Dysfunctional 3D model based on structural and neuropsychological information

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1. INTRODUCTION

Acquired brain injury (ABI) [1-2] refers to any brain damage occurring after birth. It usually causes certain damage to portions of the brain. ABI may result in a significant impairment of an individual's physical, cognitive and/or psychosocial functioning. The main causes are traumatic brain injury (TBI), cerebrovascular accident (CVA) and brain tumors. The main consequence of ABI is a dramatic change in the individual's daily life. This change involves a disruption of the family, a loss of future income capacity and an increase of lifetime cost. One of the main challenges in neurorehabilitation is to obtain a dysfunctional profile of each patient in order to personalize the treatment.

This paper proposes a system to generate a patient's dysfunctional profile by integrating theoretical, structural and neuropsychological information on a 3D brain imaging-based model. The main goal of this dysfunctional profile is to help therapists design the most suitable treatment for each patient. At the same time, the results obtained are a source of clinical evidence to improve the accuracy and quality of our rehabilitation system.

Figure 1 shows the diagram of the system. This system is composed of four main modules: image-based extraction of parameters, theoretical modeling, classification and co-registration and visualization module.

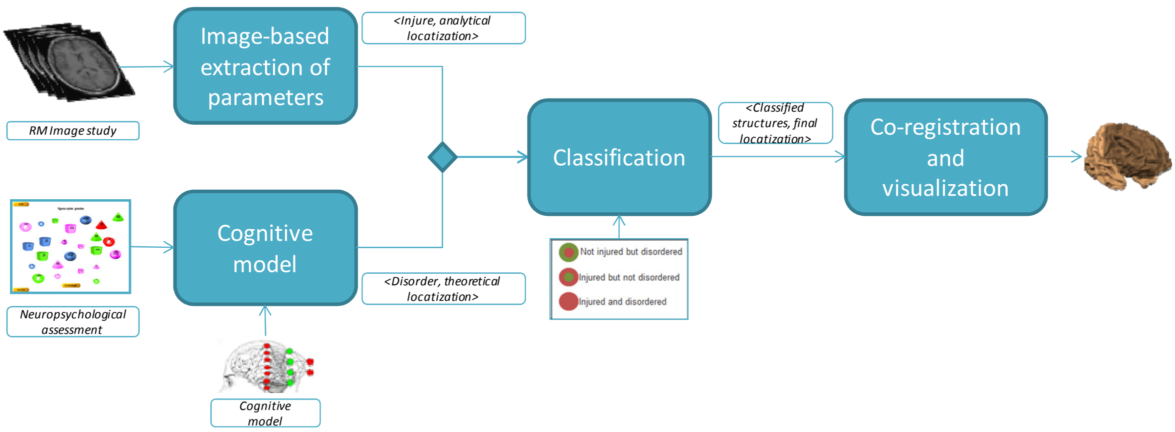

Figure 1. Functional Workflow

The remainder of the paper is organized as follows: Section 2 describes each module, Section 3 presents preliminary results and finally, Section 4 expounds the conclusions.

2. METHODS

Image-based extraction of parameters

The main objective of this module is to extract information relative to brain structures altered after an ABI event. The approach proposed in this system consists of obtaining imaging information based on intensity and location values by applying an imaging descriptor algorithm [3]. Each brain structure is identified with landmarks by co-registering the patient's imaging study with a healthy imaging study. Brain structures where landmarks are not detected are considered as **injured**.

Cognitive model

This module consists of a multimodal cognitive model based on graph theory which combines both structural and functional brain data, regarding their relationship as a whole [4]. The model gathers the patient's neuropsychological assessment and determines which functional **disorders** the patient presents and which brain structures are related to them a priori, based on theoretical models and previous empirical knowledge.

Disorder classification

Information about injure and disorder is then combined at this stage. According to the results, the system classifies each affected structure as: injured and disordered, injured but not disordered and not injured but disordered.

Co-registration and visualization

The last module computes the deformation of a healthy image-based brain volume to conform it to the classification and final localization obtained from the previous module [5]. This 3D dysfunctional volume is displayed using rendering techniques simulating mechanical and tissue properties of the brain, marking out injured from healthy structures.

3. RESULTS

Figure 2 shows the design of the system interface. This design integrates a tool bar and three different visualization areas: MRI landmarks detection module, graph cognitive module and 3D dysfunctional model.

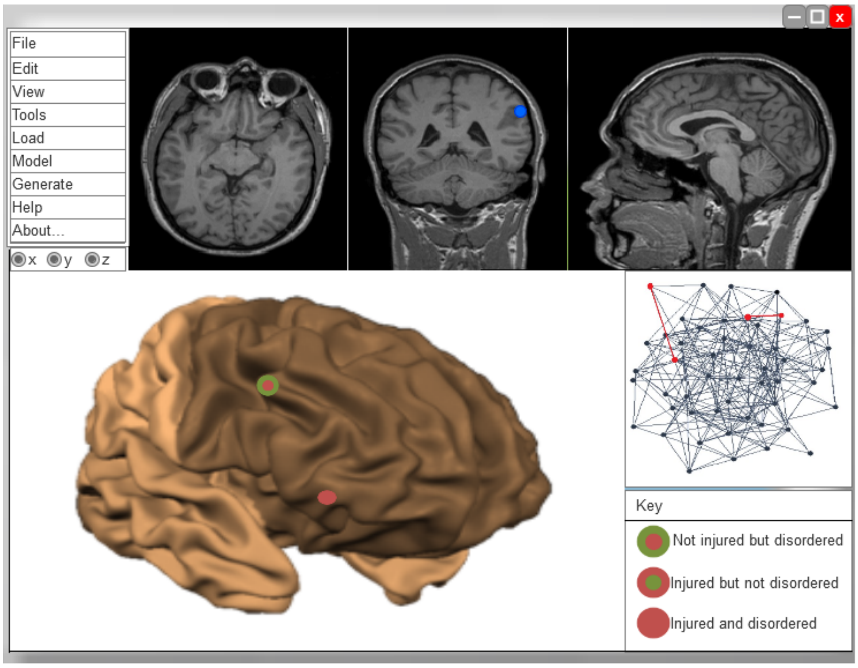

Figure 2. Interface Design

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4. CONCLUSIONS

This abstract introduces the first implementation of a system that generates a 3D model representing the dysfunctional profile of a patient with ABI, according to imaging and neuropsychological assessment information. The main goal is to assist the therapist to design the most appropriate therapy for each patient.

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