LITERATURE REVIEW

1) C. K. Chan and M. B. Sandler 1992
Scholars propose a new technique for 2-0 shape recognition based on the peak and envelope vectors extracted from the Hough space. The vectors are fed into a neural network which performs both the learning and recognition tasks.

2) Noel t Goldsmith 1998
Excellent images covering extreme focal depths in light microscopy were reproduced using a simple image processing technique for the evaluation of local sharpness in an image. The process is applicable to images from any source, and if the distance between each image is known then a quantitative contour map is also produced.

3) Loo-Nin Teow and Kia-Fock Loe 2000
Authors used well-established results in biological vision to construct a novel vision model for handwritten digit recognition. The features extracted model are linearly separable over a large training set (MNIST). Using only a linear classifier on these features, our model is relatively simple yet outperforms other models on the same data set. Research Scholars have developed a novel vision model which extracts features that are biologically plausible, linearly separable and semantically clear. With good features, we need only a relatively simple linear classifier that trains fast and gives excellent classification performance.

4) San Jose, CA, 2001
The computation time of Document Image Decoding can be significantly reduced by employing heuristics in the search for the best decoding of a text line. By using a cheap upper bound on template match scores, up to of the potential template matches can be avoided. In the Iterated Complete Path method, template matches are performed only along the best path around by dynamic programming on each iteration. When the best path stabilizes, the decoding is optimal and no more template matches need be performed.

5) S. S. Gornale Ramesh Manza K. V. Kale 2003
Recognition systems based on biometrics (faces, hand shapes and fingerprints etc.) are finally taking off although it has taken a long way to come. Fingerprints have been a precious tool for law enforcement, forensics and recently in commercial use for over a century. Evaluate the performance of these emerging technologies is tricky problem.

6) Jassar, S. 2004
In this paper, an explanation of a pen computing from the user interface perspective has been explained. The major hardware component of a pen computer (its digitizing tablet) and its major software component (its handwritten recognition engine) are both analyzed in terms of how a user’s perceivers. Finally the result of an experimental conducted in 1991 to compare the performance of input devices in pointing and dragging tasks are analyzed and found to support this study.
This paper presents the latest results of handwritten digit recognition on well-known image
databases using state-of-the-art feature extraction and classification techniques. The tested
databases are CENPARMI, CEDAR, and MNIST. On the test dataset of each database, 56
recognition accuracies are given by combining 7 classifiers with 8 feature vectors. All the
classifiers and feature vectors give high accuracies. Among the features, the chaincode
feature and gradient feature show advantages, and the prole structural feature shows
efficiency as a complementary feature. In comparison of classifiers, the support vector
classifier with RBF kernel (SVC-rbf) gives the highest accuracy but is extremely expensive in
storage and computation. Among the non-SV classifiers, the polynomial classifier (PC)
performs best, followed by a learning quadratic discriminate function (LQDF) classifier. The
results are competitive compared to previous ones and they provide a baseline for evaluation
of future works.

8) Shinichi FUJITA, Keji OMAE ChunChen, LIN Yin MING, Seinosuke NARITA 2002
This paper discusses a simulation CAI system based on the letter shape recognition method,
one of the approaches to teach Kanji (Chinese character) in actual classrooms. The simulation
CAI, which uses information technology to simulate a learning method employed in
classrooms, can ease constraints in time and place and serve a useful function in repetition
drills, an important practice in learning a language. Chapter 1 discusses what is the
significance of this system as a CAI to reproduce learning activities in actual lessons. Chapter
2 provides general notes on building a CAI for class preparation and review. Chapter 3
discusses implementation of the system and details of the system. Chapter 4 provides the
evaluation of the system. Chapter 5 is a wrap-up.

9) Hany Ferdinando 2003
This project implements the Fuzzy Logic system to recognize the handwriting digit. There are
3 constraints need to be considered here, they are: the real data were written with the same
pen; the real data will be scanned into image data and then converted to BW mode with other
software outside this project; program will read image data file instead of capturing with
special device such as camera. Software is implemented in matlab. The design of fuzzy logic
will use fuzzy logic editor. Before processing with Fuzzy algorithm, it needs to process the
image then to get its features. Only simple image processing technique will be used. Feature
extraction was made with a vertical and two horizontal lines. The position of crossing point
between these lines with the image data will be a feature. These pre-processed data will be an
input parameter for the fuzzy system. The fuzzy system has 7 inputs and 1 output with 57
rules. The average result of recognizing process is 80% after membership functions tuning.

Character recognition is an active area of research with numerous applications including web
publishing, document analysis and text to speech conversion. In this paper, authors present a
new approach for the off-line recognition of cursive Urdu Text. This methodology has been
developed for the Noori Nastaliq Script. Word (Ligature) based identification has been
adopted instead of character based identification. A multi-tier holistic approach has been
utilized to recognize ligatures from a pre-defined ligature set. Initially, the special ligatures
(Dots, Tay, and Hamza& Mad) are identified from the base ligatures. These special ligatures
are associated to the most probable neighbouring base ligature in the second step. Finally, the above information along with some other RTS invariant features of base ligature is presented to the Feed Forward Back Propagation neural network to perform the final recognition task.

11) Dr. K.V.Kale 2004
In this paper Wavelet transforms have received significant attention because their Multi-resolution decomposition allows efficient image analysis. Various scalarwavelet based techniques so far developed for SAR image compression; these wavelet transforms cannot posses all desirable features simultaneously. Relatively new class of wavelets called Multi wavelet; are new addition to the body of wavelet theory.

12) Dejan Gorgević, Dusan Cakmakov 2004
This paper proposes an efficient three-stage classifier for handwritten digit recognition based on NN (Neural Network) and SVM (Support Vector Machine) classifiers. The classification is performed by 2 NNs and one SVM. The first NN is designed to provide a low misclassification rate using a strong rejection criterion. It is applied on a small set of easy to extract features. Rejected patterns are forwarded to the second NN that uses additional, more complex features, and utilizes a wellbalanced rejection criterion. Finally, rejected patterns from the second NN are forwarded to an optimized SVM that considers only the “top k” classes as ranked by the NN. This way a very fast SVM classification is obtained without sacrificing the classifier accuracy. The obtained recognition rate is among the best on the MNIST database and the classification time is much better compared to the single SVM applied on the same feature set.

13) Joshi Abhijit R. and Dr. D.J. Sanghavi 2006
In this paper they have presented various issues involves in the design module for inflectional words in Marathi language. This work is a part of research which is aimed by developing a genetic algorithm – an ITS that helps the learners to learn Marathi language.

14) Mohammad Reza Daliri, Vincent Torre 2006
In this paper scholars presented two algorithms for shape recognition. Both algorithms map the contour of the shape to be recognized into a string of symbols. The first algorithm is based on supervised learning using string kernels as often used for text categorization and classification. The second algorithm is very weakly supervised and is based on the Procrustes analysis and on the Edit distance used for computing the similarity between strings of symbols. The second algorithm correctly recognizes 98.29% of shapes from the MPEG-7 database, i.e. better than any previous algorithms. The second algorithm is able also to retrieve similar shapes from a database.

15) Xuefeng Chen, Xiabi Liu*, and Yunde Jia 2007
Learning is important for classifiers. This paper proposes a new approach to handwritten digit recognition based on the max-min posterior pseudo-probabilities framework for learning pattern classification. Each digit class is modeled as a posterior pseudo-probability function, the parameters in which are trained from positive and negative samples of this digit class
using the max-min posterior pseudo-probabilities criterion. In the process of digit classification, an input pattern is classified as one of ten digit classes or refused as being unrecognized according to the posterior pseudo-probabilities. Experiments on NIST database show the effectiveness of the proposed approach in reducing the error rate and making rejection decisions to those input pattern which can not be reliably by even human.

16) Faisal Tehseen Shah, Kamran Yousaf 2007
This working prototype system can detect handwritten digits from a scanned image of an input form by using Neural network technique. Handwriting recognition and Image detection through this methodology is very fast and effective as compared to old fashioned image pixel comparison methodology, which is comparably slow. In the initial phase for handwritten digit input we have designed a form which can take handwritten writing samples from different people. The form must have specific format so user can give multiple input in 10 rows, and hand write 0,1,2,3,4,5,6,7,8,9 in the corresponding sampling cells (rows* columns). The cell must also have width according to your requirement (e.g set it to 20*2 pixels). Once the blank form have been manually filled by different people then scan these forms with the help of scanner. So now we have images of handwriting samples of digits. In the 2nd phase, we use image slicing technique to slice sample image of size 16*16 pixel for each digit from the scanned form. Each scanned form image will make nearly 100 images of 16*16 pixels. Repeat the same step for all scanned sample forms and place all these 16*16 pixel images (sample pool) into one location. In the detection phase, a three-layered neural network is used: After training, the obtained weight and bias are stored for each digit sequence (signature). It is now possible to identify the meaning of any handwritten digit with the help of AI engine. So now when ever any handwritten digit will be given as sample input in to the system , the output array will automatically give the digit whose corresponding match value is detected. The above process is a blueprint of human cognitive thinking process.

17) Inam Shamsher, Zaheer Ahmad, Jehanzeb Khan Orakzai, Awais Adnan 2007
This paper deals with an Optical Character Recognition system for printed Urdu, a popular Indian script and is the third largest understandable language in the world, especially in the subcontinent but fewer efforts are made to make it understandable to computers. Lot of work has been done in the field of literature and Islamic studies in Urdu, which has to be computerized. In the proposed system individual characters are recognized using our own proposed method/ algorithms. The feature detection methods are simple and robust. Supervised learning is used to train the feed forward neural network. A prototype of the system has been tested on printed Urdu characters and currently achieves 98.3% character level accuracy on average. Although the system is script/ language independent but we have designed it for Urdu characters only.

18) S K Hasnain, Azam Beg, Muhammad Samiullah Awan 2007
This paper describes the frequency analysis of spoken Urdu numbers from ‘sifr’ (zero) to ‘nau’ (nine). Sound samples from multiple speakers were utilized to extract different features. Initial processing of data, i.e., normalizing and time-slicing was done using a combination of Simulink and MATLAB. Afterwards, the same tools were used for calculation of Fourier descriptions and correlations. The correlation allowed comparison of the same words spoken by the same and different speakers. The analysis presented in this paper is seen as the first step in creating an Urdu speech recognition system. Such a system can be potentially utilized.
in implementation of a voice-driven help setup at call centers of commercial organizations operating in Pakistan/India region.

In this paper, we presented frequency analysis of Urdu numbers (one to nine). The data was acquired in moderate noisy environment by word utterances of 15 different speakers. FFT algorithm was used in MATLAB to analyze the data. As expected, we found high correlation among frequency contents of the same word, when spoken by many different speakers.

19) Ahmad M. Sarhan, Omar I. Al Helalat 2007
In this paper, an Arabic letter recognition system based on Artificial Neural Networks (ANNs) and statistical analysis for feature extraction is presented. The ANN is trained using the Least Mean Squares (LMS) algorithm. In the proposed system, each typed Arabic letter is represented by a matrix of binary numbers that are used as input to a simple feature extraction system whose output, in addition to the input matrix, are fed to an ANN. Simulation results are provided and show that the proposed system always produces a lower Mean Squared Error (MSE) and higher success rates than the current ANN solutions.

20) Thierry Artieres, Sanparith Marukatat, and Patrick Gallinari 2007
authors investigated a new approach for online handwritten shape recognition. Interesting features of this approach include learning without manual tuning, learning from very few training samples, incremental learning of characters, and adaptation to the userspecific needs. The proposed system can deal with two-dimensional graphical shapes such as Latin and Asian characters, command gestures, symbols, small drawings, and geometric shapes. It can be used as a building block for a series of recognition tasks with many applications.

21) Shumaila Malik, 2007, Dr. Shoab A. Khan
this research converts user hand written information into Urdu text. This allows natural writing just like it can be written on paper. Urdu is a complex language, features of Urdu which make it more difficult than English are: characters that vary from each other on the basis of small changes in their shape and the hat feature that carry very important information because based on type and number of these hat feature above or below the basic structure, the character can turn into a new character with different sound. Although average length of character is less but it in turn increases the overall complexity and provide less context to alleviate this problem. The system performs the recognition of 39 Urdu characters, 10 numerals and 200 words (two character words). The working of recognition system is based on analytical approach to segmentation for feature extraction, rule based slant analysis for slant removal and tree based dictionary search for classification. Hat feature recognition is 98%. The proposed tree search technique reduces the search space up to 96.2% and is therefore significantly faster than searching techniques, in which we have to process the whole dictionary to come up with the correct answer. The system has recognition rate of 93% for isolated characters, 93% for numerals and 78% for two character words.

22) Nasser Omer Sahel Ba-Karait, Siti Mariyam Shamsuddin 2008
As humans, it is easy to recognize numbers, letters, voices, and objects, to name a few. However, making a machine solve these types of problems is a very difficult task. Handwritten digits recognition (HDR) is considered as one of difficult problems in the field of pattern recognition. Hence, evaluating a performance of other algorithms on HDR problem is of great importance. In this study, Particle Swarm Optimization (PSO) based method is exploited to recognize unconstrained handwritten digits. Each class is encoded as a centroid
in multidimensional feature space and PSO is employed to probe the optimal position for each centroid. The algorithm evaluates on 5 folds cross validation of handwritten digits data, and the results reveal that PSO gives promising performance and stable behavior in recognizing these digits.

23) Muhammad Imran Razzak S. A. Hussain Muhammad Sher 2009
Harifi et al. presented a technique for Persian digits using multilayer perceptron and proposed asymmetrical segmentation pattern for feature extraction and 12 segment was used and used the shadow coding and 97.6% recognition is reported.

24) S.V. Rajashekararadhya 2009
This paper presents zone centroid and image centroid based distance metric feature extraction system for Indian script numeral recognition. The numerals centroid is computed and the numeral image is divided into n equal zones. Average distance from centroid to the each pixel in the zone is computed. Nearest neighbor and feed forwards back propagation is used for classification and 99%, 99%, 96% and 95% accuracy is obtained for Kannada, Telugu, Tamil and Malayalam numerals.

presented proposed zone based feature extraction for handwritten Hindi numerals. The image is divided into 24 zones for feature extraction. Bottom left corner of the image is considered absolute reference, the distance vector for each pixel present in the zone is computed with respect to reference zone. Then normalized distance vector is then computed by dividing the sum of distances vector of all black pixels in the zone with their total number and the process is repeated to obtain 24 feature sets.

26) Al-Taani Ahmad et al. 2009
presented structural method for recognizing on-line handwritten digits, input strokes are used for calculating and normalizing slope values of input coordinates. The change of direction is recorded using the successive slopes values. Finite Transition Network that contains the grammar of the digits is used to match primitive’s string with corresponding digit to recognize the digit. The method is tested on sample of 3000 digits written by 100 different trained persons.

27) Chan et al. 2009
Paper presents a structural approach for recognizing on-line handwriting. Structural features are extracted from the input strokes. The presented approach on 62 character classes (digits, uppercase and lowercase letters) and each class has 150 entries. Experimental results showed that the recognition rates were 98.60% for digits, 98.49% for uppercase letters, 97.44% for lowercase letters, and 97.40% for the combined set.

28) Rashad Al-Jawfi 2009
This paper implements the Fuzzy Logic system to recognize the handwriting digit. There are 3 constraints need to be considered here, they are: the real data were written with the same pen; the real data will be scanned into image data and then converted to BW mode with other software outside this project; program will read image data file instead of capturing with special device such as camera. Software is implemented in matlab. The design of fuzzy logic will use fuzzy logic editor. Before processing with Fuzzy algorithm, it needs to process the
image then to get its features. Only simple image processing technique will be used. Feature extraction was made with a vertical and two horizontal lines. The position of crossing point between these lines with the image data will be a feature. These pre-processed data will be an input parameter for the fuzzy system. The fuzzy system has 7 inputs and 1 output with 57 rules. The average result of recognizing process is 80% after membership functions tuning.

29) Azam Beg, Faheem Ahmed, and Piers Campbell 2010
Software-based Arabic optical character recognition (OCR) has been used quite successfully for many years. However, the hardware-based implementations of the OCR – which can be 10-100 times faster than the software only method – seem to not have been fully exploited. This paper briefly reviews the research material addressing software based OCR but focuses more on the hardware realization of Arabic OCR. The software-only OCR methods have achieved reasonable maturity but require use of PCs (or similar platforms), which is an obvious hindrance for OCR implementations in small form factor, such as pens or mobile devices. Different researchers have addressed individual, subtasks of Arabic (non-Latin) OCR, but not as complete, functional systems. The recognition accuracies also have significant room of improvement. The main challenge for practically functioning OCR systems in smaller sizes is the optimization of software algorithms so they can be efficiently and cost-effectively realized in hardware.

30) Alireza Behrad, Malike Khoddami and Mehdi Salehpour 2010
Optical character recognition is an important task for converting handwritten and printed documents to digital format. In multilingual systems, a necessary process before OCR algorithm is script identification. In this paper novel methods for the script language identification and the recognition of Farsi handwritten digits are proposed. Our method for script identification is based on curvature scale space features. The proposed features are rotation and scale invariant and can be used to identify scripts with different fonts. We assumed that the bilingual scripts may have Farsi and English words and characters together; therefore the algorithm is designed to be able to recognize scripts in the connected components level. The output of the recognition is then generalized to word, line and page levels. We used cluster based weighted support vector machine for the classification and recognition of Farsi handwritten digits that is reasonably robust against rotation and scaling. The algorithm extracts the required features using principal component analysis (PCA) and linear discrimination analysis (LDA) algorithms. The extracted features are then classified using a new classification algorithm called cluster based weighted SVM (CBWSVM). The experimental results showed the promise of the algorithms.

31) Sushama Shelke, Shaila Apte 2011
Compound character is a special feature of Marathi script, derived from Devanagari. It joins two or more characters in various ways forming a new character. The complexity of compound characters makes its recognition a challenging task for the researchers. The frequency of occurrence of compound characters in Marathi language is more compared to other languages derived from Devanagari. This paper presents a novel approach for recognition of handwritten Marathi compound characters using a multi-stage multi-feature classifier. In the first stage, the compound characters are classified by two stage structural classification based on various structural parameters. In the second stage, various features like pixel density features, Euclidean distance features and modified wavelet approximation
features are extracted from the structurally classified and normalized characters. The three features are applied to three different neural networks. The final recognition output is selected based upon majority voting and if all the results differ then final output is confirmed by the neural network with modified wavelet approximation features. The recognition accuracy given by the proposed system is 97.95%.

32) Gerardo Miramontes-de Le´on , Ricardo David Valdez-Cepeda 2011
This paper reports the performance of a character recognition test using MNIST handwritten-digit database. The presented assessment is twofold, first it shows the performance of a recognition test based on a very simple feature extraction method, secondly it shows a disparity within the database that may be important when recognition algorithms are compared. For the assessment of the MNIST database, a novel feature extraction scheme based on the Mojette transform is proposed. This transform has not been used as the feature extraction scheme for character recognition. The Mojette transform can be seen as equivalent to the so called projection histograms. Other descriptors, like the Kirsch directional features, require a mask and consequently, many multiplications, so the Mojette transform is mathematically less complex since it requires only sum operations. In spite of the very simple projection method used as a descriptor, a recognition rate of 97% was obtained over a testing set of 1000 samples, as used by some authors. It was found, however that for a fixed-size test of 1000 samples, the recognition rate changed on different sections of the database.

33) Ajay K. Talele , Dr. Sanjay L. Nalbalwar 2011
Automatic Cheque Processing is one of the most widely researched areas in document analysis and biometric. Various methodologies have been proposed in this area for Automatic Cheque Processing and forgery detection. An account holder gives cheques to another person as account payee or self-cheque. It is been observed that a number of forgery cases have been registered as cheque forgery, where some person has forged the signature of another person and provided a self-cheque to himself. In this paper we propose a mechanism for recognition of cheque fields, like name, amount and also verify the signature and it’s authenticity. We propose a unique two stage model of Automatic Cheque processing with detecting skilled forgery in the signature by combining two feature types namely Sum graph and HMM and classify them with knowledge based classifier and probability neural network. authors proposed a unique technique of using HMM as feature rather than a classified as being widely proposed by most of the authors in signature recognition. Results show a higher false rejection than false acceptance rate. Character segmentation accuracy is found to be 95%, character recognition efficiency 83%, Digit recognition efficiency is 91%. and system detects forgeries with an accuracy of 80% and can detect the signatures with 91% accuracy.

34) Manish Vyas Prof Amit Singhal Prof. Neetesh Gupta 2012
Discrete Hidden Markov Model (HMM) and hybrid of Neural Network (NN) and HMM are popular methods in handwritten word recognition system. The hybrid system gives better recognition result due to better discrimination capability of the NN. A major problem in handwriting recognition is the huge variability and distortions of patterns. Elastic models based on local observations and dynamic programming such HMM are not efficient to absorb this variability. But their vision is local. But they cannot face to length variability and they
are very sensitive to distortions. Then the SVM is used to estimate global correlations and classify the pattern. Support Vector Machine (SVM) is an alternative to NN. In Handwritten recognition, SVM gives a better recognition result. The aim of this paper is to develop an approach which improve the efficiency of handwritten recognition using artificial neural network.

35) Pritpal Singh and Sumit Budhiraja 2012
This paper presents an OCR (optical character recognition) system for the handwritten Gurmukhi numerals. A lot of work has been done in recognition of characters and numerals of various languages like English, Chinese, and Arabic etc. But in case of handwritten Gurmukhi script very less work has been reported. Different Wavelet transforms are used in this work for feature extraction. Also zonal densities of different zones of an image have been used in the feature set. In this work, 100 samples of each numeral character have been used. The back propagation neural network has been used for classification. An average recognition accuracy of 88.83% has been achieved.