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RPCST: A NOVEL APPROACH TO RAPID PREDICTION AND FEATURE EXTRACTION IN IMAGE PROCESSING

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Abstract:

Alzheimer's is a type of dementia that leads to problems with memory, thinking and behavior. Alzheimer's is the most common form of dementia, a general term for memory loss and other intellectual abilities serious enough to interfere with daily life. AD has no cure, but treatments to reduce symptoms are available and research continues. To reduce symptoms and to stanch the disease early diagnosis has a huge importance. Diagnosis is used to classification of AD Before classification accurate feature extraction is most important to improve the accuracy. This research proposed a new Twist Kernel Invariant Disparities (TKID) method to extract features after segmentation. This research extracts the following features are identified from this segmented image: Mean, SD, Entropy, RMS, Variance, Smoothness, Kurtosis, Skewness, IDM, Contrast, Correlation, Energy, Homogeneity, colour, size, shape, dimensions, convex and concave.

KEYWORDS: CLASSIFICATION, FEATURE EXTRACTION, SEGMENTATION, RMS, VARIANCE, SMOOTHNESS, KURTOSIS

I. INTRODUCTION

Alzheimer's disease (AD) is a complicated neurodegenerative disease involving a variety of pathogenic factors (biological and psychosocial). As the condition worsens, patients often suffer from mental and cognitive disorders, memory decline and behavior changes, which affect people's normal life ability. Mild cognitive impairment (MCI) is a state between normal and dementia which can be considered the early stage of AD. Nearly 10–15% of MCI patients are converted into AD patients every year1. Except for a few number of familial cases driven by genetic mutations, the main pathogenic factors of AD are still unclear2. In 2017, AD has become the sixth leading cause of death in the United States3. According to the International Alzheimer's Disease (ADI) report in 2019, approximately 95% of the public believe that they may suffer from AD in the future. If the disease can be detected early and measures can be taken timely, the onset of AD can be effectively delayed5. Therefore, early diagnosis and early intervention are essential for the control of AD.

Feature extraction is one of the important step in different image processing applications. It is an important tool used in different image texture analysis. Image textures are complex visual patterns which are composition of entities or regions with sub patterns and having the characteristics of brightness, shape, colour, size, etc. Feature extraction is defined as reducing the dimensions, which represents the exciting parts of the image in the form of a feature vector. It is of high importance when the data size is large when image retrieval or matching is performed. These are the primary categories of features extracted from the image. Feature extractions are used to predict the various types of fracture by various features such as Spatial, histogram ,transform, edge, shape, colour and size.

Feature extraction is the very important process before classification. So many methods are available to extract the features. But the number of features considered for classification is also less, and sometimes the vital features influencing the classifications are missed out due to the minimum selection of feature extraction metrics. In some other research works, the processing time required for feature set creation is slow. Moreover, the processing is made rapid. Hence, an efficient feature extraction method is needed, including the feature set's vital features.

II RELATED WORK

Hedayati et. al(2021)[2] proposed method is introduced in two main steps. In the first step, ensemble of pre-trained auto encoder based feature extraction modules are used to generate image feature from 3D input image and in the second step convolutional neural network is used to diagnosis Alzheimer's disease. Three different classification cases, namely; Alzheimer's Disease (AD) versus Normal Condition (NC), AD versus Mild Cognitive Impairment (MCI) and MCI versus NC are studied. Obtained results show that accuracy rate for AD/NC, AD/MCI and MCI/NC are 95%, 90% and 92.5%, respectively. Also, for all cases sensitivity and specially sensitivity rates for proposed method confirm that it could be reliable for diagnosis AD in early stage and has less error to detect normal condition.

Wang et al(2021) proposes a method for extracting bone morphological features to facilitate customized plate designs. The customized plate design involves three major steps: extracting the morphological features of the bone, representing the under surface features of the plate, and constructing the customized plate. Among these steps, constructing the under-surface feature involves integrating a group of bone features with different anatomical morphologies into a semantic feature parameter set of the plate feature. The under-surface feature encapsulates the plate and bone features into a highly cohesive generic feature and then establishes an internal correlation between the plate and bone features.

Sharmila et.al(2020)[1] implemented the two different hybrid algorithms for feature extraction and classification. Hybrid feature extraction algorithm is based on Empirical mode decomposition (EMD) and Gray-Level Co-Occurrence Matrix (GLCM), which is named as EMDGLCM. For classification purpose Support vector machine (SVM) and Convolution neural network (CNN) which is named as SVM-CNN. The proposed hybrid algorithm feature extraction and classification Improves the proposed system performance the proposed system has analysis with the help of OASIS dataset. The proposed results and comparative results shows that the proposed system provides the better results.

Shrivastava et al. (2020) [18] have gone through various techniques to classify the cancerous and the healthy bone. In this work, bone computed tomography (CT) dataset in Digital Imaging and Communication in Medicine (DICOM) format are used. This work explains distinctive AI methods for tumor recognition and order. AI is an immense area of research, out of which medical image processing is a critical territory of work. In medicinal analysis like ulcer, break, tumor, and so forth image processing made the work simpler in finding the specific reason and most ideal arrangement. AI strategies are applied to restorative pictures for irregularity discovery. It can be seen that an acceptable degree of progress has been accomplished by applying the machine learning procedures. In this work, diverse AI methods for clustering are explained.

III. FEATURE EXTRACTION METHODS

According to Neville, features can be extracted using several methods such as statistical, structural, model-based and transforming information.

i. Structural Based Feature Extraction

Structural approaches represent texture by distinct primitives and a hierarchy of spatial arrangements of these primitives. The description of the texture needs the original way of classification. The structural method has an advantage; it provides a decent symbolic description of the image.

ii.Statistical Based Feature Extraction

Based on the non-deterministic property defined to manage the relationships between the grey levels of the image, statistical methods can represent texture Features. By computing local features at each image pixel, statistical measures are defined from the local features' distributions. The statistical methods can be classified into (1) First order - one-pixel Statistics, (2) Second order -pair of pixels statistics and (3) Higher-order - three or more pixels statistics. The first-order statistics assess the characteristics of individual pixel values by waiving the spatial interaction between image pixels. The first order histogram statistics are (1) Mean- Average, (2) Variance, (3) Skewness and (4) Kurtosis.

iii.Model-Based Feature Extraction

Model-based Feature extraction works on the structure of an image, such as the fractal model and Markov model that can describe the texture. These Feature extraction methods represent an image as a probability model or as a linear combination of a set of essential functions.

iv.Transform Based Feature Extraction

Transform feature extraction represents an image in space whose coordinate system has an interpretation closely related to the features of a texture. Fourier, Gabor, and wavelet transform are some of the Transform methods. Fourier transforms have a weakness in spatial localisation.

IV PROPOSED WORK

Local image features are used for object recognition systems, and sometimes the high-dimensional feature vector may describe higher dimensions of the image. The object recognition system matches these local image features available in a database based on the query. When the number of images increases, the storage requirement of the database also increases in millions and billions of vector space. Hence, a hybrid technique arises to reduce the space requirement and increase the speed of the feature extraction process. The proposed feature extraction method uses binary space to process the feature vector, reducing storage and fast processing space.

Figure 1 shows the proposed feature extraction method. The feature vectors are formed from the relevant features of the trained data. The following features are identified from this segmented image: Mean, SD, Entropy, RMS, Variance, Smoothness, Kurtosis, Skewness, IDM, Contrast, Correlation, Energy, Homogeneity, colour, size, shape, dimensions, convex and concave.

Colour Features are calculated by using the statistical formulas

a. Mean is the average of the pixel values found in the image. It is calculated using equation (1).

$$\mu = \frac{1}{MN}\sum_{i=1}^{M}\sum_{J=1}^{N} Pij$$ Eqn. (1)

b. Standard Deviation (SD) is the measure of deviation every pixel has from the average.

$$\sigma = \sqrt[2]{\frac{1}{MN}\sum_{i=1}^{M}\sum_{J=1}^{N}(Pij \ -\mu)x^2}$$ Eqn. (2)

c. Kurtosis is the relative peak of flatness found in the image

$$\theta = \frac{\sum_{i=1}^{M}\sum_{J=1}^{N}(Pij-\mu)^3}{MN\sigma^2}$$ Eqn. (3)

d. Skewness is the measure to find the lopsided nature of pixels

$$\gamma = \frac{\sum_{i=1}^{M}\sum_{J=1}^{N}(Pij-\mu)^4}{MN\sigma^4}$$ Eqn. (4)

The texture Features such as Energy, Entropy, Homogeneity, Variance, RMS, Smoothness, IDM, Correlation is calculated.

e. Energy depends on the ASM known as Angular Second Moment, which denotes the pixels' uniformity or texture pattern.

$$ASM = \sum_{i,j=0}^{N-1} Pi,j^2$$ Eqn. (5)

f. The square root of ASM calculates energy Eqn. (6)

$$Energy = \sqrt{ASM}$$ Eqn. (7)

g. Entropy denotes the degree of randomness found in the image. It becomes small when elements become unequal. When the Co-occurrence metrics have the same element, then the value of entropy becomes high.

$$Entropy = \sum_{i.j=0}^{N-1} Pij(-1nPij)$$ Eqn. (8)

h. Root Mean Square (RMS) is modelled as amplitude-modulated A Gaussian random process whose RMS is related to the constant force and no fatiguing contraction. It relates to standard deviation, which can be expressed as

$$RMS = \sqrt{\frac{1}{N}\sum_{n=1}^{N} xn^2}$$ Eqn. (9)

i. IDM Inverse difference moment is a measure of image texture, called homogeneity. IDM features obtain the measure of the closeness of the distribution of GLCM elements to the GLCM diagonal.

$$m_k = E(x-\mu)^k$$ Eqn. (10)

j. Smoothness is a measure of relative smoothness of intensity in a region.

k. Correlation is the measure of the degree and type of relationship between adjacent pixels.

$$Correlation = \sum_{i,j}\frac{(i-\mu_i)(j-\mu_j)p(i,j)}{\sigma_i\sigma_j}$$ Eqn. (11)

l. Homogeneity defines the closeness of the element to the diagonal of GLCM. When homogeneity increases, the contrast decreases.

$$Homogenity = \sum_{i,j=0}^{N-1} \frac{Pij}{1+(i-j)^2} \qquad \text{Eqn. (12)}$$

m. Variance for the horizontal and vertical directions is calculated as follows

$$\sigma^2 = \sum_{i.j=0}^{N-1}(i-\mu_i)(Pij)\ ,\sigma^2 = \sum_{i.j=0}^{N-1}(i-\mu_i)(Pij) \qquad \text{Eqn. (13)}$$

Algorithm of Rapid prediction of Colour, Shape & Texture Extraction (RPCST)

Input: *Segmented image*

Output: *Feature vector representing the image*

Step 1: *Input the Segmented Alzheimer image*

Step 2*: F1 ←Feature Vector extraction using* Color Histogram Investigator

Check the distribution of Red, Green, Blue

```
red_value = np. mean(images[i][:, :, 0])
green_value = np. mean(images[i][:, :, 1])
blue_value = np. mean(images[i][:, :, 2])
```

Step 3: *F2←Feature Vector extraction using* Rotation Invariant Local Binary Pattern

$$RILBP = \sum_{p=0}^{p-1} s(g_c - g_p)^2\ 2^{mod(p-D,P)}$$

Step 4*: F3←Feature Vector extraction using* Directional Gabor Texture patterns

Step 5*: F4←Feature Vector extraction using* Shape Feature Investigator(SFI)

$$shape\ Factor(SF) = \frac{Area}{(Diameter)^2}$$

If 0.7 ≤ SF ≤ 0.8 then shape= circle
If 0.484 ≤ SF ≤ 0.55 then shape=square
IF 0.25 ≤ SF ≤ 0.3 then shape=rectangle
If 0.445 ≤ SF ≤ 0.483 then shape=Triangle
If 0.32 ≤ SF ≤ 0.34 then shape=Oval

Step 6*: F←F1+F2+F3+F4*

Step 7: Store the Feature set

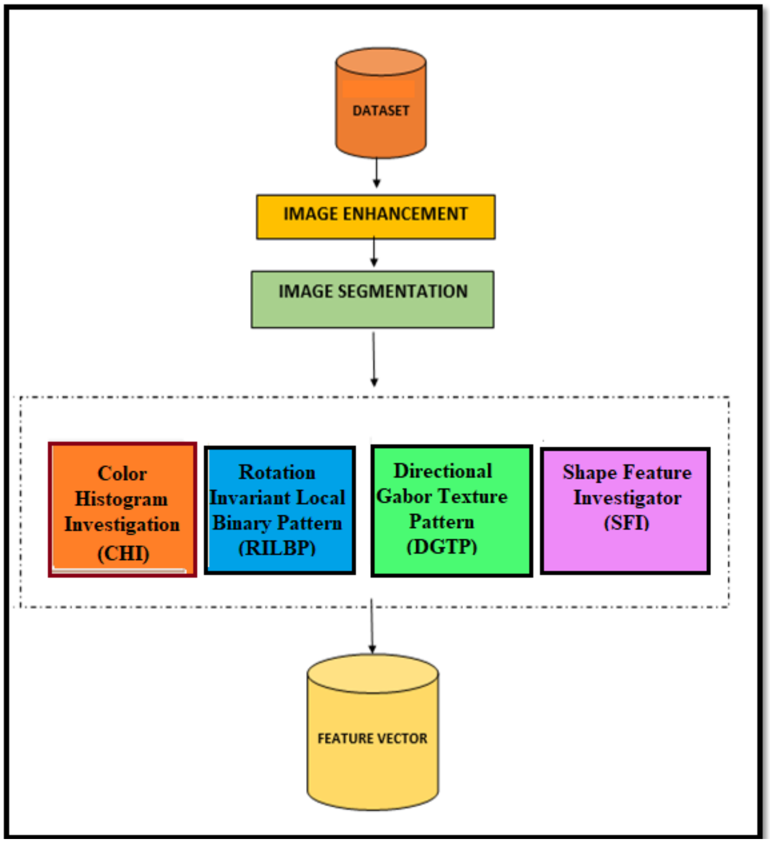

Figure 1: Proposed Feature Extraction Method

V.RESULTS AND DISCUSSIONS

The result of the proposed algorithm is shown in Figures 1 and 2. It gives the value of Mean, SD, Entropy, RMS, Variance, Smoothness, Kurtosis, Skewness, IDM, Contrast, Correlation, Energy, Homogeneity, colour, size, shape, dimensions by using MATLAB. The training set is developed with the feature extraction of values and labelled according to their disease category. An Excel file is generated and stores the value of the generated features in CSV format. This will be used as data for the training set when the classification algorithm predicts the fracture. The feature extraction process is used along with the testing data when the classifier is executed on a random image and tries finding the fracture found in it.

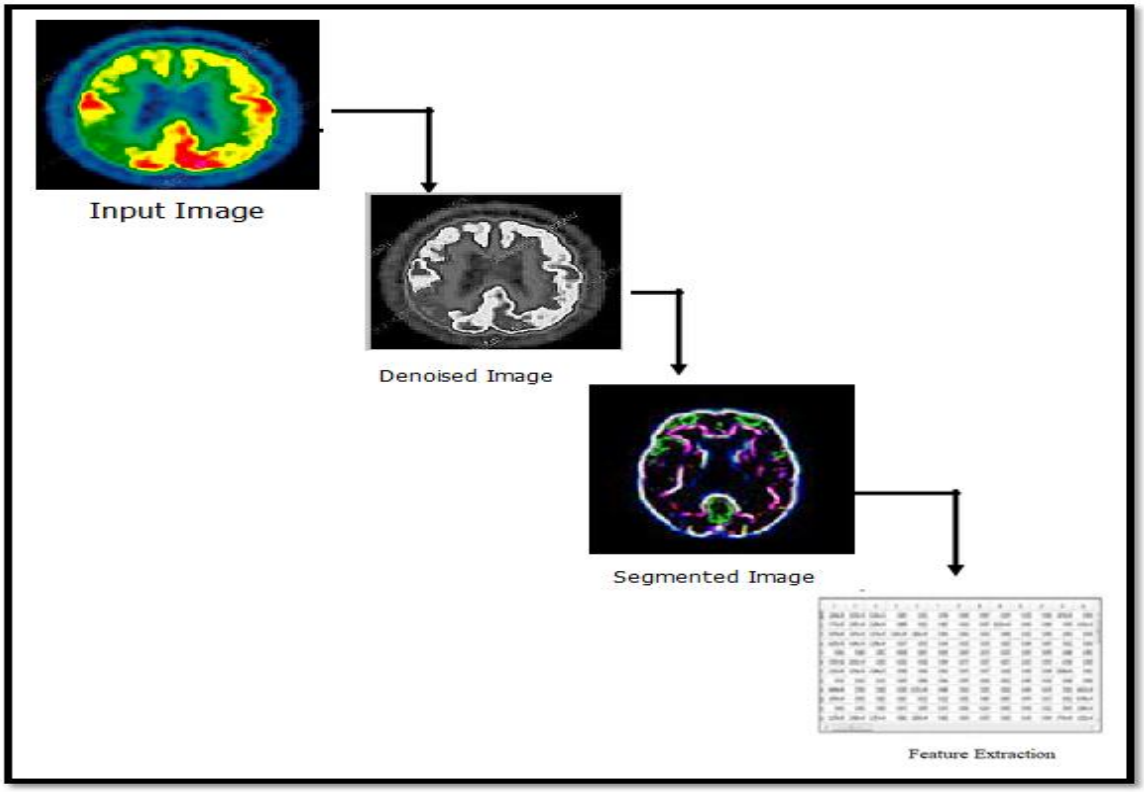

Figure 2: Feature Extraction of Proposed Method

FEATURE EXTRACTION

File	Mean	SD	Entropy	RMS	Variance	Smoothness	Kurtosis	Skewness	IDM
Image 1	2.6458e-05	4.0355e-04	6.1044e-05	0.0607	0.0031	0.0709	0.0048	-0.0017	[illegible]
Image2	-7.7752e-05	2.3807e-04	1.9294e-04	0.0696	0.0101	0.0697	0.0104	-0.0307	4.823
Image 3	-3.4738e-04	2.4972e-04	3.4738e-04	4.3267e-04	2.9565e-04	0.0018	0.0016	0.0148	[illegible]
Image 4	-4.6355e-05	4.2642e-04	2.2096e-04	0.0137	0.0333	0.0140	0.0335	0.0278	[illegible]
Image 5	-0.0014	0.0034	0.0072	-0.0029	0.0027	0.0191	0.0437	0.0175	[illegible]
Image 6	-3.7897e-06	8.4541e-04	0.0010	-0.0193	-0.0328	0.0404	0.0373	0.0357	[illegible]
Image 7	-2.1261e-05	2.0339e-04	4.7946e-05	0.0508	0.0054	0.0914	0.0075	0.0037	[illegible]
Image 8	0.0121	0.0145	0.0121	0.0105	0.0084	0.0944	0.0787	0.0019	[illegible]
Image 9	9.9459e-04	0.0018	0.0028	0.0200	-8.3571e-04	0.0485	0.0163	0.0254	[illegible]
Image 10	2.8760e-04	0.0052	0.0021	0.0141	-0.0223	0.0225	0.0301	0.0403	[illegible]
Image 11	0.0014	0.0014	0.0020	-0.0172	0.0078	0.0179	0.0160	-0.0124	[illegible]
Image 12	-3.1378e-05	2.3080e-04	1.3557e-04	0.0662	2.6030e-04	0.0662	0.0024	-0.0170	[illegible]

Figure 3: Result of the Proposed Algorithm

VI CONCLUSION

This chapter detailed the rapid matching of binary feature-based feature extraction to obtain energy, entropy, contrast, inverse difference, and directional moment. These texture features are served as the input to classify the image accurately. In effect use of multiple features of the image and its selection of a suitable classification method are especially significant for improving classification accuracy.

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