A Note on Das's PCA in Online Phases

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Abstract—PCA was effective and helpful in developing a classification system. However, it was inappropriate to perform two independent PCA models on ground truth images and query image, which was described in Figure 1 in reference "Brain MR image classification using multiscale geometric analysis of ripplet," *Progress In Electromagnetics Research*, Vol. 137, 1–17, 2013. In this note, we analyze the reason and revise Figure 1.

In an interesting and useful paper [1] in the journal *Progress In Electromagnetics Research*, Das, Chowdhury, and Kundu proposed an automatic and accurate technique for classifying normal and abnormal magnetic resonance (MR) images of human brain. They used Ripplet transform Type-I (RT) to extract features, then the decomposed low frequency subband (LFS) was sent to principal component analysis (PCA) for feature reduction, and least square support vector machine (LS-SVM) for classification. The proposed system consisted of two phases: an offline phase and an online phase.

The results over k-fold cross validation were excellent and superior to existing methods. However, they did not clearly describe the implementation of PCA in the online phase. Hence, this note is to remind readers some key issues of PCA in offline and online phases.
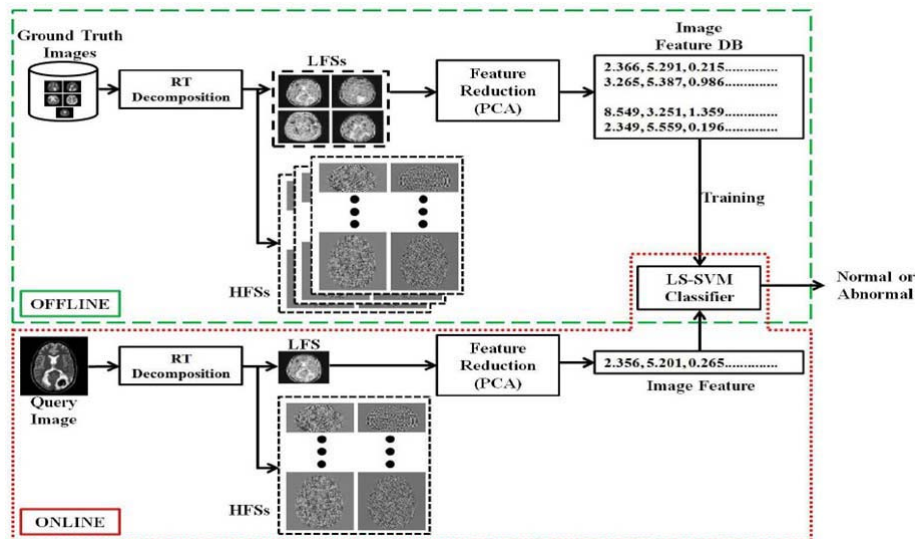

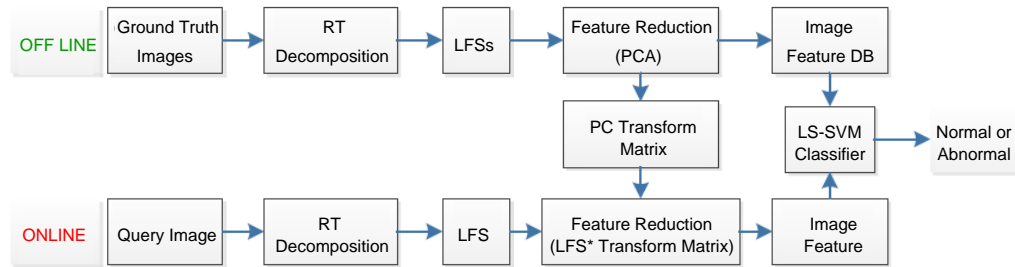**Figure 1.** Flowchart of Das's MR image classification [1].

Figure 2. A revision of flowchart of Das's system (using only one PCA model).

From Figure 1, the readers may obtain an impression of carrying out two independent PCA models on both ground truth images and query image. This is not appropriate. As known, PCA fits an n-dimensional ellipsoid to the data, where each axis of the ellipsoid represents a principal component (PC) [2, 3]. Two independent PCA models will yield two different ellipse axes, if the ground truth image and query images have different data distributions. In other words, the reduced features of offline and online phases are not from the same PC basis; hence, the trained classifier in offline phase cannot be applied to the reduced features in online phase [4, 5].

Since PCA of ground truth images will yield a transformed features and a PC transformation matrix, the correct procedure for the online phase is as follows: the LFS of RT decomposition of query image should be multiplied with the PC transformation matrix to obtain the reduced features. In this way, only one PCA model was needed in the system. We illustrate a clearer flowchart of Das's system in Figure 2.

ACKNOWLEDGMENT

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