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Transform Supported Extraction Approach for PLHCR using IBL Algorithm in Malayalam Palm Leaf

S. Gopinathan and I. Jailingeswari

University of Madras, Chennai-25, India

Abstract - Palm leaf handwritten character recognition (PLHCR) is quiet daring part of research from the past period till the present day because of damages and defects that are happening in the palm leaf manuscripts. In this work we focus especially on PLHCR of Malayalam words by detecting individual characters. The network is trained for involving recognition and classification of the proposed method. The redrawn letter is considered as valid features for neural network training. 3D element (profundity of space) is related with depth factor requested by the writer. In the Malayalam palm leaf handwritten character 3D elements are present in all the pixels. The present work is employing 2D Discrete Wavelet Transform (2D-DWT), 2D Fast Fourier Transform (2D-FFT), 2D discrete cosine Transform (2D-DCT), and 2D Inverse Discrete Cosine Transform (2D-IDCT) for the purpose of feature extraction. The 3D component along the 2D transform gets more perfect accuracy values. The best recognition accuracy obtained in this mode 98%.

Keywords - PLHCR, 3D Element, 2D Fast Fourier Transform (2D FFT), 2D Discrete Wavelet Transform (2D DWT), 2D Discrete Cosine Transform (2D DCT), 2D Inverse Discrete Cosine Transform (2D IDCT)

1. INTRODUCTION

Among of all Indian languages, majority of work has been carried out in Bangla and Devanagari by Anish et.al [1]. The researches and studies performed on South Indian language scripts like Malayalam, Tamil, Kannada and Telugu have grabbed the attention of Communications and IT Ministry in recent days.

Approaches which are consisting of more refined features are used for extracting specific and special characters from the test patterns. Later they are implemented in increased and advanced model. This is partitioned as two heads such as transform domain and spatial domain by R.M.K.Sinha et.al [2]. The spatial domain approach is corresponding to the features that are derived straight from the image pixel description which is unique to a specific design. Whereas the transform domain is even more detailed and elaborate. In this transform, the transformation of image is carried out by using space from another one of the available methods. The languages like Sanskrit, Konkani and Hindi are making use of Devanagari script, while the languages like Bangla, Manipuri and Assamese are making use of Bengali script and Punjabi is using the Gurumukhi script by K.Prabhakar et.al [3]. The traditional ancient literature belonging to Southeast Asia along with India has been preserved by writing on palm leaves by P.N.Sastry et al [4]. The palm leaves were considered as the main source of writing material for many centuries. It was found that one of the old and finest preserved documents was documented from the 2nd century AD by F.Pinn et al [5]. Palm leaves were used as source for writing and recording various art formats, medicine hints and other details about astronomy by T.R.V.Lakshmi et al [10]. The common features found in common in all of these languages were that they were scripted down from left side to right. But, the Urdu language is an exception case here because it is scripted from right side to left side by P.N.Sastry, Krishnan, and B.V.S.Ram [8]. There is another significant feature seen in these languages, the vowels are not written directly when they are followed by a word starting with consonant. This will lead to write a character composite. At times the consonants tend to mingle with other consonants or vowels to create a new complex character by P.N.Sastry, N.V.Rao, and R.Krishnan [9].

2. EXISTING WORK

In the existing work N.S.Panyan,T.R.V.Lakshmi ,R. Krishnan, N.V.K.Rao have proposed transform based techniques in Palm Leaf Character Recognition PLCR using Telugu palm leaf character[11]. They reported two levels transform based techniques of DWT, DCT, and FFT are used for feature extraction using KNN method, they shown 96.4% of recognition accuracy.

3. METHODOLOGY

3.1 Data collection

The data input provided in this set up is completely varying when comparing to the present proposed method. The attribute or character identification is involving by scanning the particular piece of content and saving them in a computer data base. Later this image is made use as an input value for problem identification. The proposed work is for identifying the Malayalam syllables in

ancient palm leaf scripts. Firstly a leaf is selected and the pixels are found. Then (x, y) coordinates for all pixels are studied with the help of digital Nikon measuroscope (an instrument used for measuring the x y coordinates). Dial Indicator Plunger Assembly is having an accuracy level of 0.01 microns least count, which is used to calculate data depth at every pixel which can vary from 10 microns to 150 microns. At once the (x, y, z) coordinates are obtained by using MS excel, the characters are received on the computer screen and saved and processed in future for syllable recognition. The conception of minimum Euclidian distance is followed on the present architecture for making comparison with existing designs in database [11]. The following Fig.1 represents the data collection.

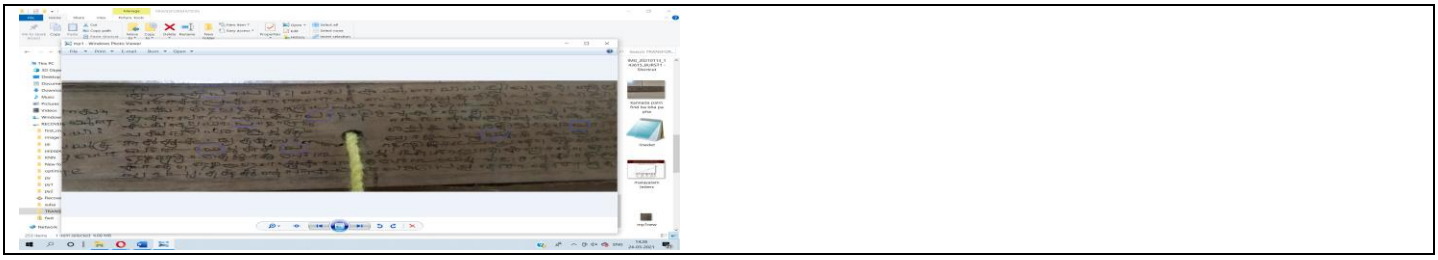

FIGURE 1: A PALM LEAF SCRIPT IN MALAYALAM

3.2 ***Algorithm for the proposed work***

Step 1: Select Malayalam palm leaf Handwritten Character taken as Input Dataset.

Step 2: Selecting specific confusing character “pa”, “pha” in Malayalam character.

Step 3: Identification of pixels position for each syllable Which ranges between 10 to 40 pixels related to the Syllable. The syllable present in left is considered as the Origin O (0, 0) coordinates according to the reference with all other pixels coordinates which is measured using Measuroscope.

Step 4: The coordinates (x, y) are estimated with the help of a Nikon Measuroscope-Model 20 along with display of Nikon SC-102.

Step 5: Later the coordinate z is estimated with a dial gauge in type of plunger and SYLVAC 50 a digital Reader.

Step 6: Later the coordinates (x, y, and z) are obtained by using the syllables with the support of MS excel and Saved in computer for future use.

Step 7: Normalized each Character by 32 *32, binarized, for preprocessing

Step8: Apply Transform FFT followed by DWT

Step9: Obtained dissimilar properties are filtered again applied DCT and Reconstruct image by IDCT

Step10: classification by IBL method takes similarity measure brought into accuracy got 98% through ‘xy’ Projection plane.

3.3 Architecture of Four phase Transform Supported System

The Distance calculation estimation is used for all pixels along the border line of syllable. At few prime points of a character such as starting point, ending point, curves, and loops, the Z-dimension is calculated. This is a significant attribute. By involving a combination of any two of coordinates at same time the syllables/ designs can be acquired. For instance 'XY', 'YZ', 'XZ' projections by P.N.Sastry et.al. [6-10]. The Z-value is calculated by studying the distance in between the bottom of a pixel that is present along the border of syllable and the nearby adjacent plain surface of the palm leaf script The proposed work has totally considered 31 classes of Malayalam script. In each class four images were involved for training the system and one of the image was involved in accuracy prediction. So, totally the count of images used for training is 31x4=124, while the images used for testing is 31x1=31.

The data collection for the proposed method is executed in a special method when comparing to existing methods of scanning a document. Now the total number of samples and for training and testing data sets are increased, and images were rotated by −10 °,−9 °, −8°, −7 °, −6 °, −5 °, −4 °, −3 °, −2 °, −1 °, 0 °, +1 °,+2 °,+3 °,+4 °,+5 °,+6 °,+7 °,+8 °,+9 °,+10 °. The technique for increasing the images for training and testing data sets was proposed by Chaudhri in IEEE transactions [12]. This method increases the training and testing data set of all images which is measuring later as 124x21=2604. The testing sample images are also increased and become 31x21=651 images. All the above images are present in "XY" projection plane. The same method is used for producing images for "YZ" and "XZ" projection Planes. The system was tested with 651 images along 2604 images for training data set.

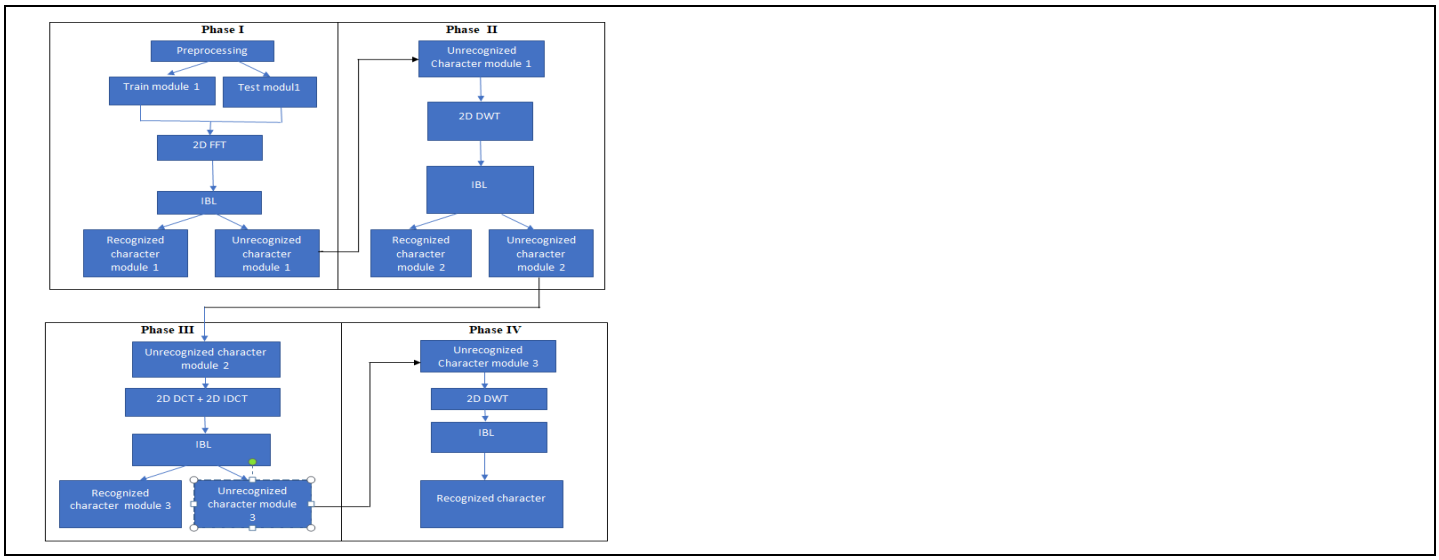

FIGURE 2: PROPOSED METHOD PLHCR ARCHITECTURE OF FOUR PHASES TRANSFORM SUPPORTED SYSTEM

The calculation for accuracy is done. The above Fig.2 is representing the four phases used for transforming support system. The above said setup for prediction is forwarded for all border line pixels of each character. Within the limit of a particular syllable, prominent focuses such as, curves, bends, starting point, ending point, circles are used for calculating the Z- value using Nikon Measuroscope – Model 20.

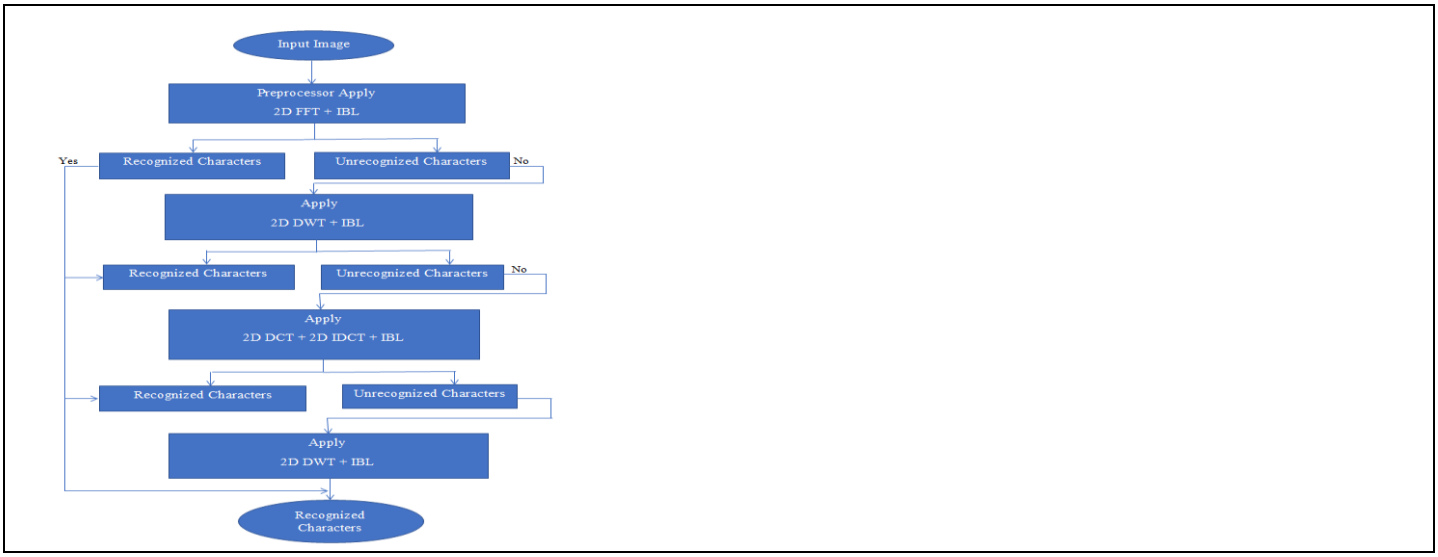

FIGURE 3: FLOW CHART FOR PROPOSED METHOD OF PLHCR TRANSFORM SUPPORTED SYSTEM

4. EXPERIMENT

In this architecture every character is considered as an input image. Fig.3 represents Flow chart of the Proposed System. In Fig 2. the proposed method PLHCR Architecture of four phase transform supported system shown that the new feature set for both testing and training the pictures are obtained. All the images are binarized and preprocessed with the help of OTSU Threshold value 0.6 by R.C.Gonzalez et.al [21].Now these images are resized into 32 X 32 for Phase-I then apply 2D FFT for each and every pixel of the image. The outcome the image with new transformed of values of pixels becomes the feature of respective image. The IBL (Instance Based Learning) classifies the new data points based on the similarity measure of the easier stored data points. It calculates Euclidean distance between the images used for testing and training character image is determined by O(n). From the obtained calculations which ever database image is having the smallest Euclidean distance for test image is taken as the correct match for testing. Later the suggested algorithm is checking if the test image has identified correctly or not. If any characters are identified wrongly in the Phase-I, then they are made as input in the following Phase-II also. For Phase-II 2D DWT is made use for extraction of features for wrongly identified test images from Phase-I and training images. Similarly, the Euclidean distance is determined between testing and training images. In this 2D FFT case images are denoted as

$$F(u,v)=1/MN\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}f[x,y)e^{-j2\pi(\frac{ux}{M}+\frac{vy}{N})}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}f[x,y)e^{-j2\pi(\frac{ux}{M}+\frac{vy}{N})} \quad (1) \quad [18]$$

$$for\ 0 \le u \le M-1\ and\ 0 \le v \le N-1 for\ 0 \le u \le M-1\ and\ 0 \le v \le N-1$$

In the above equation (1) M is denoting the total number of rows and N is representing the total number of columns of respective images. The total number of image pixel is 60 in simple terms, M=60 and N=60. In this research (x, y) are the pixel coordinates of spatial domain, while the (u,v) are representing the coordinates of transform domain. All the characters are preprocessed and classified in the first phase of the analysis using the 2D FFT trained and tested images. Next the distance for Euclidean is determined. Similar to Phase-I the image with smallest distance is considered as the image for testing. The proposed algorithm checks if the accuracy of the image recognition has improved or not. In the Phase-II of the analysis 2D DWT has been used. The details about the image f(x, y) is represented in following equations (2) & (3)

$$W\phi\ (j0, m, n) = 1/\sqrt{MN}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}f(x,y)\phi\ j0,m,n(x,y)1/\sqrt{MN}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}f(x,y)\phi\ j0,m,n(x,y) \quad (2) \quad [19]$$

$$W\ \phi\ (j, m, n) = 1/\sqrt{MN}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}f(x,y)\ \ \Psi j,m,n(x,y)1/\sqrt{MN}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}f(x,y)\ \ \Psi j,m,n(x,y) \quad (3) \quad [19]$$

Here in this equation $\phi\ j0\ ,m,n\ (\ x,y\ )\phi\ j0\ ,m,n\ (\ x,y\ )$ and $\psi\ i\ j,m,n\ (\ x,y\ )\psi\ i\ j,m,n\ (\ x,y\ )$ is translated and scaled according to Haar based functions while j0=0;N=M=2J;J=0,1,2,…J-1;m=n=0,1,2,…2j-1.

The total number of rows and columns in diagonal variation of the image are being measured using the directional wavelet, where i = H, V and D correspondingly. In this approach the average of image known as f(x, y), is derived with the use of equation (2) as mentioned earlier. This is majorly employed to identify the feature vector of the syllables in the Phase-II of the proposed algorithm in order to find the characters that were identified wrong earlier. Moreover the algorithm was tested using the 2D IDCT + 2D DCT in the phase-III while 2D DWT was used in the phase-IV. The respective architecture of the proposed method making use of 2D DCT + 2D IDCT and 2D DWT in Phase-III and Phase-IV are represented in Fig 2.

In phase-III the characters were classified by feature extraction by making use of 2D DCT + 2D IDCT. 2D DCT (Discrete Cosine Transform) used for transforming values of pixels from spatial domain to transform domain. 2D IDCT (Inverse Discrete Cosine Transform) used to recover an original image into spatial domain from its transform domain.

$$F[u,v]=1/N^2 \sum_{m=0}^{N-1}\sum_{n=0}^{N-1} f[m,n]\cos\left[\frac{(2m+1)u\pi}{2N}\right]\cos\left[\frac{(2n+1)v\pi}{2N}\right] \sum_{m=0}^{N-1}\sum_{n=0}^{N-1} f[m,n]\cos\left[\frac{(2m+1)u\pi}{2N}\right]\cos\left[\frac{(2n+1)v\pi}{2N}\right]$$

(4) [20]

Where u,v, discrete frequency variables (0,1,2,….N-1),f[m,n] N by N image pixels (0,1,2,….N-1) and F[u,v] = 2D DCT result. $where: u, v\ discrete\ frequency\ variables\ (0, 1, 2, \dots, N-1), f[m,n]\ \ N\ by\ N\ image\ pixels\ (0, 1, 2, \dots, N-1), and$ The 2D DCT is fast. It can be snappily calculated and is best for images with smooth edges. The DCT portions are all real figures unlike the Fourier Transform shown in equation (4)

$$F[m,n] \sum_{m=0}^{N-1}\sum_{n=0}^{N-1} c[u]c[v]f[u,v]\cos\left[\frac{(2m+1)u\pi}{2N}\right]\cos\left[\frac{(2n+1)v\pi}{2N}\right] \sum_{m=0}^{N-1}\sum_{n=0}^{N-1} c[u]c[v]f[u,v]\cos\left[\frac{(2m+1)u\pi}{2N}\right]\cos\left[\frac{(2n+1)v\pi}{2N}\right]$$

(5) [20]

Where m,n = image result pixel indices (0,1,2,…..N-1),F[u,v]= N by N 2D IDCT result

c[λ]= 1 for λ=0 and c[λ]=2 for λ=1,2,3,…N-1,f[m,n]= M by N 2D IDCT result.

$c[\lambda] = 1\ for\ \lambda = 0\ and\ c[\lambda] = 2\ for\ \lambda = 1,2,3, \dots N-1, f[m,n] = M\ by\ N\ 2D\ IDCT\ result$ The 2D Inverse Discrete Cosine Transform (2D IDCT) can be used to retrieve the image from its transform representation shown in equation (5). The pixel values that have been transformed and shown as 2D DCT + 2D IDCT equations (4) & (5) as respectively.

The Euclidean distance is being calculated among testing and training characters, the smallest distance found is taken as the identified character for the approach. The results are verified if the characters are recognized accurate and correctly with the help of proposed approach algorithm. Later the unidentified images are made to pass on as the input in the next phase-I. In phase-IV the 2D DWT is made use for changing the values of pixels, in order to use them as feature vector. The features of 2D DWT are extracted by using the equation (2) in the architecture that has been modified according to Fig.2. Fig.4 shows Malayalam character 'pa' in XY plane of projection .The Time complexity is generally estimated by counting the number of quantity of standard operations performed by the algorithm. When analyzing time complexity of an algorithm worst case is to find last n value, Big-O Notation finds liner time O (n). It gives run time in the worst case and this is the best possible time complexity. The accuracy calculation in overall is reported in the following sections.

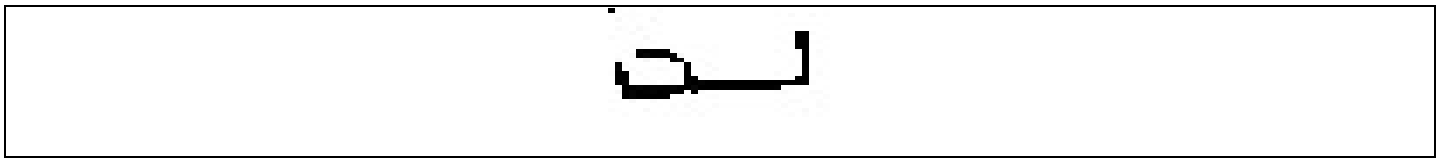

FIGURE 4: MALAYALAM CHARACTER 'PA' IN XY PLANE OF PROJECTION.

5. RESULTS AND OUTCOMES

It is crystal clear that all the patterns are totally varying from one another. So, definitely the recognition accuracy can be improved and increased with the proposed method. The proposed approach is making use of 2D transforms such as 2D FFT, 2D DCT+IDCT and 2D DWT for extracting the features in all of the four phases along with various combinations. The overall accuracy for recognition of characters was discovered. Malayalam language is consisting of infinite number of confounding and characters. These characters can be strangely comparable and therefore the similarities of characters are tough and confusing for identification. The characters which are alike are being made into group for analysis in further. In Malayalam language characters like “pa” and “pha” are grouped in the same group because they are having more similarities in them. This may lead to the chances of decrease in recognizing the characters more accurately with the help of any sort of recognition approach or model. As mentioned before, every single characters encrypted on the palm leaves are chosen by pixel points according to the three coordinates (X, Y, Z) is measured. The following Table I is representing the sample set of X, Y, Z values respectively for the Malayalam syllable “Pa”. The issue of recognition of characters without getting confused can be solved using the proposed approach of projection images. Table II is specifying the various relevant works for the proposed System. Table II is specifying the various relevant works for the proposed System. Fig 5 shown the results of 2D Transform of Fast Fourier, Fig 6 shown the results that Transformation of Discrete Cosine as well as Inverse Discrete Cosine to reconstruct the original image without the damage of smoothness. Fig 7 shows the

accuracy calculation using Instance Based Classifier. From Fig 8, Fig.9 shown analysis report of Time Complexity. Compared with optimation methods of GD and SGD. SGD shows the best optimization and less expensive and faster optimization method.

TABLE I.

X, Y, Z COORDINATE OF A PALM LEAF MALAYALAM CHARACTER "PA"

PIXEL VALUE	X	Y	Z(MICRON)
1	0.284	1.043	76
2	0.273	1.047	45
3	0.281	1.177	34
4	0.214	0.478	56
5	0.677	0.872	54
6	1.256	1.773	33
7	1.273	1.245	77
8	1.375	0.398	32
9	1.489	0.453	55
10	0.094	0.105	34
11	1.589	2.534	82
12	2.256	2.134	87
13	1.456	1.872	92
14	0.342	1.345	68
15	2.247	1.178	54

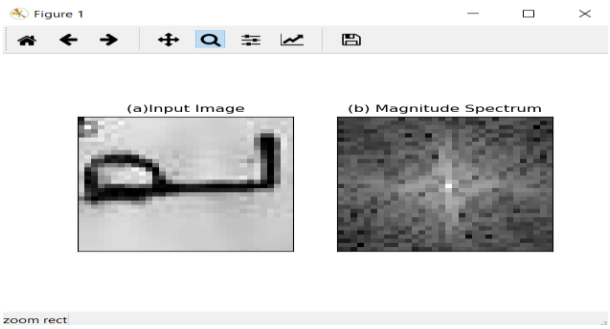

FIGURE 5. 2D FFT

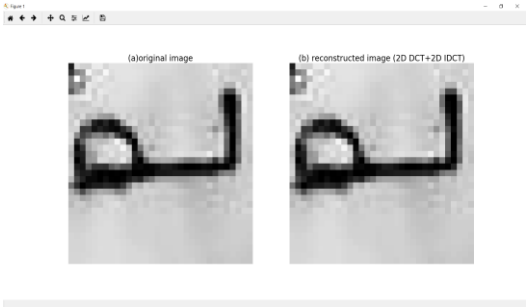

FIGURE 6. 2D DCT +2D IDCT

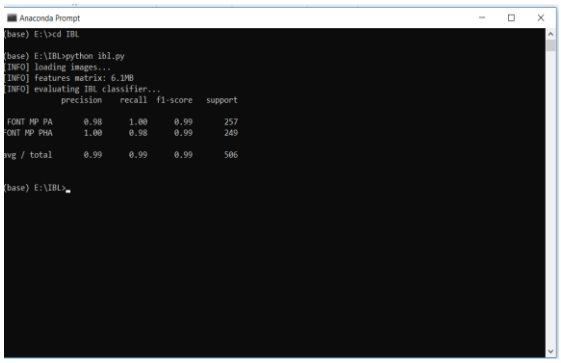

FIGURE 7. IBL CLASSIFIER

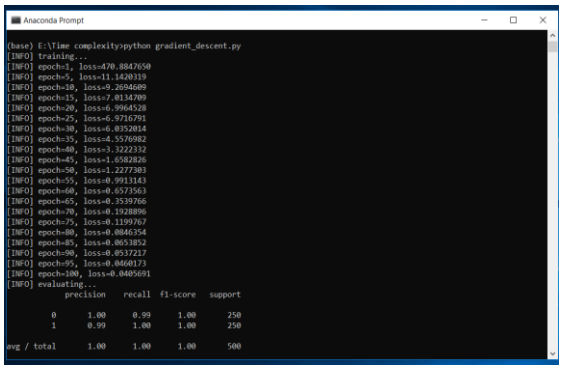

FIGURE 8. GRADIENT DESCENT CLASSIFIER

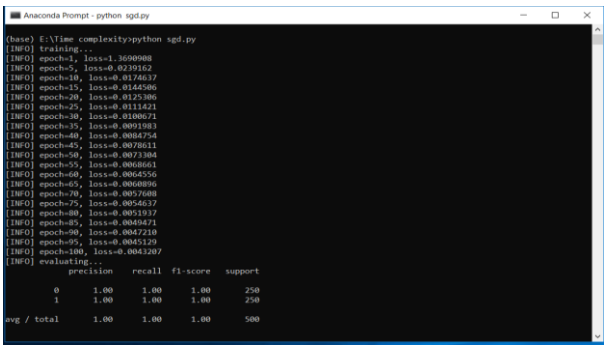

FIGURE 9. STOCHASTIC GRADIENT DESCENT CLASSIFIER

TABLE II.

TABLE SPECIFIES VARIOUS RELAVANT WORKS FOR THE PROPOSED SYSTEM

PAPER	**FEATURES**	**CLASSIFIER**	**ACCURACY (%)**
HCR using Fuzzy zoning by Lajish [13]	Fuzzy zoning, NVD	CMNN	78.87
HCR using 1D Wavelet by John et al [15]	Wavelet	MLP	73.8
HCR using Wavelet and projection profiles by Raju [14]	Wavelet, Aspect Ratio	MLP	81.3
HCR using Vertical and Horizontal LPA alg.by Rahiman et al [17]	VL & HL Count and position	Decision Tree	91

HCR using wavelet and svm by Jomy John et al. [16]	Haar Wavelet Transform	SVM	90.25
HCR using Decision Tree by P.N.Sastry,et al [7]	2d correlation	Decision Tree	90
HCR using multilevel Approach by P.N.Sastry. et al[9]	2D FFT,2D DCT	Decision Tree and SEE5/C5 algorithm	92.8
HCR using 2D transform by N.S.Panyam, et al [11]	2D FFT,2D DWT, 2D DCT	KNN	96.4
Proposed Two-level Method	2D FFT,2D DWT, 2D DCT, 2D IDCT	IBL	98

6. CONCLUSION

The proposed method can be implemented for recognition of Malayalam characters that are hand written in palm leaves by employing the combination of dissimilar classifiers. The approach has been performed in 4 phases. Acute and extreme accuracy reduction is performed as from phase-I to II, phase-II to III, phase-III to IV and so on. For identifying the individual characters by extracting the features using transform supported with Neural Networks while IBL classifier is also employed. It is made that the proposed work has got best accuracy level of 98% compared with the existing work percentile of 96.4%. As future work of the proposed system, a system which is capable of recognizing all the characters from ancient and old degraded files and documents. Later on converting them into form suitable for machine editing and preserving them for future use is suggested. It is expected in fore coming days that machines and technologies for automatic scanning for palm leaf characters can be developed for data recognition and acquisition which can avoid and reduce the human interface errors. So, the accuracy percentile of recognition would be increased.

REFERENCES

[1] Anish S, Preeja V, A Novel Method on Malayalam Handwritten Character Recognition, I.J.E.A.T 4(6) (2015) 2249 – 8958

[2] R.M.K Sinha , H. Mahabala , Machine recognition of Devanagari script, IEEE Trans. Syst. Man Cybern. 9 (1979) 435–441

[3] K. Prabhakar , R. Jagadeesh Kannan , A comparative study of Optical character recognition for Tamil script, J. Sci. Res. 35 (4) (2009) 570–582.

[4] P.N. Sastry Modeling of palm leaf scribing analysis using statistical pattern recognition, ECE Department, JNTUH, India, Sept. 2010 Ph.D. dissertation .

[5] F. pinn, R. Vaidyanathan, D. Heppel, Princely states report, J.Indian States Hist.2 (2) (2001) https://en.wikipedia.org/ wiki/History _ of _ science _ and _ technology _ in _the _ Indian_ subcontinent

[6] P.N. Sastry, R. Krishnan, B.V.S. Ram, Classification and identification of Telugu handwritten characters extracted from palm leaves using decision tree approach, J.Appl. Eng. Sci. 5 (3)) (2010) 22–32.

[7] P.N. Sastry, R. Krishnan, B.V.S. Ram, Telugu character recognition on palm leaves –a three dimensional Approach Technol. Spectr. 2 (3) (2008) 19–26

[8] P.N. Sastry , R. Krishnan , Isolated Telugu palm leaf character recognition using radon transform, a novel approach, in: World Congress on Information and Communication Technologies (WICT), 2012, pp. 795–802.

[9] P.N. Sastry , T.R. Vijaya Lakshmi , R. Krishnan , N.V. Rao , Analysis of Telugu palm leaf characters using multi- level recognition approach, J. Appl. Eng. Sci. 10 (20) (2015) 9258–9264

[10] T.R.V. Lakshmi , P.N. Sastry , R. Krishnan , N.V.K. Rao , T.V. Rajinikanth , Analysis of Telugu palm leaf Character recognition using 3D feature, in: International Conference on Computational Intelligence and Networks (CINE), Jan. 2015, pp. 36–41.

[11] N.S. Panyan, T.R.V. Lakshmi, R. Krishnan, N.V.K. Rao, Modeling of palm leaf character recognition system Using transform based techniques, in: Pattern Recognition Letters 84(2016) 29-34.

[12] U. Bhattacharya , B.B. Chaudhuri , Handwritten numeral databases of Indian scripts and Multistage recognition of mixed numerals, IEEE Trans. Pattern Anal.Mach.Intell.31 (3) (2009) 444–457.

[13] Lajish V.L " Handwritten Character recognition using perpetual fuzzy zoning and class modular neural networks," Proc.Of 4th Int.National Conf.on Innovations in IT, 2007, pp.188-192

[14] G.Raju,"Wavelet transform and projection profiles in handwritten character recognition performance analysis" Proc.Of 16th International Conference on Advanced Computing and Communications, Chennai 2008, pp.309- 314.

[15] G.R John, D. Guru "1-D wavelet transform of projection profiles for isolated handwritten character recognition" Proc.Of ICCIMA07, Sivakasi, 2007, pp.481-485, Dec 13-15.

[16] J.John, K.V.Pramod, K. Balakrishnan "Unconstrained Handwritten Malayalam Recognition using Wavelet Transform and Support Vector Machine Classifier "in International Conference on Communication Technology and System Design ELSEVIER 2011.

[17] M.A. Rahiman, N.M S R.Masha, M.Rema, R.Meenakshi, G.M.Kumar"Recognition of Handwritten Malayalam Characters using Vertical and Horizontal Line Positional Analyzer Algorithm" 2011 International Conference IEEE

[18] https://homepages.inf.ed.ac.uk/rbf/HIPR2/fourier.htm

[19] http://www.irdindia.in/journal_ijacte/pdf/vol5_iss3/4.pdf

[20] https://www.engr.colostate.edu/ECE513/SP09/lectures/lectures11_12.pdf

[21] Rafael Gonzalez, Richard E.Woods, "Digital Image Processing", Third Edition.