Urdu Handwritten Signature Recognition Empowered with PNN

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Abstract

Handwriting is human personal information that is used for personal identification. It is a means of communication and saving data. Handwritten information can be used in the computer once it is converted to digital form (machine language). Signatures play the most important role in our lives as of taking admissions in university or any government job, credit card shopping, and bank cheques require your signatures and they take signatures in different situations and conditions as well. Our working will focus on Pakistani National Language Urdu Handwritten Signature Recognition which converts Urdu Handwritten signatures to be stored in E-form. The working done on it is with the help of Pattern Neural Network. The proposed method gave the result of up to 73% and this will help us to save our documents in electronic form.

Key words:

Machine Learning, Artificial Intelligence, Urdu Handwritten Signature Recognition (UHWSR), Urdu Signatures, Pattern Neural Network, Digital Image Processing.

1. Introduction

Writing is a human physical expression but at the same time acquired the skill. Handwriting is an individuals' personal skill and it's a personal identification which is also very important for security purposes. The handwritten signature is a central part of the validation of any business transactions and agreements as well. Signature recognition demands an individual to provide a sample of text which serves as a core of measurement of their writing. Handwriting is known to be the source of communication and record the information [1]. The objective of the signature recognition process is to recognize the writer of a given sample, while the reason of a signature verification process is to confirm or reject the sample. The writing sample can be examined by way of two separate techniques. As we all know that there are some employees who use long and difficult combinations of letters and numbers, their owner will look towards a system that is required for fingerprint or iris pattern will be identified by a sensor. Composing is human physical articulation however simultaneously a procured aptitude. Mark's acknowledgment requires a person to supply an example of content that fills in as a base of estimation of their composition. Biometrics is the study of programmed acknowledgment of individuals relying upon their physiological and conduct traits. For quite a long time, transcribed marks have been an indispensable piece of approving business exchange contracts and understandings. Among the various types of biometric acknowledgment frameworks, for example, unique finger impression, iris, face, voice, palm and so forth., the mark will be most generally utilized [2]. Signature Recognition is the system of deciding to whom a specific signature has a place. A handwritten signature is an individual unique characteristic of a human that is of person authentication receiving methods. Nevertheless, in daily life when their large number of signatures are created is unmanageable. So, there comes the demand for an automatic algorithm approach to handle person verification based on the handwritten signature. A signature confirmation technique, for the most part, recognizes an individual's unique and produced signatures, tolerating the real signatures and dismissing the forged ones [3]. Urdu is the National language of Pakistan and its population is around 197 million. Moreover, also in India, there are around 100 million local Urdu speakers. In speaking form, Urdu and Hindi are the third main language of the world called 'Hindustani' but these both are different in written format. Urdu language is getting popular because of its classical richness (poetry). Optical Character Recognition (OCR) is in demand for local speakers to facilitate them easily readable through mobile or tablet and also for digitizing a large number of documents like magazines, newspapers, handwritten documents [4]. Signatures show persuasive proof and gives an important form of indexing for successful document image processing and getting back of data in a vast range of applications. Signature is a person's name written in a creative way as a form of identification in approving a check or document or summarizing a letter. Signature forgery consults to performance of false duplication of the signature of the other person. Signature forgery is done in order to:

- Commit frauds
- Deceive others
- Alter data etc.

An example of signature forgery is cheque writing shown in figure 1. [5]

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Fig. 1 Detecting Forgery Signature

(a). Physiological:

That takes the biological traits of users, such as fingerprints, iris, face recognition, hand geometry, etc.

(b). Behavioral:

Considers dynamic traits like voice recognition, handwritten evidence and specific expressions [6]. The way we sign has wide social and legal acceptance in authentic behavioral biometric traits. People sign every day to prove their identity and this doesn't give any massive measurements. This identification verification is the most attacked. With the enhancement of new technology, the previous systems are replaced with advanced techniques to identify a person [7]. These techniques are biometrics which will involve individual biological traits like face, finger-prints, voice, signature, etc. Between the different forms of biometric recognition systems for example fingerprint, iris, face, voice, palm, etc., the signature will be mostly used. Signature recognition is a behavioral biometric. Writing is human physical articulation however simultaneously an obtained ability. Mark's acknowledgment requires a person to supply an example of content that fills in as a base of estimation of their composition. The reason for the mark acknowledgment procedure is to recognize the essayist of a given example, while the motivation behind a mark check procedure is to affirm or dismiss the example. The composing test can be inspected by method for two separate strategies [8].

1.1 Static/Off-line Signature Recognition:

In this medium, users are going to write their signature on paper, then it will go through an optical scanner or a camera, and the biometric system identifies the signature analyzing its shape. This group is also known as "off-line". The off-line data is easy to collect, the only hardware needed is just a scanner. This can be done to the signatures done in the past and help to compile the documents which were not in electronic form. Off-line handwriting recognition is a significant type of biometric recognizable proof since signatures are a socially acknowledged ID technique that is ordinarily utilized for banks, charge card and different business exchanges. Off-line signature preparing is regularly utilized in office mechanization frameworks that approve checks, Master-cards, contracts and authentic records [9].

1.2 Dynamic/Online Recognition System:

In this medium, users will write their signature in a digitizing tablet, which needs the signature in real-time. Another possibility is the requirement of signatures by means of stylus-operated PDAs. Some systems also work on smart-phones or tablets with a capacitive screen, in which users can sign using a finger or an appropriate pen. Dynamic recognition is also known as "on-line". On-line handwriting recognition means that the machine identifies the writing while the user writes. The term real-time or dynamic has been used in place of online. Concerning the recognition technique and the speed of the computer, the identification lacks behind the writing to a greater or lesser extent. An individual is always required at the time of signing and a person should be attentive in writing the signature and for the recognition of signature, there is the installation of special hardware. Dynamic signature devices ought not be mistaken for disconnected electronic mark catch frameworks that are utilized to catch a realistic picture of the mark and are regular in areas where shippers are catching marks for exchange approvals [10].

1.3 Types of Signatures

There are three different types of signatures:
Genuine signatures:
A genuine signature is when that specific writer writes his own signatures under normal conditions and this is not being restricted to any rules.
Fraud signatures:
Forged signatures are the handwritings of a pretender with the objective of it being identified as genuine signatures of another individual. Its characteristics are large as compared to the genuine signature [9].
Disguised signatures:
Disguised signatures are the signatures that are produced under the situations where an authentic signer produces the signatures to reject the authenticity of the signed documents later in the future [10].

2. Literature Review

On-Line handwriting recognition means that when the user is going to write it will be recognized by the special hardware machine/ electronic tablet or digitizer, it is also known as real-time or dynamic [11]. Off-Line handwriting recognition means it will only be done when a writer will be finished writing. Timely dependent local features are

unavailable. For converting the image to a bit pattern, an optical scanner was used [12-13]. Although verification and identification are not that different terms in signature, we have to be very particular like the purpose of signature recognition is to identify given sample writer and the purpose of signature verification is to accept or rejects the sample that was provided. depending on several distance functions some methods are for recognition. Hidden Markov Model and many other algorithms are helping in improving the prior knowledge [14 -16]. Many of pattern recognition problems for doing signatures on tablets and handwriting occurred. Problems may be equations, drawing of lines, symbols as well. Later in pre-processing, external segmentation (isolation of characters/words occurring), the noise was reduced, characters were recognized, recognition of words, gestures, line drawings, and then signature verification is being done. Off-line verification using global features of signatures can be done by Support Vector Machine (SVM) for verification and classification of signatures [16]. The off-line signature can be done using Hough transform and through this signature image and strokes can be explained [11]. Signatures can be identified through four steps:

Preprocessing: signature image is normalized to pixels and then the threshold is processed. Shifting: In off-line signature, verification shifting is applied. Shifting is applied to translate each pixel in the signature body. Hough space detection: horizontal line Hough transform is utilized to capture parameterized Hough space in signature images.

Classification: to classify the signatures by using Hough transform Back Propagation Neural Network is used.

$$\Delta Wij = qij\ xj + aAWij(k-1)$$

Eight-bit signatures were scanned on a computer. In order to obtain skeleton structure shifting and thinning are implemented [9].

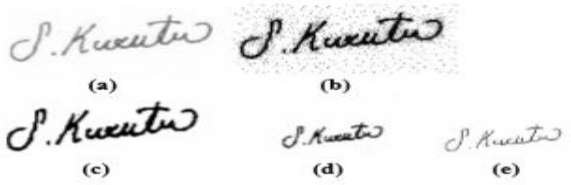

Fig. 2 Example Results after Scanning Handwritten Signature

In above figure (a) is for scanned image, (b) is background elimination (before the extraction features data area is being cropped), (c) is noise reduction (filters are applied for reducing binary image, in case the black pixels are in greater quantity than white pixels, cohesion pixels will be black else will be white), (d) is width normalization (width and height of an image is adjusted without change in ratio of width and height), (e) thinning (this is to discard the thickness difference done due to pen. Hilditch's Algorithm is used) [10]. Character Image (in this RGB color model is used and its purpose is to give comfort with the specification of colors. Other color models like CMY (cyan, magenta, yellow), CMYK (cyan, magenta, yellow, black) and HSI (hue, saturated, intensity) and NTSC. The RGB color is convertible to NTSC and grayscale image can be made by ignoring color information (hue, saturation). Histogram based threshold can convert a grayscale image to a binary image [10] [11]. The threshold value was developed according to Otsu's algorithm. This method selects that value of threshold that can maximize class variance [12]. Parametric Approach: This shows a signature pattern, reference and test signature parameters are checked whether the signatures are real of fraud [13]. Some parameters that are being used are speed, acceleration, Fourier transforms, and pen downtime ratio, etc. [14] [15] [16]. Over here signature database comprising of 75 different people having 984 samples (12 signatures each person). After performing the experiments 125 skilled fraud signatures were collected. 95% accuracy was achieved. Concluded that the off-line signature recognition system (SRS) features were cluster-based global features. To provide our identity to have access to many of the things in our daily life, every individual signature plays the best role in recognition of the identity. Radial Basis Function Network is a method that is trained with images sample in the back-end (database) and feature extraction is done before they are used for training [17]. Biometric systems are trained with sensory units for detecting the clear feature extraction unit. Using minimum attributes those features will check the original data and then this feature set is compared with stored set in database and matched score was generated. The back-propagation algorithm in which the neural network is generated with RGB pixels as input and the output will be gray-value [18]. For these cropped images were used and the image size will be reduced by dividing the image according to the scaling ratio. Most of the time when signatures are done through hands may have tilting issues that may be resolved by rotation elimination. Radial Basis Function Network (RBFN) is constructed on its basis including three layers named as input, hidden & output layer. The input layer is created by sensory units that connect the network with its surroundings. The hidden layer is the middle layer that implements nonlinear changing from the input layer to the hidden layer. Output layer: creates a response of the network to activation signals implemented to the input layer. RBFN architecture had proved to enhance the performance and training of the network [19] [20]. Using an image database containing 70 people having 700 signatures, MATLAB is evaluated above to have reformed pixels. Methodology used for designed algorithm is as under 1) signatures are scanned, 2) scanned image size will be checked, 3) morphological operations are implemented, 4) gaining edges of shapes in image, 5) from every signature center of gravity is taken out, which is more accurate and calculated in two levels giving the accurate

value to differentiate among real and fraud signatures, 6) Hough transform is applied morphological operations are applied, 7) this data is then fed to neural network using back-propagation algorithm [21]. Input images are converted to binary images, then that image is being resized (edges are reduced) and then thinning is done by using the threshold process. [22] [23]. Image area, maximum horizontal and vertical projection, edge detection-Laplacian of Gaussian smoothing filter are applied to reduce the noise sensitivity and it all can be calculated with a convolution filter. Signature correct rejection and acceptance, false rejection and acceptance is also very important and is done through signature verification and identification. It has been examined that after training stages efficiency found in this Hough transform and Neural Network was above 95%. The importance of handwritten is so vast that in the Thai language they have also contributed a lot in recognition of their local language signature [24]. Their working showed their interest in this topic for which they proposed a methodology in which several steps are involved: i. scanning the photograph that will be input image, ii. pre-processing is done in a recognition system, iii. Feature extraction is again to find the most prominent features of the handwriting image. After all this process the recognition step comes in which at first grouping is done from the features that are gained through Multilayer perception (MLP) that are divided into groups of signatures that concedes with other groups so it is not that much accurate and suitable for signature recognition while the second is the use of Radial basis function (RBF), its division is different from others [25]. Computational Intelligence approaches like Fuzzy system [26, 27], Neural Network [28], Swarm Intelligence [29] & Evolutionary Computing [30] like Genetic Algorithm [31, 32], DE, Island GA [33], Island DE [34, 35] are strong candidate solutions in the field of smart city [36-39] and wireless communication [40-43]. PNN also lies under computational intelligence approaches. In this article, the PNN based solution is proposed for Urdu handwritten signature identification.

3. Problem Statement

To correct and effective recognition of Urdu handwritten signature. Online handwriting recognition mostly waits until the whole curve is traced out pre-processing the analysis however, this may hold-up the recognition process. The signature recognition process should be able to detect Urdu handwritten signature. To make our system much efficient to differentiate between real and fake/fraud signature. To utilize a model approach for handwritten signature recognition. The objective of handwritten signature recognition is to confirm the only correct person is permitted to enter high-security systems. Signature recognition is done to resolve and contrast the characteristics/quality. To find out the skilled frauds and understands the physiological parameters of the signer. We are going to use Artificial Neural Network Technique for Urdu Handwriting Signature Recognition.

4. Methodology

Figure3 shows the proposed UHWSR Model in detail. It states as Data is collected on A4 size paper by taking handwritten signatures from individuals. That collected data is taken from almost 10 persons on paper of almost 50-60 signatures of every individual by dividing the page into boxes and signers are demanded to sign within the boxes. After that, every signature done is being scanned and cropped and around the signature, images are obtained that are then arranged in proper order by giving the images proper number.

Pre-processing on every individual signature is done. In the pre-processing stage, the working on every single image, Noise is removed, image is resized, RGB is converted to greyscale then to binary form noise is to be removed because it is the result of errors in the image acquisition process that results in pixel values that do not show the true identities of real scene. So, after removing the noise in the image and after that Image is resized means that pixels of every single image is to be made similar. Image that is taken of every individual is not same as in online signature recognition, the is provided with stylus or pen and it after processing will not require the image conversion to greyscale level but in off-line signature recognition, no special stylus or pen is given instead the signer can use any ordinary pen with any color. That's why it is necessary to convert the obtained images that were signed by the signer to be converted to greyscale. After pre-processing, segmentation is done on the scanned images, which means that signs of signer are separated from the background into two parts of the original image.

The values extracted from local binary images are saved into an excel sheet created. Data set are created and then that data is pre-processed in which 0 values columns are removed. When the 0 values are removed, Classification is done upon that and 10 classes are created of binary values. These MATLAB values and binary values are stored in MATLAB after making two classes and after that machine learning is performed. The data extracted is given to the Neural Net and are then trained, in these variables passed are trained in which input/output is obtained. After obtaining the trained data set values, best model is chosen from the back-end where different models are already there but the best among them is chosen, this process is mainly called Model Validation, upon which afterward testing is done to get the required results

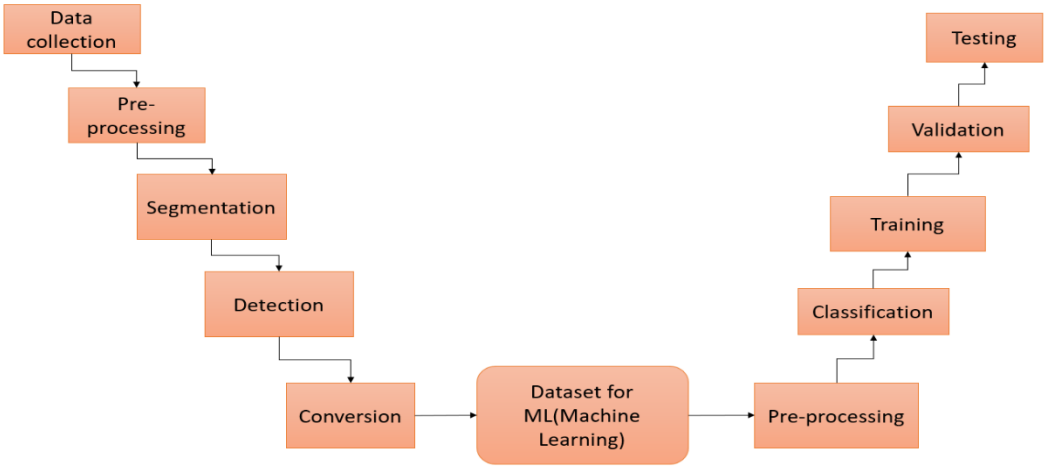

Fig. 3 Proposed UHWSR Model

5. Simulation & Results

MATLAB R2018a is used for simulation purposes. Figure 4 shows the MATLAB values of the scanned images of the dataset using in proposed Urdu Handwritten Signature Recognition (UHWSR). These are the trained MATLAB values, taken after running code on each image. Figure5 shows the testing values of obtained. Five classes are created each assigned with a different value. Figure 6 shows the Output Classes (a). Training Confusion Matrix; (b). Validation Confusion Matrix; (c). Test Confusion Matrix; (d). All Confusion Matrix. This whole image gives the data set in the training and is divided into 3 parts i.e. Train Confusion Matrix, Test Confusion Matrix and the Validation Confusion Matrix and the last image gives the overall confusion matrix. Models are first trained, secondly testing process is implemented, third validation is done and after that, the last window shows the overall matrix. By looking at the above picture, we are unable to see the exact outcomes of the matrix. Figure7 shows the final results obtained from the proposed UHWSR system. Figure 8 and 9 shows the ROC and the best performance graph of the proposed UHWSR.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	0.000804	0.000519	0.000606	0.000523	0.000618	0	0	0	0	0	0	0	0	0.999994	0.003217
2	0.001	0.000503	0.000682	0.000488	0.000692	0	0	0	0	0	0	0	0	0.999994	0.003034
3	0.000829	0.000696	0.000589	0.000692	0.000583	0	1.95E-06	1.96E-06	1.96E-06	0	1.95E-06	0	1.95E-06	0.999995	0.002646
4	0.000982	0.000669	0.000609	0.000679	0.000594	0	0	0	0	0	0	0	0	0.999995	0.002828
5	0.00074	0.000509	0.000496	0.000504	0.000489	0	0	0	0	0	0	0	0	0.999996	0.002641
6	0.000741	0.000437	0.00052	0.000436	0.000517	0	0	0	0	0	0	0	0	0.999996	0.002342
7	0.000677	0.000519	0.000492	0.000521	0.00049	0	0	0	0	0	0	0	0	0.999996	0.002512
8	0.00074	0.000567	0.000514	0.000565	0.000514	0	0	0	0	0	0	0	0	0.999996	0.002405
9	0.000708	0.000472	0.000413	0.000466	0.000414	0	0	0	0	0	0	0	0	0.999997	0.002009
10	0.000644	0.000571	0.000471	0.000568	0.000475	0	0	0	0	0	0	0	0	0.999996	0.002435
11	0.000668	0.000451	0.0005	0.000453	0.000495	0	0	0	0	0	0	0	0	0.999997	0.001977
12	0.001102	0.00072	0.000631	0.00071	0.000608	0	0	0	0	0	0	0	0	0.999992	0.003539
13	0.000927	0.000662	0.000602	0.000659	0.000602	0	0	0	0	0	0	0	0	0.999995	0.002697
14	0.000806	0.000567	0.000413	0.000557	0.000417	0	0	0	0	0	0	0	0	0.999996	0.00252
15	0.000793	0.000469	0.000485	0.000477	0.000486	0	0	0	0	0	0	0	0	0.999997	0.002278
16	0.000824	0.000525	0.000492	0.000522	0.000481	0	0	0	0	0	0	0	0	0.999996	0.002515
17	0.000689	0.000577	0.000464	0.000569	0.000463	1.33E-06	2.71E-06	1.37E-06	2.71E-06	2.67E-06	2.74E-06	2.67E-06	2.74E-06	0.999996	0.002418
18	0.000809	0.000657	0.00051	0.000657	0.000495	0	0	0	0	0	0	0	0	0.999994	0.003012
19	0.000823	0.000535	0.000451	0.000544	0.000458	0	0	0	0	0	0	0	0	0.999996	0.002543
20	0.000683	0.000412	0.000496	0.00042	0.000493	0	0	0	0	0	0	0	0	0.999997	0.001999
21	0.000555	0.000425	0.000368	0.000427	0.00038	0	0	0	0	0	0	0	0	0.999998	0.001983
22	0.000555	0.000425	0.000368	0.000427	0.00038	0	0	0	0	0	0	0	0	0.999998	0.001983
23	0.000817	0.000872	0.000554	0.000863	0.000554	0	0	0	0	0	0	0	0	0.999992	0.003578

Fig. 4 MATLAB Values of Scanned Images

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	0.001	0.000503	0.000496	0.000488	0.000692	1.95E-06	0	0	1.95E-06	0	0	1.95E-06	0	0.999994	0.002512	0.067093					
2	0.000829	0.000696	0.000514	0.000692	0.000583	0	1.95E-06	1.96E-06	1.96E-06	0	1.95E-06	0	1.95E-06	0.999995	0.003539	0.067069					
3	0.000982	0.000669	0.0005	0.000679	0.000692	1.95E-06	0	0	0	1.95E-06	0	0	0	0.999995	0.00252	0.06709					
4	0.000901	0.000554	0.000723	0.000447	0.000724	0	0	0	2.15E-06	0	0	4.31E-06	0	0.999995	0.002876	0.067088					
5	0.000803	0.000218	0.000497	0.000546	0.000724	0	0	0	0	4.31E-06	0	0	2.15E-06	0.999999	0.001404	0.066881					
6	0.000782	0.000323	0.000723	0.000413	0.000724	0	2.16E-06	2.15E-06	2.15E-06	0	4.31E-06	2.15E-06	4.32E-06	0.999994	0.003102	0.067127					
7	0.0019	0.000466	0.001195	0.001018	0.001404	3.64E-06	3.63E-06	3.64E-06	0	0	0	1.24E-06	0	0.999994	0.002794	0.067162					
8	0.002028	0.000561	0.001214	0.001018	0.0013	3.12E-06	3.12E-06	1.47E-06	3.12E-06	0	1.24E-06	0	0	0.99999	0.003318	0.06732					
9	0.001856	0.000561	0.001198	0.001299	0.001176	1.24E-06	1.24E-06	0	1.24E-06	0	0	0	0	0.999985	0.004478	0.067418					
10	0.000807	0.000879	0.00121	0.000877	0.001216	0	0	0	0	0	1.79E-06	0	0	0.999991	0.00335	0.067287					
11	0.000799	0.001298	0.00107	0.00129	0.001062	1.79E-06	0	1.79E-06	0	1.79E-06	0	1.79E-06	0	0.999988	0.003801	0.067357					
12	0.001124	0.000446	0.000989	0.000448	0.000985	0	0	0	1.79E-06	0	0	0	0	0.999993	0.003012	0.067167					
13	0.000724	0.000544	0.000483	0.000436	0.000487	0	0	0	0	7.78E-07	0	7.76E-07	0	0.999997	0.002094	0.066979					
14	0.000724	0.000544	0.000461	0.000436	0.000469	0	7.75E-07	7.78E-07	0	0	7.76E-07	0	7.76E-07	0.999997	0.001972	0.066966					
15	0.000724	0.000544	0.000523	0.000436	0.000527	0	0	0	7.78E-07	0	0	7.76E-07	0	0.999997	0.002025	0.067001					

Fig. 5 Testing Values obtained

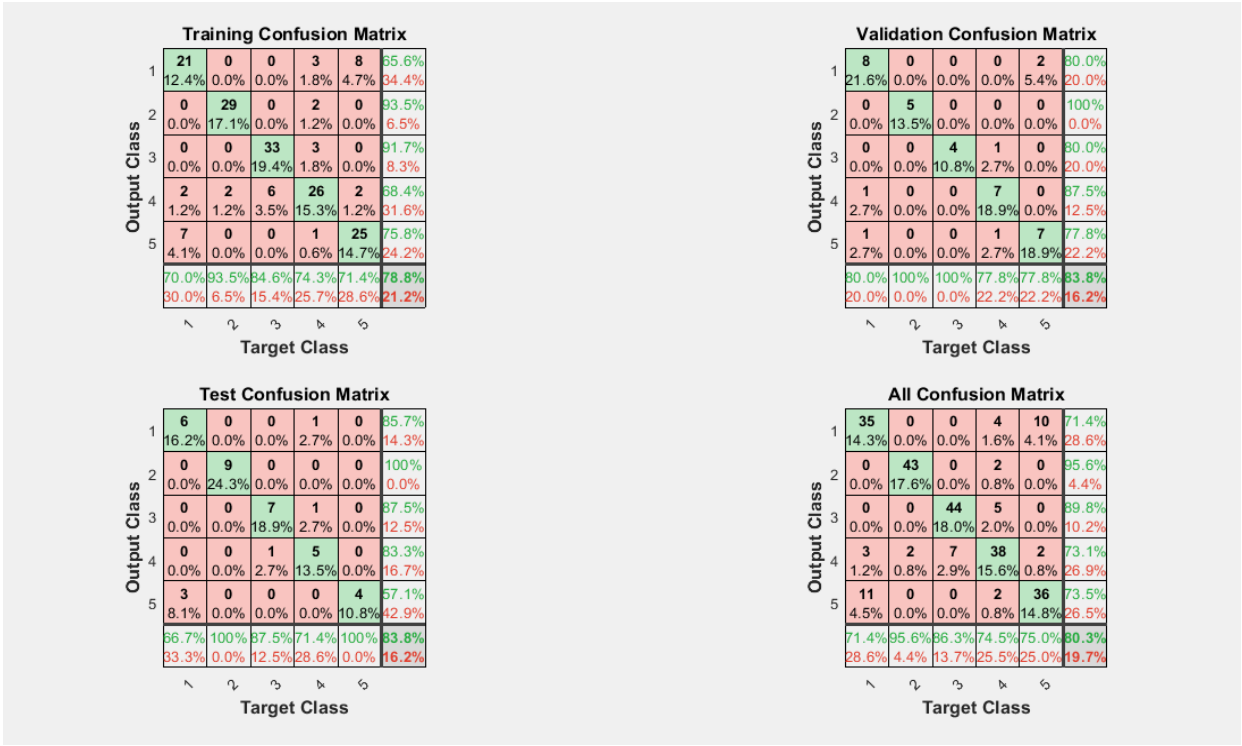

Fig. 6 Output Classes (a). Training Confusion Matrix; (b). Validation Confusion Matrix; (c). Test Confusion Matrix; (d). All Confusion Matrix of proposed UHWSR system

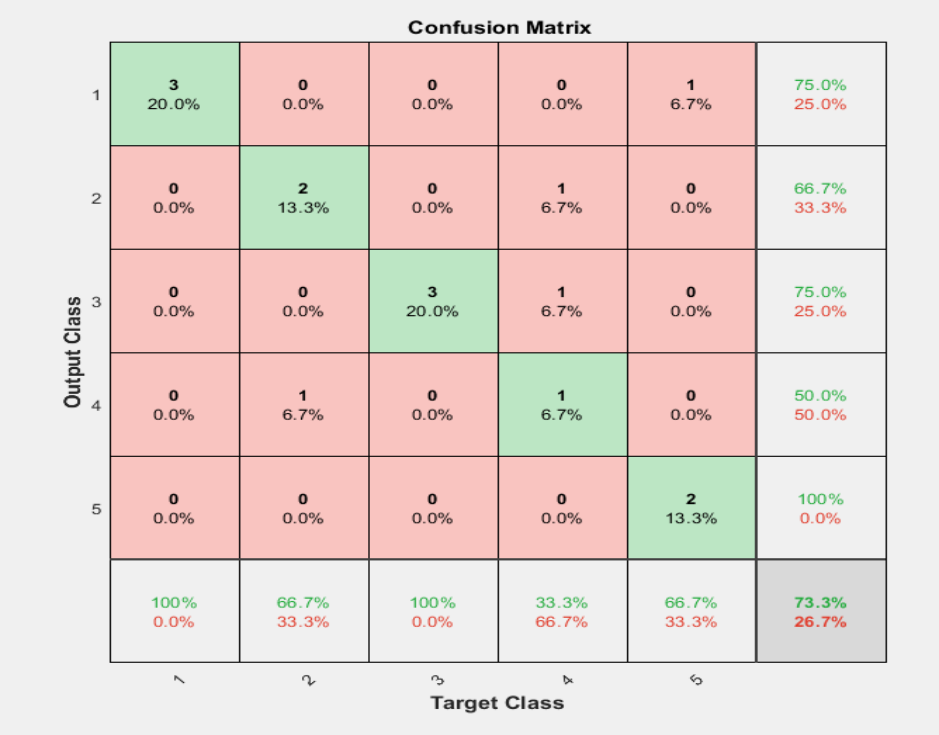

Fig. 7 Final Results obtained of proposed UHWSR system

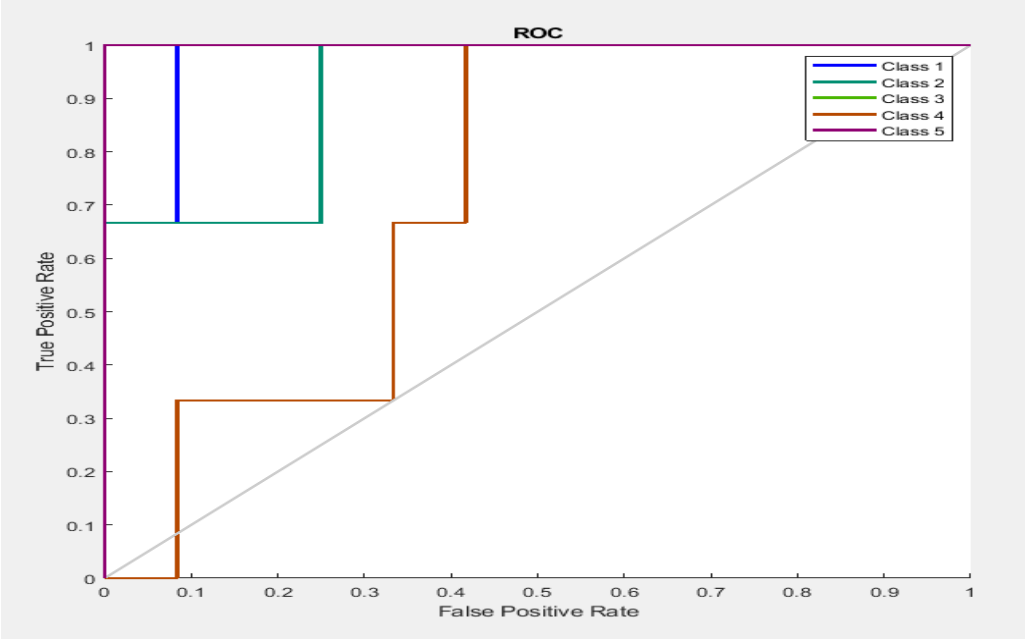

Fig. 8 ROC of the proposed UHWSR system

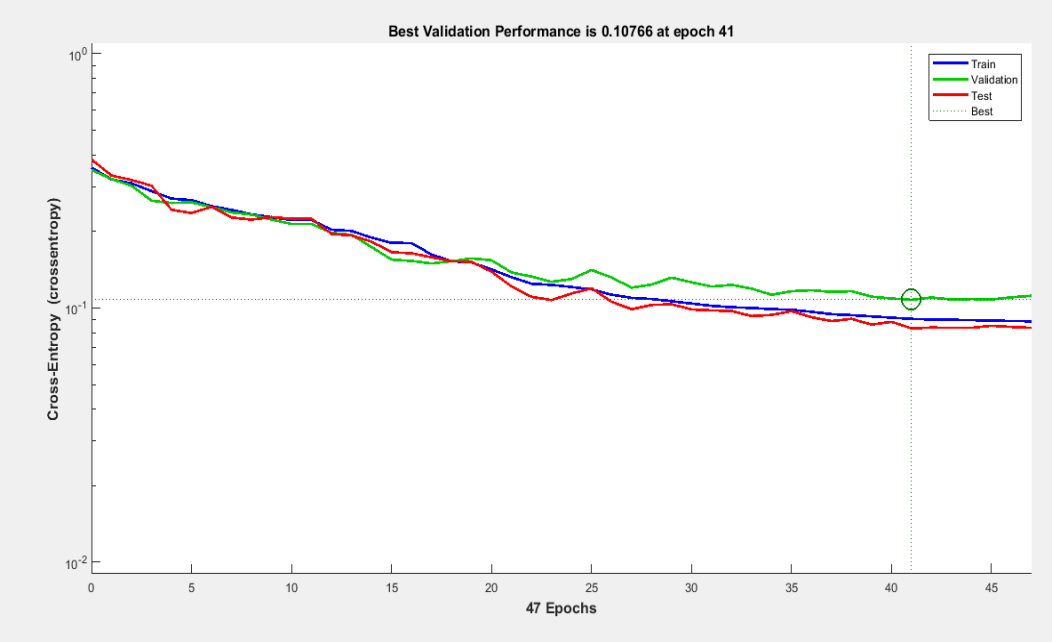

Fig. 9 Best Validation Performance proposed UHWSR system

5. Conclusion and Future Work

The proposed system was to perform the recognition of Urdu Handwritten Signatures which gives the best result of 83% accuracy in accordance with the data set taken. It can be more accurate by increasing the number of samples. Strokes of signatures were highly noticeable in our samples as is shown as the peak values. Here signature differs from person to person as it is a human personal thing under different situations and conditions under which the signatures are being gathered. That is why it is important that the sample set is chosen under different situations and conditions to gather all possibilities. this will help our country to be recognized more as of other countries has done a lot of working in signature detection of their national language and our aim is to detect Urdu signature and our language also get full importance and working on it will help others as well. In past the working done in the Urdu language was recognizing the characters that are linguistic and compound characters, writing different ways of dates as well as recognized and stored in E-form. In this way, our data that are being signed by grandparents specially or any other document that in the past were not stored in E-form can be stored and safe at the future end as well. That's why our working totally focuses on Urdu Handwritten signatures but in the future, this can be done to store other handwritten languages and the system will be made more efficient. In future working can be more accurate by increasing the sample size moreover to detect the different types of signatures: skilled signatures, un-skilled signatures and forged signatures in Urdu language mainly but our working can be fruitful in detecting other languages signatures as well.

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