Performance assessment of a visual attention system entirely based on a human vision modeling

[Authors : O. LE MEUR[1,2]; P. LE CALLET[2]; D. BARBA[2]; D. THOREAU[1];
[1]- Thomson R&D Rennes, France [2]- IRCCyN Nantes, France]

Introduction

The aim of our work is to model the bottom-up human visual attention. The bottom-up mechanism involved in the human visual attention refers to the involuntary attention. In fact, spatial locations in our visual field can grab effortlessly our attention. Bottom-up attentional selection is a fast, often compulsory, stimulus-driven mechanism. The model we develop consists in simulating such mechanism on still color pictures.

I. Global scheme of the model

A functional model has been derived from psychophysic experiments [1,2]. It is decomposed into three parts :

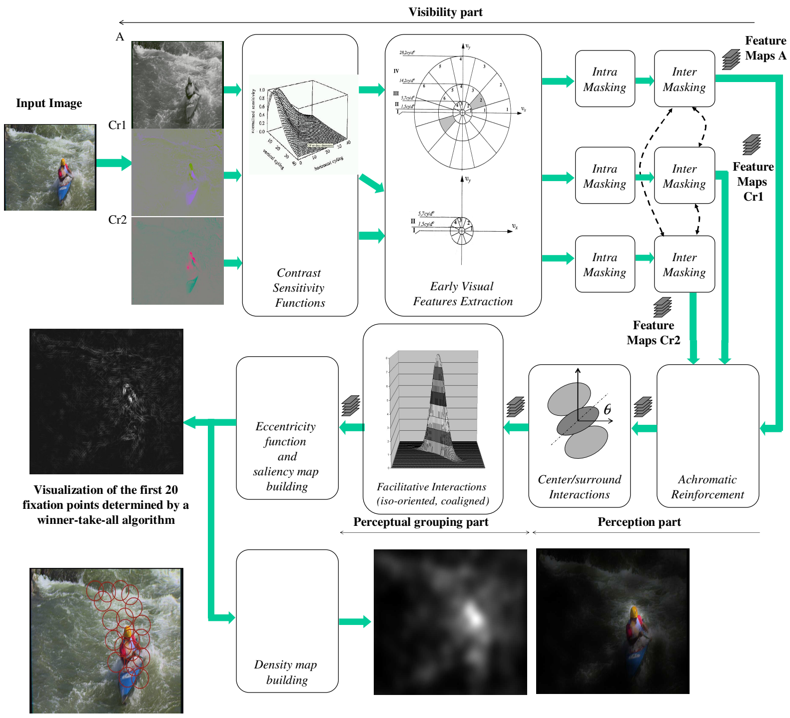
Visibility
- color separation into Krauskopf pathways
- contrast sensitivity functions
- perceptual sub-band decomposition
- intra/inter pathway masking effects

Perception
- Achromatic reinforcement by chromatic context
- center/surround suppressive interaction

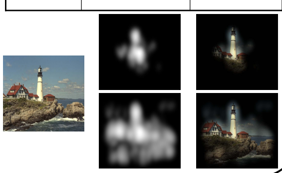
Perceptual grouping
- higher level structure construction by grouping and binding visual features (iso-oriented and co-aligned linear structures).

Finally, a saliency map* is computed by filtering with a 2D gaussian PSF the outputs of the perceptual grouping part, to reinforce region with high density of interest points.

* A saliency map is an explicit 2D map that encodes the saliency at every location in the visual scene.



Source	Density map (1s,14s)	Highlight of ROI (1s, 14s)



II. Objective assessment of your model : comparison with the state of the art

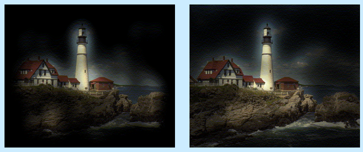
Evaluation of computational bottom-up model performance can not readily achieved and there is no real consensus on a particular method. Nevertheless, we propose to assess our model by using the **Kullback-Leiblur metric** :

$$KL(P|H) = \sum_i P(s_i) Log \frac{P(s_i)}{H(s_i)}$$

where P represents the predicted probability density function and H represents the human probability density function.
s_i represents a spatial location of the probability functions.

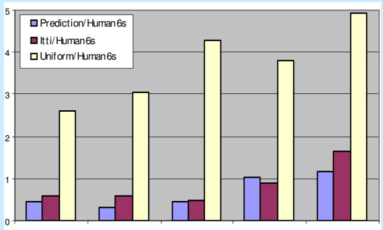
III. Results

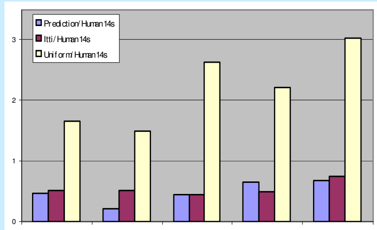
To assess the performances of our model, we use the metric previously described and compare our results with the model of L. Itti and with an uniform model (each pixel has the same saliency value).



Subjective results: Circles represent fixation points : yellow for the human fixations and red for the predicted fixations stemming from our model.

Objective results: In average, our model provides the best results with the proposed metric. the improvement is close to **12%** (compared to Itti's model).





Compared to an uniform model, to the L. Itti's model, our model (blue bar) conducts to the best results.

IV. Conclusions and references

A purely bottom-up model has been designed. The novelty lies on the fact that we use numerous properties of the human visual system to build a coherent approach. Successively, the behaviour of retinal and cortical cells is simulated by using contrast sensitivity function, visual masking and oriented perceptual decomposition. By keeping in mind the desire to develop a coherent approach, we outperform the most famous bottom-up model (4% in term of correlation coefficient and 12% for the Kullback metric).
From this unsupervised areas of interest detection, the efficiency of several applications could be improved : video compression driven by saliency map, image quality assessment based a reduced reference frame, …
Our futures works will consist in designing such applications.

[1] O. Le Meur, P. Le Callet, D. Barba, D. Thoreau, "*From low-level perception to high level perception, a coherent approach for visual attention modelling*", Proc. SPIE Human Vision and Electronic Imaging IX (HVEI'04), San Jose, CA.
[2] O. Le Meur, P. Le Callet, D. Barba, D. Thoreau, "*Masking effect in visual attention modelling*", Proc. Workshop on Image Analysis for Multimedia Interactive Services (WIAMIS), Lisboa, Portugal.

Contact :
Olivier LE MEUR – PhD student
THOMSON - Research & Innovation
1, avenue de Belle Fontaine - CS 17616
F-35776 Cesson-Sévigné - France
Tel : +33 (0)2 99 27 36 54
Fax : +33 (0)2 99 27 30 15
Email : olivier.le-meur@thomson.net

Dominique THOREAU
THOMSON - Research & Innovation
1, avenue de Belle Fontaine - CS 17616
F-35776 Cesson-Sévigné - France
Tel : +33 (0)2 99 27 32 43
Fax : +33 (0)2 99 27 30 15
Email : dominique.thoreau@thomson.net

Dominique BARBA – *Professeur*
Lab IRCCyN , UMR CNRS 6597
Ecole Polytechnique de l'Université de Nantes
Rue Christian Pauc BP 50609
44306 Nantes CEDEX 3 - France
Tel: + 33 (0)2 40 68 30 22
Fax: + 33 (0)2 40 68 30 66
Email : dominique.barba@polytech.univ-nantes.fr

Patrick LE CALLET
Lab IRCCyN , UMR CNRS 6597
Ecole Polytechnique de l'Université de Nantes
Rue Christian Pauc BP 50609
44306 Nantes CEDEX 3 - France
Tel: + 33 (0)2 40 68 30 47
Fax: + 33 (0)2 40 68 30 66
Email : patrick.lecallet@polytech.univ-nantes.fr

ICIP 2004