ABSTRACT

TOWARDS EARLY DETECTION OF ALZHEIMER’S DISEASE USING TEXTURE ANALYSIS OF MAGNETIC RESONANCE IMAGES

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In the absence of permanent cure, early detection and diagnosis of Alzheimer’s disease (AD) is of utmost importance to make use of palliative measures for enhancing the quality of life of millions of Americans. However, a large number of people having AD are not diagnosed at an early enough stage where medications can delay the full onset of the disease (NIA 2013). While various image processing techniques have been proposed to address this challenge, none of the techniques provide a robust and reliable solution. In this thesis, we present a novel technique using texture analysis of $T_2$ MR images to lay the foundation for an effective solution. The technique consists of the following four steps. First, we utilize the textural property of the MR images to obtain a set of features that encode statistically meaningful information about the spatial distributions of the gray tone variations. Second, we compute texture feature maps (a
feature value stored at every image voxel) on the white matter regions of the images that
are segmented into regions of interest (ROIs) based on the anatomical structure of the
brain. Third, we identify the subset of relevant and uncorrelated features from our initial
feature set by using statistical measures like mean, coefficient of variance, and mutual
information. These features yield statistically different values in the different ROIs and
also in the different subjects for the same ROI, and the variations in the values are
independent of each other. Thus, they are expected to afford better predictive powers in
terms of detecting early signs of AD than the complementary set of features. Last, we
validate the utility of the relevant features by carrying out statistical hypothesis tests on
two groups of subjects, where the first group consists of subjects who have the APOE ε4
genes that are often found in AD patients, and the other group comprises of subjects who
do not have the APOE ε4 genes. Results show that the entropy-type features yield
promising results and are able to distinguish between the two types of subjects in many
cases. It is hypothesized that the lack of statistical differences for certain subjects
belonging to the two groups is due to the non-advent of neurodegeneration in those
subjects. Hence, we believe that this technique provides a valuable first step towards
early detection of AD without requiring genetic information and functional imaging
modalities. Further work will involve more effective feature set generation and extensive
validation and verification using ground truth information and long-duration trials
involving monitoring of subjects who are predicted to have early symptoms of AD.