FUSION AND ANALYSIS OF MULTIMODAL IMAGING

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EXTRACTION OF 3D STRUCTURES AND RANKING ACCORDING TO MORPHOLOGY

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Introduction Obtaining quantitative information about brain structure characteristics is important to identify if some neurological disorders are coupled with an abnormal configuration of the brain. To obtain such information, anatomical brain atlases have been used. Usually being two-dimensional and based on few studies, they do not hold accurate information relative to a given population, and thus cannot be used to reflect "normal" configurations. In this paper we propose a new method to explore 3D medical brain image databases and isolate corresponding volumes of interest (VOI), enabling us to obtain in a reasonable amount of time accurate quantitative information pertaining to brain structures of a given population.
Methods Given one entry of the database (chosen arbitrarily as a reference): A_0 and a selected VOI: V_0, the retrieval of the corresponding VOIs: $V_1, V_2, \cdots, V_n$, from the whole database: $A_0, A_1, \cdots, A_n$, follows this three-step scheme:

1. Correct for global morphometrical variations by applying an affine transformation on each image of the database to obtain the registered (with A_0) images $A'_1, A'_2, \cdots, A'_n$.
2. From the definition of V_0 (size and position), extract the VOIs $V'_1, V'_2, \cdots, V'_n$ from $A'_1, A'_2, \cdots, A'_n$. Correct for regional morphometrical variations between V_0 and $V'_1, V'_2, \cdots, V'_n$ by applying again an affine transformation to obtain $V''_1, V''_2, \cdots, V''_n$.
3. Correct for local non-linear morphometrical variations between $V''_1, V''_2, \cdots V''_n$ and V_0 by applying a deformation field on $V''_1, V''_2, \cdots, V''_n$ to get the wanted VOIs corresponding to V_0: $V_1, V_2, \cdots, V_n$.

The global and regional affine transformation and the non-linear deformation field are found using a registration procedure analogous to optical flow techniques. The algorithm eliminates morphometrical variations and brings out the morphological differences between anatomies.
Results This procedure was applied to a database of 10 normal brain MR images to extract a portion of the right temporal lobe. Classification according to correlation and zero-crossing methods have been produced to test the feasibility of such criteria to evaluate resemblance.

Our method differs from previous work in that we use a multi-step registration approach to exclude ourselves from meaningless information outside the VOI. This permits to distinct between morphometrical and morphological differences, which could help to put forward quantitative information about a population.
Conclusion We have developed a procedure to extract corresponding VOIs from a database of brain MR images. Future works are oriented toward using similarity criteria to partition those VOIs according to morphology, putting forward only morphometrical differences to provide a better understanding of dissimilarities between a patient and the group of normal subjects with corresponding morphology.

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