

A Multimodality Workstation In Practice

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A workstation for multimodality analysis has been under clinical test for two years in a big hospital in Madrid. While algorithm implementation was straightforward, connectivity posed significant problems during the implementation. The tool was found quite useful in some clinical situations, mainly temporal epilepsy, neurosurgery planning, brain tumours and schizophrenia.

Introduction

Multimodality image analysis is supposed to become an extremely useful tool in clinical practice, mainly due to the increasing availability of complementary image sources. However, there still remain significant technical issues not easy to solve. This makes it difficult to apply the fusion procedures in a straightforward way and prevents their spreading in routine practice. In order for a multimodality system to really work in a clinical environment several requirements have to be fulfilled: it is necessary to provide a set of algorithms able to account for different registration situations, a suitable user interface (that is, simple and user friendly), lack of connectivity troubles and sustained technical support. In this paper we present our two-year experience in designing, implementing, implanting and supporting such a system in a 2000 bed Hospital in Madrid.

Material and methods

DESIGN CRITERIA

One of the main final goals in multimodality is to make easier the joined interpretation of morphologic and functional studies. All the complexities relative to the registration algorithms should be hidden for the end users as much as possible. The program has to be able to import images from different sources (mainly MRI, CT, SPECT and PET), providing the necessary tools for the registration, fusion, quantification and visualisation of results.

The platform should be low cost, and based on standards as much as possible. The user interface has to be very simple and user friendly.

IMPLEMENTATION

Supported modalities and acquisition devices: In our particular setting, connectivity was provided for all the following imaging systems: Siemens Orbiter-75 and Diacam (SPECT); Elscint Posicam HZL and Adac CPET 250 (PET); Philips Gyroscan and General Electric Signa (MRI); Philips LX and Siemens Somatom (CT). INTERFILE and DICOM media import are also supported.

3D Registration: Intrasubject registration makes use of two well-known and clinically validated methods: An interactive landmark-based tool [1] and an automatic volumetric tool based on the AIR algorithm [2,3]. When necessary, intersubject registration is performed by means of the SPM package, external to the application [4].

Visualization: The platform includes standard 2D and 3D visualization tools, such as Zoom/Pan, grey level window, colour LUTs, tri-planar orthogonal viewing, 3D rendering, etc. Presentation of fused results can be performed via translucent colour overlays (Brightness –Hue fusion) or by selective superposition (shutter tool).

Image processing: Four types of segmentation methods were made available in the application: Manual, thresholding, region growing and clustering. The most important feature of the workstation is the quantification tool (volume and activity) of fused studies. Its main purpose is to measure PET (SPECT) activity within MRI-defined areas, since anatomical structures are much better depicted on the MRI image. A Talairach grid can be semiautomatically generated, in order to provide a fast segmentation-free quantitative analysis of the functional study.

Platform: The program runs on WINDOWS NT/95 using the IDL 5.x programming environment (Interactive Data Language, RSI Systems).

Results

TECHNICAL RESULTS: Software implementation and testing of the algorithms was the easiest task in the project. Connectivity issues, on the other hand, were usually troublesome and almost no device could be straightforwardly connected, especially non-DICOM modalities, which required different degrees of ‘hacking’. In our experience, despite the increasing availability of the DICOM standard, connectivity is still the most significant technical challenge in practice, especially when equipment from different manufacturers is involved.

CLINICAL RESULTS: The application has been under clinical validation with more than 150 patients (SPECT, PET, CT and MRI) with different pathologies, mainly brain tumours, temporal epilepsy and schizophrenia. Clinical interest was very high among nuclear medicine specialists, and lower for radiologists, though some referring clinicians were also very interested, mainly in neurosurgery planning and neuropsychiatry research.

CT/MRI/MRA fusion was found very useful in neurosurgery for either conventional and frame-less stereotaxy surgery planning. No other clinical applications involving CT reached a routine use.

Brain SPECT/MRI fusion was very helpful for the nuclear medicine specialists since it provides them with a detailed anatomical background. The procedure has become part of the standard imaging protocol in treatment-resistant temporal epilepsy. It was also considered very interesting in studies based on oncotropic tracers, where it provides a better anatomical localisation of the positive areas detected.

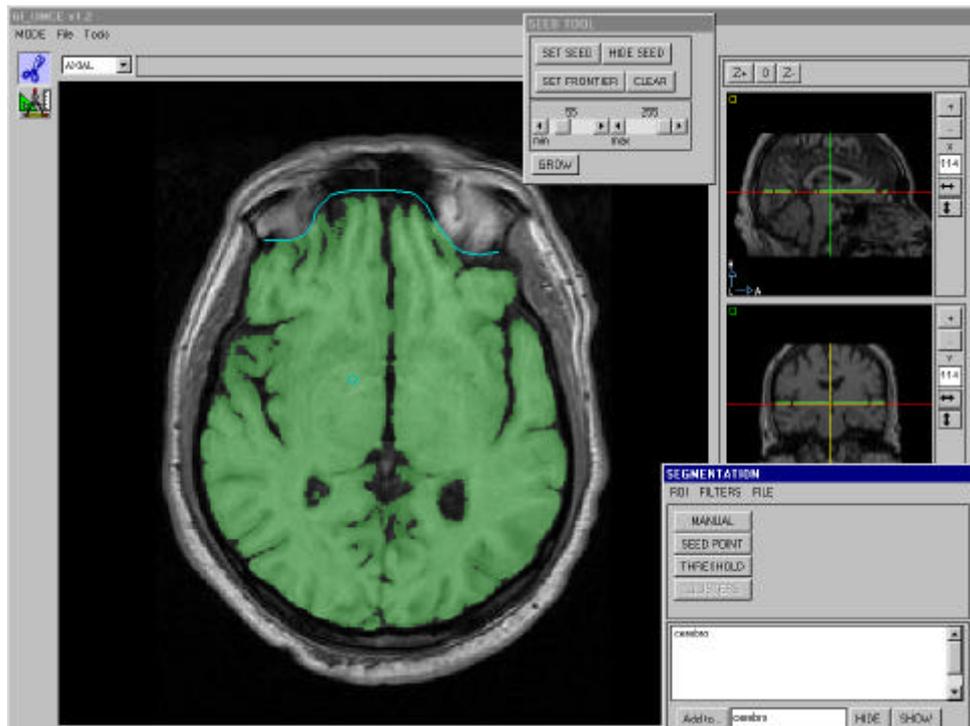
PET/MRI fusion offers advantages similar to those described for SPECT. In our centre it is mainly used for improving the accuracy of PET quantitative results in brain imaging. Some research projects on schizophrenia are making use of these quantification tools [5].

Conclusions

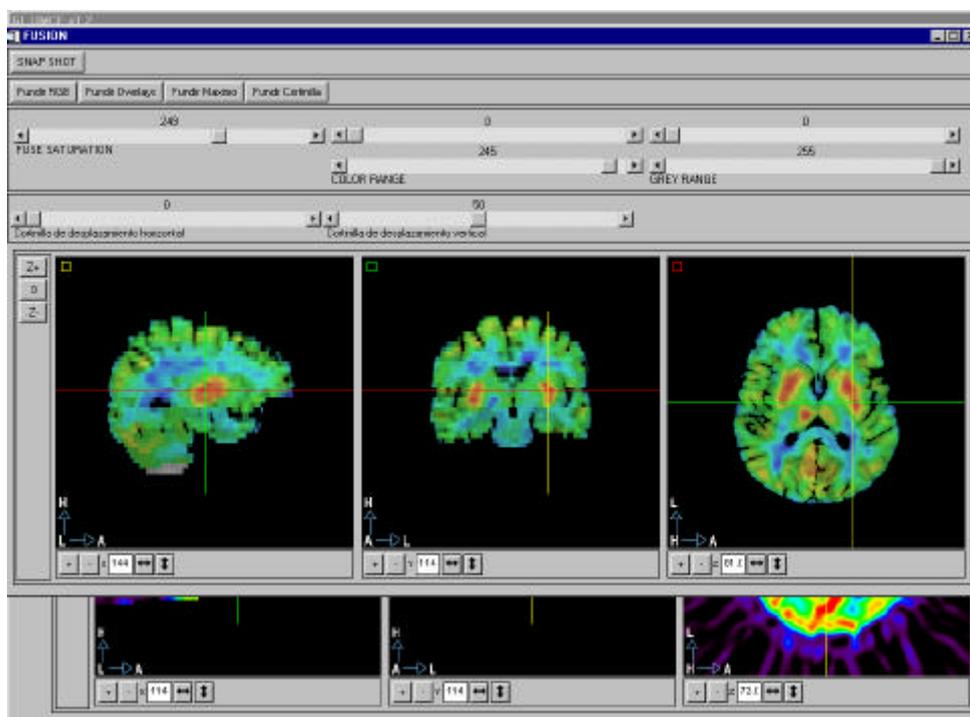
There are few tools in the market able to offer efficient multimodality capabilities, and they are usually difficult to integrate in multi-manufacturer environments. Implantation of these systems has shown to be quite laborious and support demanding. In our case, the system has yielded very good results as a tool for the joined interpretation of anatomical and functional studies. Furthermore, in some clinical situations the multimodality analysis has become a routine procedure. The key points for the success are a proper solution of the connectivity issues, the simplicity of use and an adequate technical support and user training during the implantation and after.

References

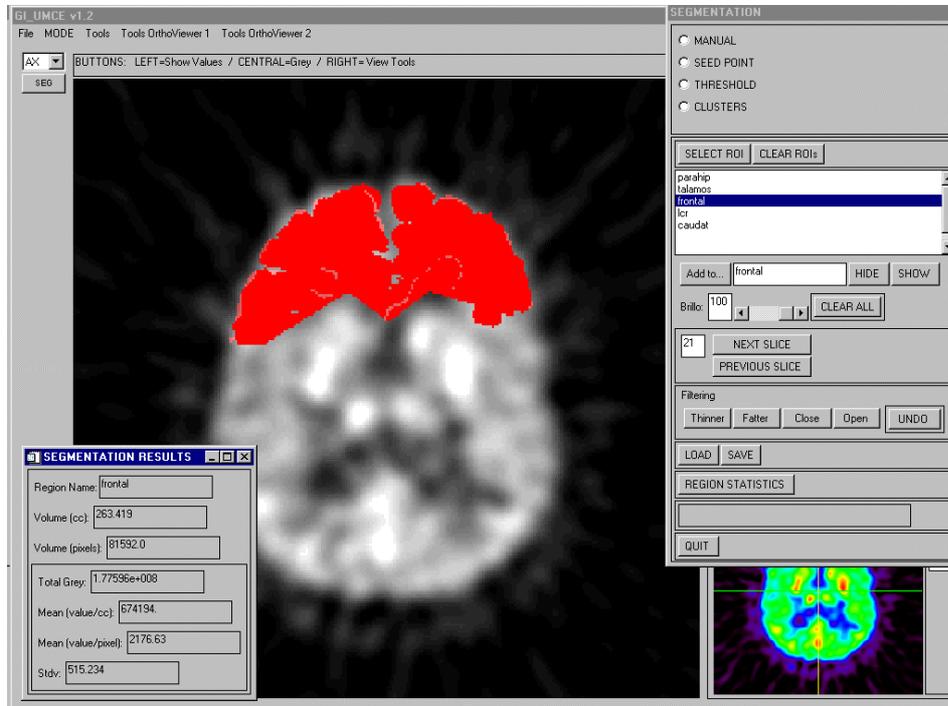
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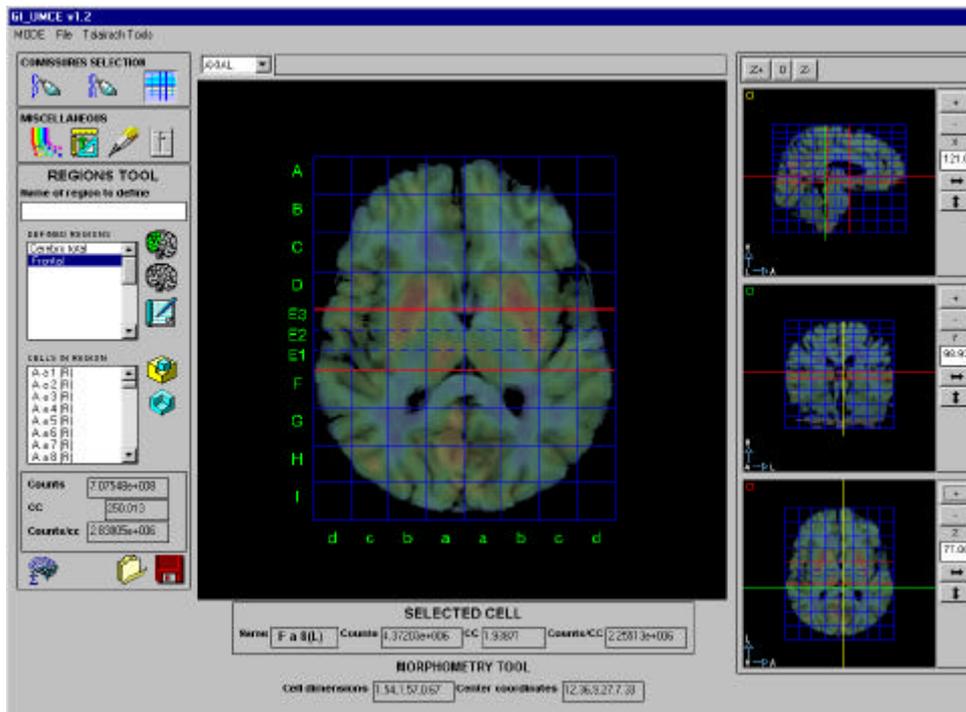
Segmentation tool: Segmentation is required in order to define ROI's and when volumetric registration is applied. The user interface is kept very simple.



Fusion tool: Joined visualization of registered images: Brightness=MRI, Hue=PET



Quantification tool: Region volume and PET activity are measured on areas previously defined on a registered MRI (Frontal lobe, in this picture).



Talairach tool: This allows for a fast quantification according to the Talairach coordinate system. Regions are defined as sets of cells. (Cerebellum should be edited out –not in this picture-).