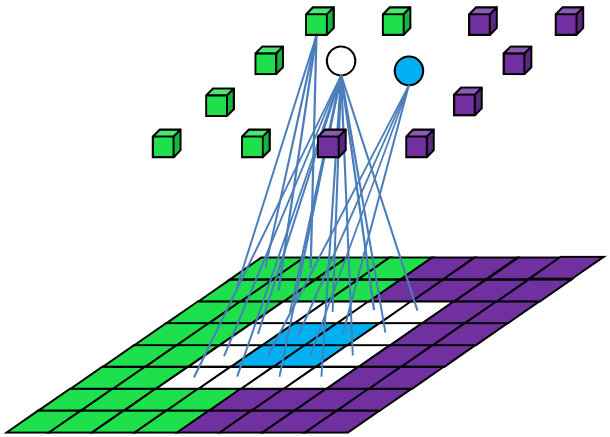
Foveal Bounded Irregular Pyramid

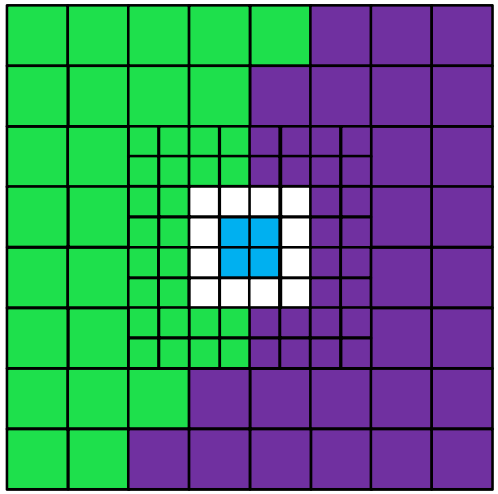


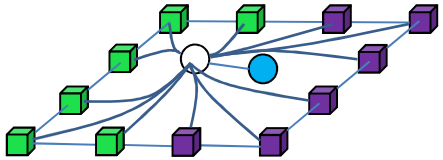


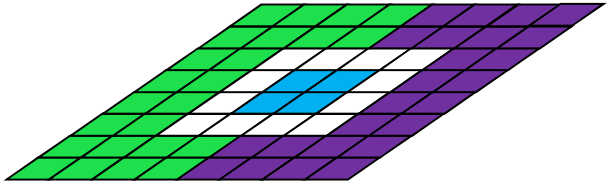
Level 0 - Fovea

R. Marfil and A. Bandera, Comparison of perceptual grouping criteria within an integrated hierarchical framework, *Lecture Notes in Computer Science*, 5534, 366-375, 2009.

Foveal Bounded Irregular Pyramid







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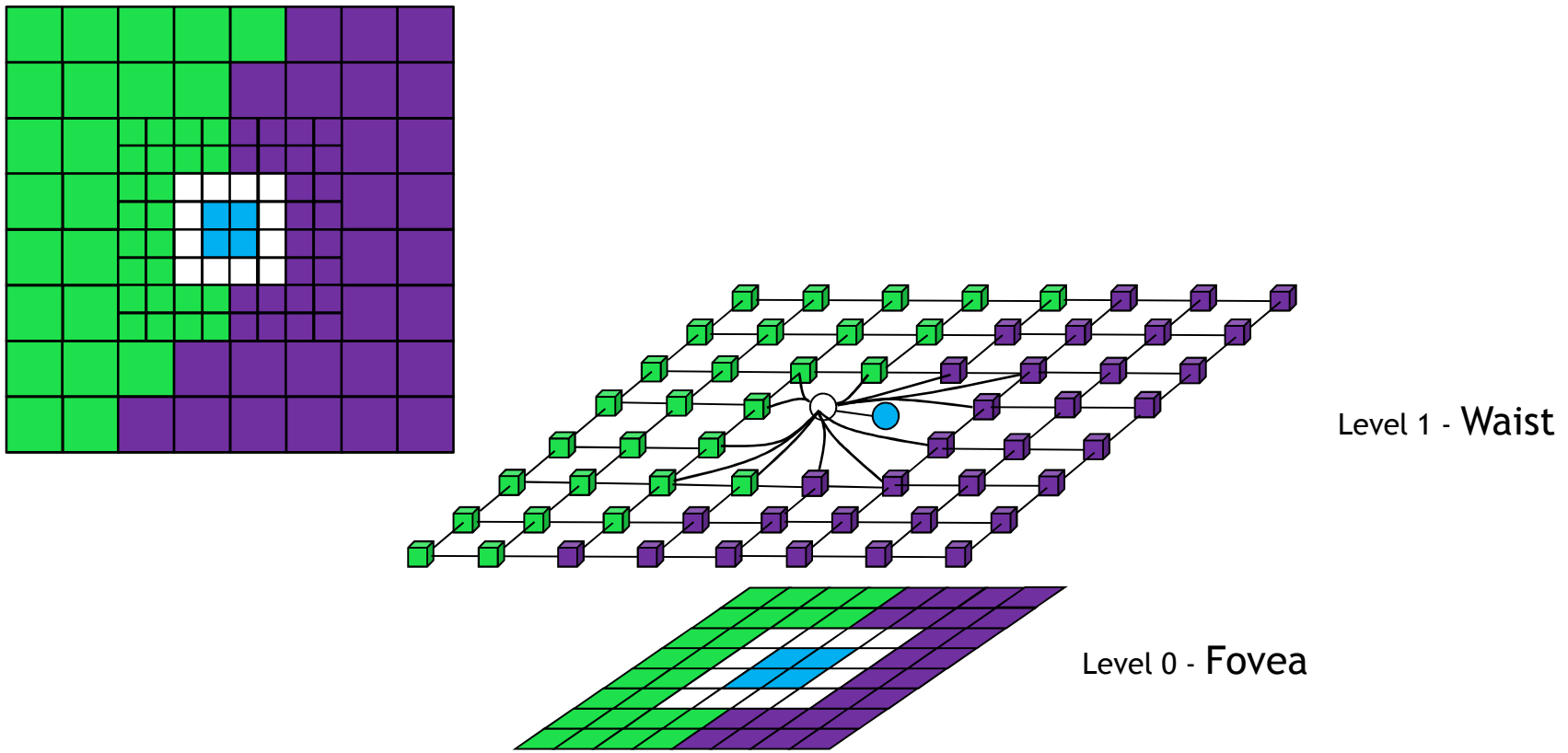

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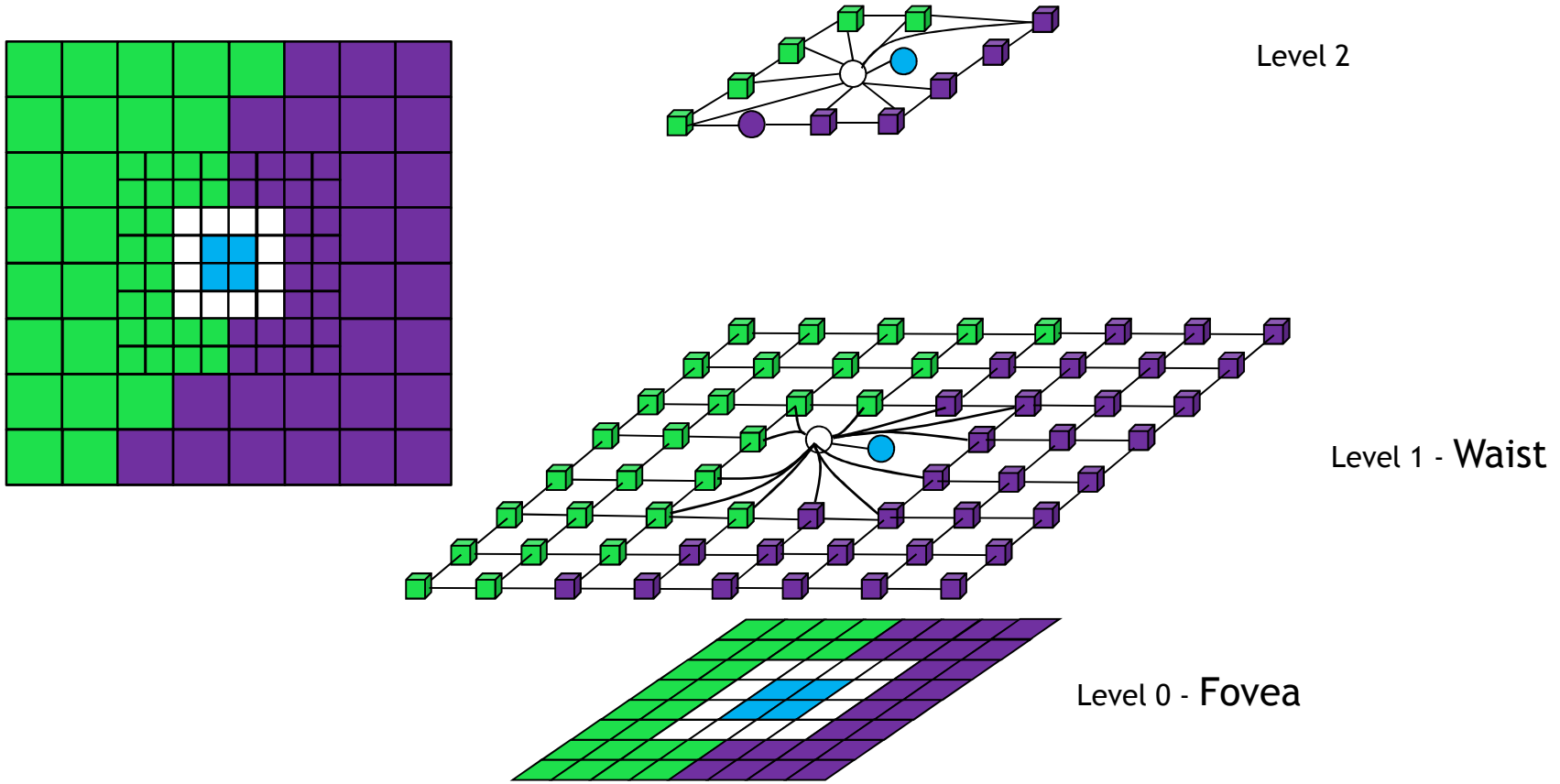

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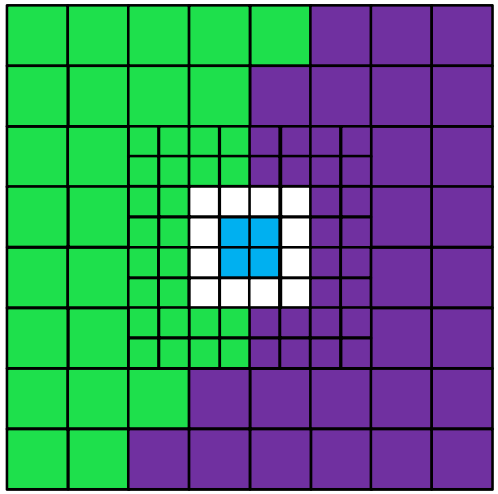
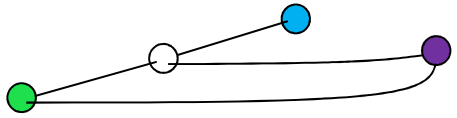
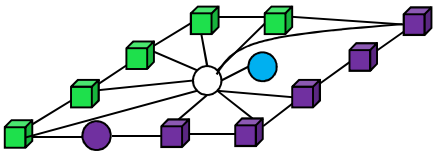
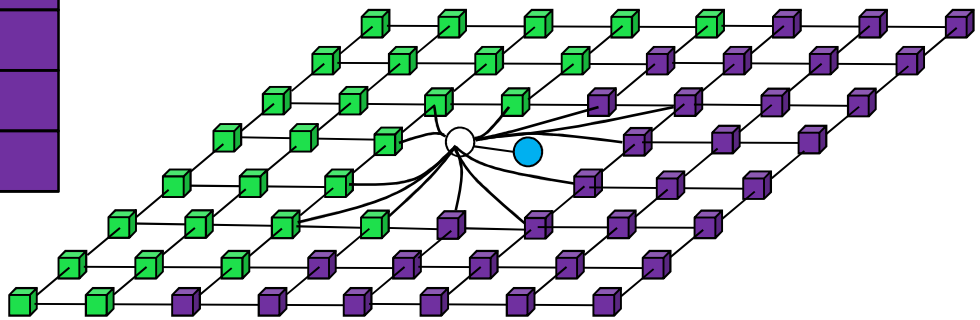




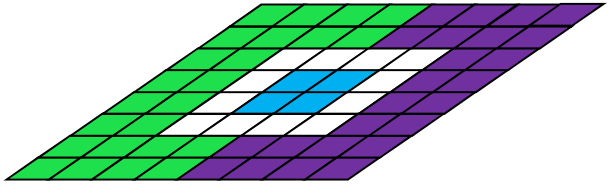
Level 3



Level 2



Level 1 - Waist



Level 0 - Fovea

R. Marfil and A. Bandera, Comparison of perceptual grouping criteria within an integrated hierarchical framework, *Lecture Notes in Computer Science*, 5534, 366-375, 2009.

1. Levels from l_0 to l_m with $l < waist$ are built using color information:
   Distance between to nodes x_i and x_j:

$$\psi^{\beta} = \sqrt{(L_{\mathbf{x}_i^{(l)}} - L_{\mathbf{x}_j^{(l)}})^2 + \beta(a_{\mathbf{x}_i^{(l)}} - a_{\mathbf{x}_j^{(l)}})^2 + \beta(b_{\mathbf{x}_i^{(l)}} - b_{\mathbf{x}_j^{(l)}})^2}$$

2. Levels $l > waist$ are built using color and edge information:
   Distance between to nodes y_i and y_j:

$$\varphi^{\alpha}(\mathbf{y}_i^{(l)}, \mathbf{y}_j^{(l)}) = \frac{d(\mathbf{y}_i^{(l)}, \mathbf{y}_j^{(l)}) \cdot min(b_{\mathbf{y}_i^{(l)}}, b_{\mathbf{y}_j^{(l)}})}{\alpha \cdot c_{\mathbf{y}_i^{(l)}\mathbf{y}_j^{(l)}} + (b_{\mathbf{y}_i^{(l)}\mathbf{y}_j^{(l)}} - c_{\mathbf{y}_i^{(l)}\mathbf{y}_j^{(l)}})}$$

Boundary

Colour distance

Canny

Common boundary between regions

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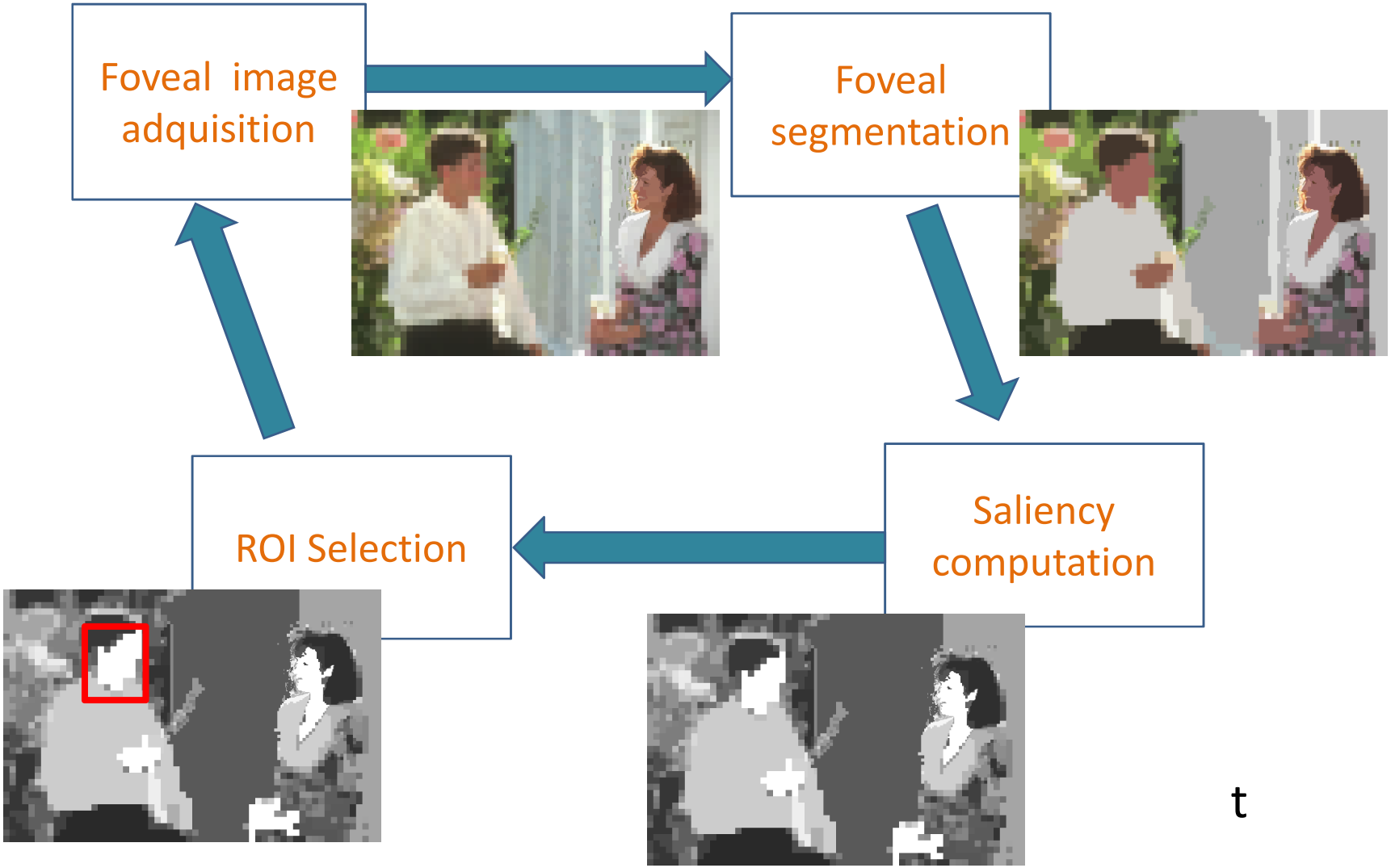
Segmentation and visual attention



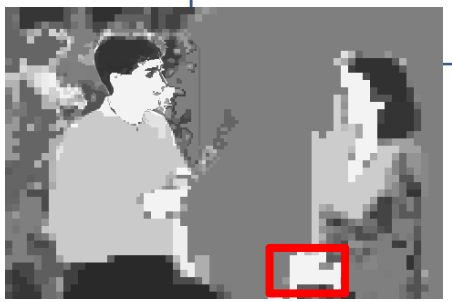
Segmentation and visual attention

Foveal image adquisition

Foveal segmentation

Saliency computation

ROI Selection



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Experimental results

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Future work

- Bounded Irregular Pyramid with dual graph
- Evaluation with the attention mechanism presented in:

R. Marfil, A. Bandera, J.A. Rodríguez y F. Sandoval, A novel hierarchical framework for object-based visual attention, *Lecture notes in Computer Science*, 5395, 27-40, 2009.

A. J. Palomino, R. Marfil , J.P. Bandera and A. Bandera, A novel biologically inspired attention mechanism for a social robot, EURASIP Journal on Advances in Signal Processing, vol. 2011.

Merging att… …tion: acti… …on

Thanks!
Any questions?

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