User Interface Design for Assisting Diagnosis of Focal Cortical Dysplasia

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Introduction: Patients with focal cortical dysplasia and refractory epilepsy usually require surgical intervention for seizure control and to improve their quality of life. However, due to the focal and subtle nature, the diagnosis of epileptogenic foci with high-resolution structural magnetic resonance (MR) images still remains a challenge. Because the metabolism activation of epileptogenic regions differs from the normal areas, functional scans, such as positron tomography (PET) and single photon emission computed tomography, have been successfully used as complementary information to increase the diagnosis accuracy. In our hospital, after investigating the scans in spatially dispersed applications, a neuroradiologist must mentally correlate the outcomes in order to reduce the number of missed lesions. This is a time-consuming task, not always suitable for routine clinical practice. Our work aims at designing a graphical user interface (GUI) for an integrated diagnosis environment application that helps neuroradiologists to be more effective and more efficient.

Materials and Methods: Because our prospective users are unsure of their needs, we adopt the user-centered spiral design model for our project. This model consists of four phases: planning, risk analysis, engineering and evaluation. The usability testing of the prototype developed in the first spiral reveals the following issues: (1) lateralisation hint; (2) image exhibition area; (3) coordinated views of MR and PET; (4) displacement and rotation of cutting planes; (5) number of required interactions; (6) work session saving; (7) image saving; and (8) transfer functions. We chose the Qt cross-platform application and user interface framework [1] for implementing our new GUI, and three major operating system environments, Ubuntu Linux, Microsoft Windows and Apple's Mac OS, for evaluating our codes incrementally.

Results: After the analysis of the user's opinions and the diverse GUIs of well-known medical visualization tools, namely OsiriX, Amira, Philips Arya, FreeSurfer, 3D Slicer, Mango and MRIcro [2], a new GUI was conceived. Its layout is presented in the figure.

Discussion/Conclusion: When the appearance (user interface) of an application is changed, most of previously developed codes, such as multiplanar and curvilinear reformatting and multimodal registration, should be re-structured for tailoring to the new GUI. Currently, we are in the engineering phase of the second spiral, i.e. in the phase of the implementation and testing of the codes. Most of the old codes have been revised and updated to meet the technical specifications of the most current versions of OpenGL API [3]. Although Qt provides several on-the-shelf functions for accessing the graphics programming unit (GPU), we decided to use its API directly for the sake of portability. On the other hand, we decided to apply the image manipulation facilities available in Qt to reduce our development time. Although the new GUI has not been completely concluded for usability evaluation among the prospective users, the iterative and incremental coding tests we are performing along the project development show that at least the cross-platform compatibility and efficiency requirements will be satisfied.

References: [1] Qt Project. http://qt-project.org/. Accessed Feb 2015; [2] List of neuroimaging software. http://en.wikipedia.org/wiki/List_of_neuroimaging_software. Accessed Feb 2015; [3] OpenGL 4.5 Reference Pages. https://www.opengl.org/sdk/docs/man/. Accessed Feb 2015.