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Fractional Optimization Approach for Compressed Medical Image Classification

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Abstract: Human anatomy is beyond the reach of ordinary man and to get into it requires a super relative effort. Vigorous research is on but, deep research is still required so as to understand every chromosome of human anatomy. The medical images, its classification and diagnosis of diseases in human suffers due to the fact that the images so captured will be high dimensional and having disturbances of various nature, spikes, occlusions etc. Training of medical images becomes more challenging in the presence of such factors and if the acquired images are not smoothened properly then accurate medical diagnosis becomes impossible. Revisiting all approaches which hinder the best possible diagnosis and in order to address the drawbacks a possible solution is given in this research paper to smoothen medical images resulting in correct diagnosis assessment.

Keywords: DR, FR, FSVD, ICA, IR, LDA, NN, PCA, SVD, SVM.

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I INTRODUCTION

The performance criteria of medical image processing tools are its robust classification accuracy which results in accurate human disease diagnosis. The approaches so far used and implemented still have some loop holes and needed to be worked minutely. Medical Images are raw and have high database. The robustness of the algorithmic system software is judged by their adaptability to changing environs of imaging, image storing aspect, image dimension aspect, training of dataset, various metrics of classification etc. Medical images largely suffer due to high intensity variation and low contrast [1,2] and thus an illumination invariant approach must be developed for accurate classification. Classification narratives such as Image intermediate representation, minimal feature selection, maximum compression and optimized weights are some of the hierarchical bench marks set for this research work which ultimately help in for exact medical image case retrieval.

II THEORIZING THE ALGORITHM

To develop the classification algorithm and to define the accuracy of medical image retrieval following theoretical aspects are needed to be brought forward. The medical image retrieval system and its software must incorporate the following aspects for optimized solution.

- The images picked up by a digital camera or a scanner is raw file [3] indicating un-processed gray image. These un-processed images are required to be brought into a proper format for effective storage and manipulations. Many numbers of raw formats such as TIFF, PNG, JPEG etc., are being used but, in this research work only JPEG format is being used as a standard format because of its effective coding option.
- The medical disease history represents classes and sub-classes giving out a huge medical dataset which ultimately requires a large storage space. The objective now revolves around effective dimensionality reduction such that system space and processing time can be saved and critical cases can be dealt with greater urgency. Redundancies are minimized by accounting for statistical dependence of random variables, there by getting principle components [4]. This process is arrived at by Image representation, Intensity equalization, feature selection and feature extraction. The data integrity and reliability are further improved by decomposing and optimizing the dataset and the test images. Principal component analysis (PCA) is the predominant statistical method which uses orthogonal transformation and converts a set of correlated variables into a set of linearly uncorrelated variables called as principal components. The number of principal components is less than or equal to the number of original variables. This transformation is such that it finds maximum variance vectors in the dataset resulting into uncorrelated orthogonal basis set vectors.
- An important aspect of machine learning with respect to medical image processing is feature extraction and its selection [5]. The process starts with extraction from an initial set of measured data and builds

descriptors resulting in formation of a feature subset which is later used for effective image reconstruction and classification. The process is advantageous with respect to simplification in image reconstruction, easy interpretations, less processing time and reduction in variable redundancies. The entire process results in raw image dimensionality reduction. The features give out an n-dimensional vector space which is later used for pattern recognition.

- Medical images are considered to be gray and intermediate representation techniques such as principal component analysis (PCA), linear discriminant analysis (LDA) and independent component analysis (ICA) operate on image gray level matrices which are said to be sensitive to intensity variations. Non-linearity of imaging components with volume effect does alter the gain due to which histogram variations do occur effecting overall classification rate. To alleviate this effect an intermediate representation technique known as intermediate representation singular value decomposition (IR-SVD) [6] is used in this research work.
- Spatial distribution of gray level values are prime considerations for local feature extraction and gray level co-occurrence matrix (GLCM) [7] forms the basis for statistical based feature extraction which may include energy, entropy, contrast, autocorrelation etc.
- Machine learning [8] uses many algorithms in order to get correct patterns for exact classifications. Sets of weights are matched between test and dataset. By determining patterns classification can be achieved. Neural Network concept is quite robust as far as classification and detection of medical images are concerned. Its adaptability nature with respect to weights makes it most preferable architecture. Its iterative nature also makes it usable as far as training of the dataset is concerned. It symbolizes learning and semantic concepts.

III ALGORITHMIC VALIDATIONS

A defined procedure for solving a problem is algorithm and is implemented in software so as to be executed by a computer. In computer science, a selection algorithm is an algorithm for finding best possible classified image. The Algorithm is based on three aspects of Compression, evaluating feature vectors and classification based on genetically optimized neural network. The aspects are algorithmically described as below:

III.1 Image Representation

Image representation (IR) [9] plays a typically important role in image classification. The IR methods such as PCA, LDA despite good acceptance fails classification just because of image intensity variations such as spikes, optical disturbances etc. and low contrast. Image gray value matrices on which they manipulate are found to be very sensitive to these variations. It is known fact that every image matrix has a Singular Value Decomposition (SVD) and is regarded as a composition of a set of base images generated by SVD. The leading base images having large singular values on one hand are sensitive to image variations and on the other hand dominate the composition of the image. If the weights of the intensity variation sensitive base images are subtly deflated by a parameter ί in order to alleviate image intensity variations then image reconstruction and classification becomes perfect.

III.2 Compression Algorithm

Features are essential parameter for effective medical image classification but, these feature vectors are of high dimension and hence required to be compressed [10]. Principle component analysis is the most sought-after technique since it projects original data onto a much smaller space ultimately resulting in dimension reduction. PCA is a linear transformation method and performs pattern classification task. PCA builds a subspace from a vector space by reducing the dimensions. PCA always points towards the directions of maximum variance in the dataset. PCA projects the entire set of data onto a different subspace. Listed below are the general steps for performing a PCA:

1. Consider the complete dataset consisting of n-dimensional samples. Ignore the class labels.
2. Compute the n-dimensional mean vector.
3. Compute the covariance matrix of the whole data set.
4. Compute eigenvectors ($\mathbf{e}_1$, $\mathbf{e}_2$, $\mathbf{e}_d$) and corresponding Eigenvalues (λ_1, λ_2, λ_d).
5. Sort the eigenvectors by decreasing Eigenvalues and choose k eigenvectors with the largest Eigenvalues to form a n x k dimensional matrix w in which every column represents an eigenvector).
6. Use this n x k eigenvector matrix to transform the samples onto the subspace. This can be summarized by the mathematical equation: $\mathbf{y}=\mathbf{w}^T\times \mathbf{x}$. $\mathbf{x}$ is a $n\times1$- dimensional vector representing one sample, and $\mathbf{y}$ is the transformed $k\times1$-dimensional sample in the new subspace.

III.3 Feature Extraction

In digital image processing singular value decomposition [11] plays a fundamental role since every image can be considered as a matrix of variables and can be decomposed such as large images can be stored as smaller ones. The only condition is that the image matrix must be square one. Storage size is reduced by using fewer singular values as images can be approximated by using only few singular values. The singular value decomposition of a matrix A of m x n matrix is given in the form,

$$A = U\Sigma V^T$$

Where U is an m x m orthogonal matrix; V an n x n orthogonal matrix, and $\sum$ is an m x n matrix containing the singular values of A.

$$\sigma_1 \geq \sigma_2 \geq \cdots \geq \sigma_n \geq 0$$

These singular values are arranged in decreasing magnitude along the diagonal and the zero singular values are placed at the end of the diagonal. These SVD features are used further as input to feed forward neural network which is optimized with genetic algorithm and classification is done by distance metrics such that minimum distance is the criteria for detection and classification.

III.4 Classification

Comparing the weights of the test image with the known weights of the database performs identification. Mathematically, a score is found by calculating the norm of the differences between the test and known set of weights, such that a minimum difference between any pair would symbolize the closest match. For the realization of classification unit, the genetic optimization-based classification system [12, 13] is developed. The system reads the query features and compares with the knowledge available for classification.

1. Apply IR- SVD on each of the image for each class in the database, such that $D_i = U_iS_iV_i^t$. where, $U = [u_1, u_2, u_m]$, $V = [v_1, v_2, v_n]$, and $S = [0\ X_i\ 0]$, X_i=diag (s_i), s_i are the computed Singular vector for each image.
2. The obtained Singular Vector is applied with the fractional intensity optimization value ί and a modified SVD values are obtained as, $F_i=U_iS_i^{ί}V_i^t$
3. Each training image $T_i^{(k)}$ is then projected using the obtained feature image.
4. For the resultant image dimension reduction method PCA is applied, where the Eigen features are computed and for the maximum Eigen values Eigen vectors are located and normalized for this projected image.
5. A test image $Qr \sim \epsilon R^{m\times n}$is transformed into a feature matrix $Mr\ \epsilon R^{r\times c}$ by $Mr = UrSrVr^{\ t}$.
6. For the developed query feature an image representation is developed and passed to the PCA.
7. These feature vectors are passed onto the feed forward neural network which is optimized by genetic algorithm for classification.

The system block schematics for the developed algorithm are as shown below:

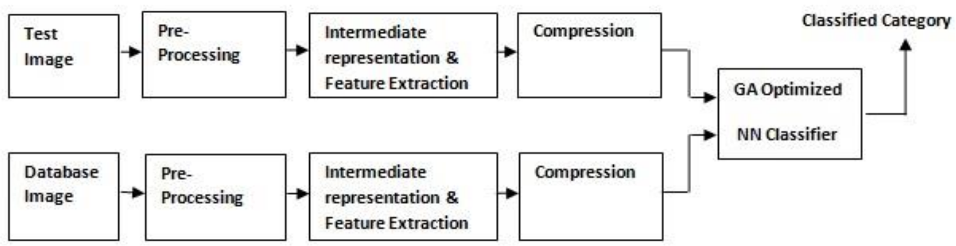

Figure 1: Block Schematics Representation

IV CONCLUSION

Medical image processing is the ever-growing area of research and its importance became more profound with the advent of machine learning. Many algorithms are being developed and it has become a never-ending phenomenon with days passing by. The most problematic part in medical image processing is handling of large intensity variation and low contrast along with storing and processing of vast medical images. The very requirement is that the raw images must be pre-processed first in order to handle such disturbances and later it should be stored for further processing. In this research work optimization is done twice, one during compression and the other during classification. One optimization is with respect to image matrix and the other is with respect to neural network. Optimization of image matrix results in effective compression whereas optimization of neural network results in optimized weights which are later used for effective classification.

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