Laura Igual, Antonio Hernandez, Sergio Escalera,
Miguel Reyes, Josep Moya, Joan Carles Soliva,
Jordi Faquet,Oscar Vilarroya, Petia Radeva
Computer Vision Center (CVC)
{ligual}@cvc.uab.cat

Automatic Techniques for Studying Attention-Deficit/Hyperactivity Disorder

Context

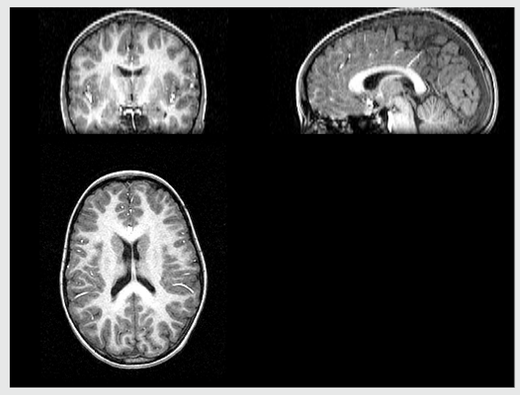
• **Attention-deficit/hyperactivity disorder** (ADHD) is among the most common childhood psychiatric disorders affecting around 8-12% of the worldwide population.

• According to standard criteria (DSM-IV-TR and ICD-10 diagnostic criteria) ADHD is a neurodevelopmental disease characterized by:

✓ **Inattention** ✓ **Hyperactivity** ✓ **Impulsivity**

• Currently, many research works are devoted to analyze brain alterations related with ADHD.

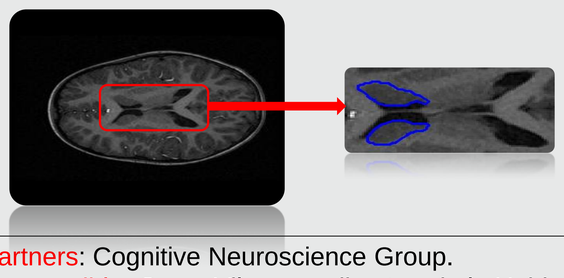
• Structural neuroimaging studies identifies the brain circuits altered in ADHD.



Automatic analysis of anatomical differences in ADHD children MRI

• The ADHD children presented significant **volumetric differences** in certain structure as the **caudate nucleus** [1].
• Manual labeling of MRI slices are used, but reproducibility and feasibility of these studies can be questioned.
• **Aim:** automatic techniques to accelerate and make the procedure clinically feasible.

Brain Caudate Nucleus Segmentation



Partners: Cognitive Neuroscience Group.
Responsible: Oscar Vilarroya, director de la Unidad de Investigación en Neurociencia Cognitiva y director de la Cátedra “El cerebro social”.

Brain Caudate Nucleus Segmentation using Graph Cuts

We propose an automatic segmentation method based on the graph-cuts energy minimization framework [3]. In this framework, an energy function is minimized in order to find the optimal segmentation of the image, using region and context information.

Main steps of the algorithm:
1. Apply Atlas-based method [2] to initialize the structure segmentation.
2. Define multiple hypothesis of seeds.
3. Apply Graph-cut method to refine the segmentation.

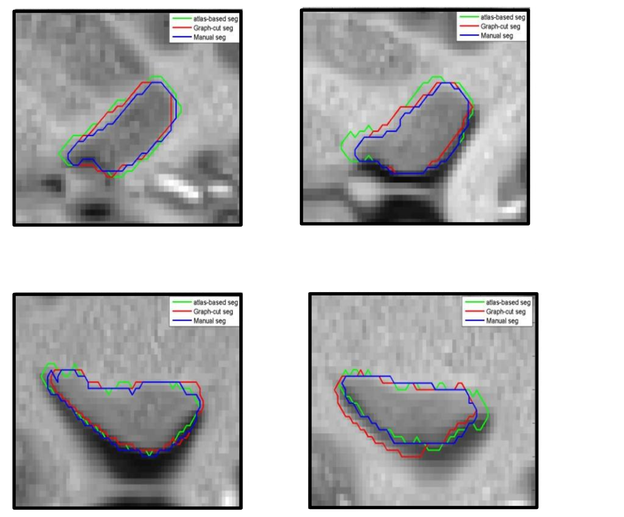
$$\mathbf{E}(\underline{\alpha},\mathbf{k},\underline{\theta},\mathbf{z}) = U(\underline{\alpha},\mathbf{k},\underline{\theta},\mathbf{z}) + V(\underline{\alpha},\mathbf{z})$$

Region potential
Encodes local information based on intensity models.

Boundary potential
Contrast information computed by a Multi-scale approach [3].

Materials:
• 40 children/adolescents with ADHD (ages 6–18),
• 40 healthy control subjects matched on age, gender, and handedness.

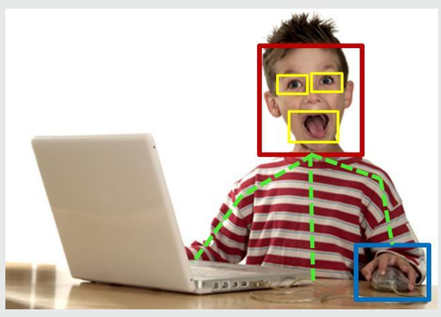
Qualitative Results



Future work:
• Automatic extraction of shape descriptors.
• Apply to data in the challenge Caudate Segmentation Evaluation 2007 [4].

Automatic analysis of behavior in ADHD children

Aim: Search for behavioral patterns related to ADHD Automatically extract behavioral information using Computer Vision and Machine Learning techniques



Materials (5 hours recorded):
• 5 children/adolescents with ADHD
• 5 healthy control subjects

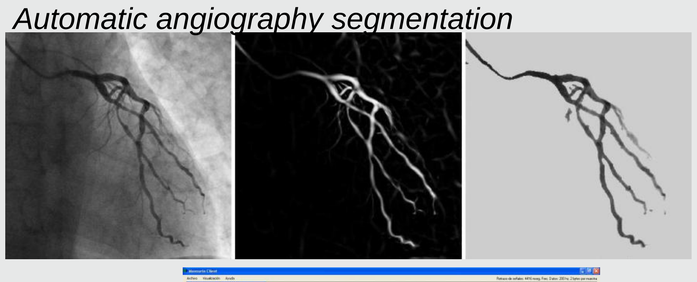
Partners: Parc Taulí, Centre de Salut Mental Infantil i Juvenil de Martorell. Responsible: Josep Moya, jefe del Observatori de salut mental de Catalunya.

Automatic detection, tracking and analysis of landmarks
• Cheap hardware → **general corporal analysis**

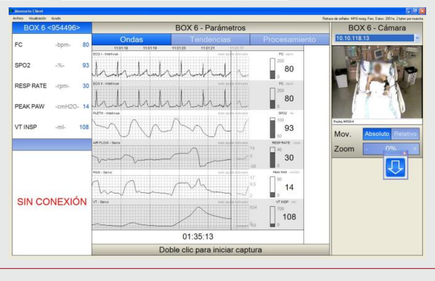
Future Lines

• Multi-modal analysis combining:
→ Automatic anatomical analysis of **MRI structures in combination with behavioral information**
• Generalization of the Segmentation and Behavioral analysis techniques for different health care applications:

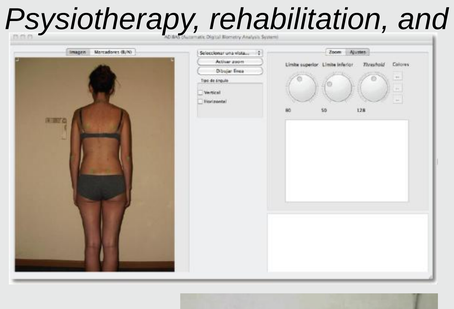
Automatic angiography segmentation



Impatient monitoring



Psysiotherapy, rehabilitation, and sports



Sign language recognition

Acknowledgments

This work has been supported in part by projects TIN2009-14404-C02 and CONSOLIDER-INGENIO CSD 2007-00018.

[1] Carmona S, Vilarroya O, Bielsa A, Tremols V, Soliva JC, Rovira M, et al. (2005): Global and regional gray matter reductions in ADHD: a voxel-based morphometric study. Neurosci Lett. 389:88-93.
[2] Tomás, X.; Carmona, S.; Vilarroya, O.; Bielsa, A.; Rovira, M.; Trèmols, V.; Soliva J.C.; Gispert (2009) Automatic caudate segmentation in MRI: Comparison of SPM & INSECT + ANIMAL in a paediatric population. Psychiatry research: Neuroimaging (submitted).
[3]Y. Y. Boykov and M.-P. Jolly. Interactive graph cuts for optimal boundary & region segmentation of objects in n-d images. In ICCV, pages 105 –112 vol.1, 2001.
[4] S. Candemir and Y.S. Akgul. Adaptive regularization parameter for graph cut Segmentation. In LNCS, volume 6111, pages I: 117–126, 2010.
[5] 3D Segmentation in the Clinic: A Grand Challenge, Bram van Ginneken, Tobias Heimann, Martin Styner (www.cause07.org)