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A Survey on Ancient Marathi Script Recognition from Stone Inscriptions

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Abstract:

Rigorous Research has been done on ancient Indian script character recognition. Many research articles are published in last few decades. Number of OCR techniques is available in market, but OCR techniques are not useful for ancient script recognition. But more research work is required to recognize ancient Marathi scripts. This paper presents different techniques which are published by different researchers to recognize ancient scripts. Also challenges in recognition of ancient Marathi scripts are discussed in this paper.

Keywords- Ancient Script, Stone Inscriptions, Script Recognition, Optical Character Recognition, Hidden Markov Model, Ancient Marathi Script

Introduction:

Many inscriptions are found in the ancient cities of India [1, 4]. These inscriptions are very important as the major sources of getting information about ancient India. These inscriptions also provide valuable information about time, place, historical information and situation connected with the inscription and the evolution of the languages over centuries. Currently, the content of each of these inscriptions is converted into readable Marathi language manually by archaeology experts. These experts have specialized knowledge to understand the ancient scripts. The inscriptions are very difficult to read by human by naked eye and the manual procedure would be time-consuming. The Inscriptions were used as one of the information sources to recognize the expansion of the Marathi language. Recognizing the content of this inscription becomes a huge challenge due to various reasons. The inscriptions may be damaged and/or partially erased. Lack of specialized knowledge and a lack of available resources for inscription reading is also another major problem. Currently, the existing archaeology experts do many efforts to read the inscriptions.

In ancient period many information was written on the stone surfaces by the people. All ancient documents written on the stone surface are called as "Inscriptions". The Indian inscriptions are classified into four classes: cave, rock, slab, and pillar [2]. The information written on the drip ledges of the cave is called cave inscriptions. The document written on natural stone is called stone inscriptions. Slab inscriptions and pillar inscriptions are the later written on the human processed stone such as slabs and pillars [2].

Ancient Marathi character recognition from stone inscription is a challenging problem in pattern recognition [1, 5]. This is because of the large variation in writing style of individual. Robust feature extraction method is essential to improve the performance of Ancient Marathi character reconstruction system. Due to the presence of background and other noise, the characters in many ancient inscriptions are damaged and therefore there is a need to recognize each character and convert it into readable form.

Marathi script:

Marathi is an Indo-Aryan language spoken by around 83.10 million Marathi people in Maharashtra, India. Among all the spoken languages in the world, Marathi language is having 10th rank in the world. Also Marathi language is having some old literature. Marathi is one of the Prakrit languages which are developed from Sanskrit. Marathi language first appeared in the 11th century in the form of stone inscriptions. Since from the 13th century to the mid-20th century, it was written using Modi alphabets, and from 1950 it was written in Devanagari scripts. Language is used as one of the communication method. The purpose of language is to share and understand the thoughts of other people, whereas script is a collection of characters of two or more languages.

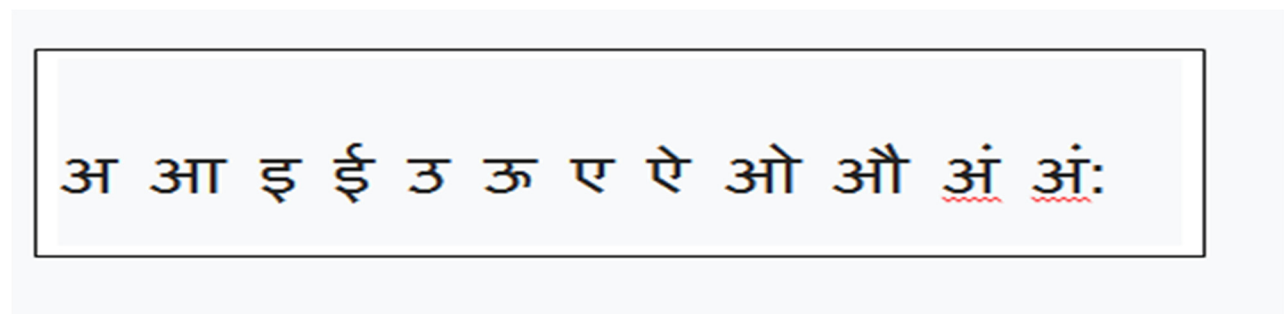


Fig 1. Marathi Vowels

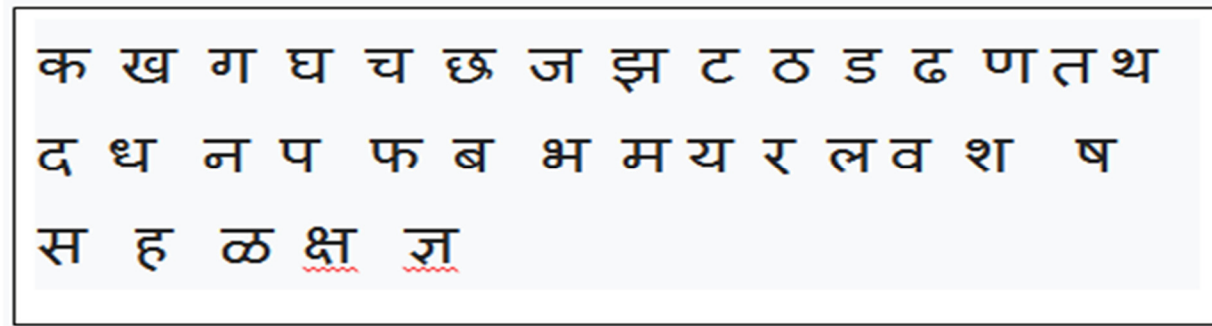


Fig 2. Marathi Consonants

१	२	३	४	५
एक	दोन	तीन	चार	पाच
६	७	८	९	१०
सहा	सात	आठ	नऊ	दहा

Fig 3. Numbers

Representing language in visual form is called writing. Writing uses a set of symbols to represent the sound of speech. The writing system is classified into two types i.e. consonants and vowels. Marathi is written in form of Devanagari scripts. Marathi consists of 13 Vowels, 36 consonants and two modifiers [1]. Now Marathi vowels are updated as 14 so now Marathi Barakhadi is called Chaudakhadi. The vowels are shown in Fig a), and Fig b) shows Consonants.

Challenges in Ancient Script Recognition:

In the ancient Marathi script recognition problems are due to overlapping characters, broken characters, character touched with another character, complex structure of character, an order of symbol variations, stroke order variations, variation in direction, skewed characters, size of alphabets, the intensity of uneven characters, large background noise, same foreground, and background. Some basic challenges are discussed below.

➤ Overlapping Characters:

Ancient Marathi scripts are human written so there is a possibility to overlapping of characters. The problem of overlapping of characters in recognition is solved, the To solve the problem of overlapping of character problem using segmentation

➤ Broken Character :

Broken character means partially vanished or damaged character. This may happen because of rainfalls and other resources and also it may happen during the preprocessing stage.

➤ Character Touched with other Characters:

The writing styles of persons are different. So there is the possibility to overlapped characters. The recognition of overlapped characters is a very difficult task.

➤ The complex structure of Character:

It may be two-dimensional structures. It is also known as matras or vowels arise around consonant, character or several components.

➤ Order of Symbol Variation:

The writing of consonant and vowel has a phonological order for their occurrences. Matra in Marathi is before a base consonant, so it occurs left to it.

➤ Stoke Order variations:

Stroke of characters may differ when writing the character. For example, two matras may be written partially, and completed after the base component is written

➤ Variation in Directions:

The ordering of stokes is varied within a symbol. The stoke order, number and direction variation are high. Marathi characters and constitute is a central challenge in online recognition of Marathi scripts.

➤ Size of Alphabets:

Most scripts are made up of large characters. Due to the internal graphics structure of these characters, split and conquer recognition option is more feasible. Combination of consonant and vowel creates a new symbol. This symbol cannot be segregated with original characters.

➤ Large Background Noise:

There is possibility of addition of noise in the image at the time of image acquisition. Most of the ancient scripts have large background noise because of variation of background. Removal of background noise is a challenging problem.

➤ Same Background and Foreground:

Many of the ancient script has the same foreground and background. Preprocessing is a very difficult task in such cases.

Ancient Script Recognition:

From the past few years researchers are taking lot of efforts on character recognition. The task of character recognition is not very simple. The character recognition is classified into two types online recognition and offline recognition. Each type may require separate hardware and recognition algorithm. In online character, recognition computer recognizes the symbol as they are written. Offline character recognition is performed after writing or printing is completed.

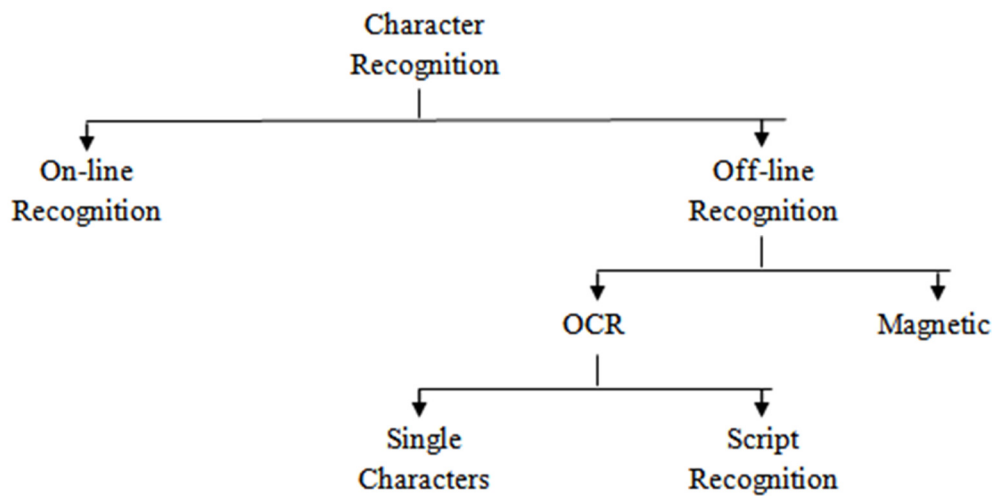


Fig 4. Character Recognition Types

Nowadays the problem of script recognitions using digital devices is a very active research area. Script information is acquired in two forms online and offline. Offline system use scanner digitizer to transfer the image to the computer. Recognition process includes the following steps

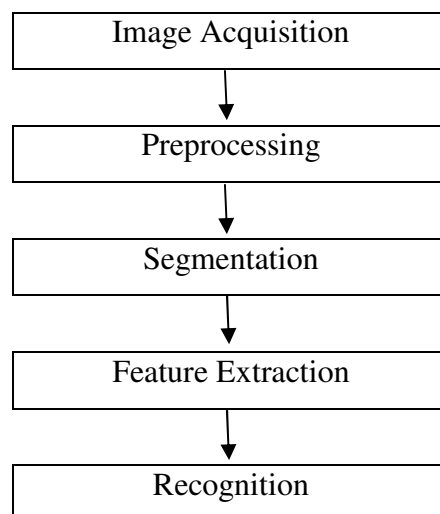


Fig. 5. Text Recognition Steps

The preprocessing step includes conversion of grayscale image to binary image, removal of noise, thinning and thickening, skew detection and correction. The actual preprocessing start from the binary image, Binary image separates foreground pixels from background. In this process the threshold value is selected and the value above threshold is white and below threshold is black. The acquired image may contain noise, so it is required to remove noise from this image. Commonly low pass filters are used to remove noise and forwarded to post-processing. After removing the noise, image is thinned to extract features. This information is used for further analysis and recognition [7]. Segmentation stage includes segmentation of text into word, line, character etc. The final stage is feature extraction, selection and classification.

Literature Surway:

Many researchers are interested in the recognition of ancient documents because it is now one of the challenging research areas. This interest is increasing because the ancient document provides very rich information of Indian history. There is no automatic method to read text from the ancient Marathi script with good results [5] and the more robust OCR (Optical Character Recognition) systems may fail in the ancient script recognition

There are many difficulties to read and recognize ancient Marathi scripts like overlapping characters, broken characters, and one character touched with another character, complex structure of characters, and order of symbol variations etc. While writing there may be variation in the curves of characters, this creates the complexity in recognition of characters. Proper choice of convenient parameter is a very important step in script recognition. Another problem is the different handwriting style of different or the same people. For such variation recognition system is must be robust.

Previous Script recognition systems are based on statistical methods. Bonzinovicand Shrihari (1989) invented a multi-tiered approach for offline cursive script recognition. The main problem of script recognition is the transformation between levels of representation. The first step is input image is smoothed and slant correction is applied to it. The horizontal reference line is located. A minimum in y component is used for segmentation. And the further process is done. This system got accuracy is in between 50% to 75% [9].

Kundu et al (1889) used Hidden Markov Model (HMM) for word recognition and used 40 features to identify rotations translation and size. Vector quantization is used to identify a set of vectors from 2500 letters. Same character shape collects together in this approach. These classes are stated word level in HMM [8].

In paper [12] cost-effective thresholding algorithms used to extract binary image character from the machine. For binary representation, such type algorithms are used. This algorithm is used to identify whether point is converted into a binary one or not. It is also useful in character extraction from a binary image. The first algorithm is a nonlinear. Adaptive procedure is implemented with minimum hardware. And the second approach is towards specialized high volume applications.

S. RajaKumar, Dr V. Subbiah Bharathi proposed a novel non-uniform slant correction preprocessing technique for the improved accuracy of recognition of ancient Tamil text. Local slant correction is implemented by using a global optimization problem. For global optimization slant angle is used. Slant angle correction technique is nothing but average slant angle estimation and corrected by the shear transformation. Accuracy of this algorithm is tested on validation and test set. Base Line result on validation is 78.2% and the test result is 84.5%. The result of Non-Uniform slant on validation is 80.5% and on test 85.8% [13].

L.Sumalatha and B.Sujatha proposed "A New Approach for Recognition of Mosaic Textures by LBP Based On RGB Model". This method of recognition is based on the local binary pattern. The properties of local texture image and their histogram are very powerful texture feature. The local Binary Pattern(LBP) is based on the probability of occurrences of elementary Binary patterns (texels). The features are computed from each band of isotropic colour LBP matrix for recognition of stone texture. The obtained results are promising and show the possibility of efficiently recognizing complex products based on texture. Based on LBP four texture classes are created. The recognition success rate of four classes is Brick 22.25%, Granite 26.85%, Marble 31.85% and Mosaic 92.45%[14].

In paper[15] focus is on developing applications with OCR functionality to identify Sinhala inscriptions. For that, the Artificial Neuron Network (ANN) and Convolutional Neuron Network (CNN) are used. This method evaluates the recognition rate of two technologies which was performed on train data and test data. CNN result is best on OCR.

Qixiang Ye, David Doermann presented a paper that analyzes and compares technical challenges method and the performance of text recognition and detection in the color image[16]. Text recognition converts the image into strings. In previous research, word recognition is a central part of text recognition.

Shuping Liu, Yantian Xian, Huafeng Li, and Zhengtao Yu introduced a novel text detection model based on MCA and sparse representation. It provides two good text detection results. First is enhanced power of text reconstruction and used the MCA based method to detect text in the reconstructed text image. The practical approach in this paper increased the performance of text detection [17].

Dr Antony P J, Savitha C K presented handwritten character recognition approaches. The proposed system empowers machine mapping of Kannada Unicode structure. Image processing techniques such as template matching, machine learning techniques such as Bayes decision rule based on the statistical classifier. Artificial Neuron Network [18], support vector machine, multiple combinations can be used for classification and recognition of ancient character recognition. Multiple classifier combination is based on blend classifier where every classifier ids trained.

Classifying ancient manuscripts based on handwritten style is a very important role in the field of paleography [19]. Recognizing the handwriting style in Arabic manuscript helps us to find the origin. And also find the date of the manuscript. Both Gabor filter and Local Binary Filter are used to extract features from the letter. Selected features are sent to Support Vector Machine(SVM) classifier[20]. The images are collected from Qatar National Library (QNL). This method is proposed by Kalthoum Adam, Somaya Al-Maadeed.

Ancient scripts are multi oriented and also required much effort to recognize it. This problem is solved by Single Layer Hierarchical Graph Neurons. The SLHGN is already implemented for single-cycle memorization and recall operation. This scheme increases the number of stored patterns, The method was presented by Benny Benyamin Nasution Computer[21].

Neha Gautam, R.S. Sharma, Hazrati Garima invented a Handwritten Text Recognition Method. The Handwritten Recognition Method is playing an important role in deeply rooted writing [22]. These displays need of ancient scripts to be recognized and Ariyaka is taken base script and recognized by OCR Classification with an accuracy of 85.73%.

The hybrid model for recognition is developed for 30 characters of different centuries. Some characters are not discovered. The age identification and classification of characters by the hybrid model is satisfactory. This model is easily extended to Indian languages. Script Translation is also done by this model. This model is invented by K. HarishKashyap, Bansilal, P. ArunKoushik [23].

A simple method for recognition and translation of ancient Tamil text inscriptions is done for identification of Tamil character. Tamil stone inscriptions are recognized and translated using LabVIEW. The images of Ancient Scripts are segmented by using the segmentation method. The optimization techniques PSO, DPSO, FPSO are used for the segmentation process. The proposed method is simulated under Matlab and Lab view[24].

Sonika Rani Narang, Manish Kumar Jindal, Pooja Sharma proposed system for recognition of ancient Devnagari scripts.[25] Two feature extraction techniques viz.DCT (Discrete Cosine Transformation) zigzag feature and histogram of gradients are used to extract features of Devanagari script. For recognition three classification techniques are used. There are SVM (Support Vector Machine), Decision Tree and Naïve Bayes. The database is collected from various libraries. The recognition accuracy using SVM classifier is 90.70% with DCT zigzag feature vector of length 100.

Ancient Sinhala script recognition enables the archaeologist to reveal historical event in ancient Srilanka. The manual method of character recognition harms future research. In the research K.G.N.D. Karunarathne, K.V. Liyanage, D.A.S. Ruwanmini, G.K.A. Dias, S.T. Nandasara[26] developed an application with OCR functionality to recognize ancient Sinhala script. This method focus on ANN (Artificial Neuron Network) and CNN(Convolutional Neuron Network). The CNN has better result over OCR application.

Rajkumar S., Dr.Subbiah Bharathi V invented Ancient Tamil Script Recognition System to extract character or components containing stroke in various directions. The length of the structuring element is the threshold to 70% of the distance between the median and baseline of the word image. The proposed algorithm is inspired by a simple observation over different languages.

Text Recognition is useful for computer vision, License plate recognition, and ancient script recognition [27]. The text may be written on any type objects like wall, stone etc. The MSER (Maximally Stable External Region) can detect almost all character from an image with low quality.

In [28], the reconstruction of Brahmi and Hoysala Noise-free languages are considered. Brahmi training set consist of the base as well as compound characters. The recognition result of the Brahmi script is better than the Hoysala Script. These scripts are studied by Soumya A and G Hemantha Kumar.

H.S. Mohana, Navya. K, Rajithkumar. B. K, Nagesh. C, introduced Kannada character extraction method. The SIFT algorithm extracts invariant features from images and most widely applied to computer vision problems. The images matching the character feature is achieved more accuracy. It has required less time for computation. So the SIFT Algorithm is used for Character Matching of stone inscription. Kannada Scripts are in both horizontal and vertical direction. Matched images are restored and send for further processing [29]. The accuracy of this algorithm is 89.5% with 15 sec. computation time. The extraction experimental result of the pixel matching approach obtains a similarity-based retrieval rate of 72.5%.

Stone inscriptions are a source of reshaping history. They have importance in human because they act as a resource of history. The characters are changed over centuries from another character. So reading ancient character is very difficult. A person with knowledge of ancient characters can read scripts. Sachin S Bhat, H.V. Balachandra proposed a method to identify various ancient Kannada scripts using advanced recognition algorithm. Proposed algorithm involves various methods like image acquisition, noise removal, and segmentation of character set, feature extraction, classification and recognition of segmented character. This system is proposed for the prediction of era characters. Kannada script of various periods referred to as test characters. These characters are automatically sampled from the script, and matched with various characters of scripts. The classifier is tested on samples of Kannada characters [31].

Manjunath Aradhya V and Hemantha Kumar G invented a recognition system which uses low dimension feature representation with enhanced discriminatory power. [32]. PCA (Principal Component Analysis) and neuron network are used for the recognition process. The combination of PCA and neuron network is used for character recognition. The PCA is a dimension reduction technique based on a component of multidimensionality.

The historical document image contains noise due to degradation, faint ink strokes, background images, ageing of palm and so on. After preprocessing the input image is selected for conversation. The feature extraction is playing an important role in the recognition process. The method proposed in [33] uses HOOSC (Histogram of Orientation Shape Context) feature

extraction. ANN (Artificial Neuron Network) for classification feature extraction method used for other languages. HOG (Histogram of Gradient) is another classification method. The proposed method by Amrutha Raj V, Jyothi R L, Anilkumar A gives 96.4% accuracy [33].

The use of PCA and Radon Transform is helpful to increase the efficiency of character recognition. Radom Transform with PCA is a very fast and efficient method for character recognition. The Radom Transformation character can be rotated with any angle, so it is useful for identification of characters. The Radom transformation gives a better result in the presence of noise. The accuracy of the proposed algorithm is 85-95% with 200 samples. This method is proposed by Purnima Kumari Sharma, Mandira Deori, Balbindar Kaur[34].

The digitization of inscription is the greatest challenge. The inscriptions present history and culture of ancient periods. OCR system is used to recognize the ancient text of Kannada scripts [35]. The results of the system were designed for segmentation and recognition.

Conclusion:

Ancient Marathi Character Recognition is a very interesting and challenging research area. This research is very useful for Archeology related people. The main aim is to provide faster, automatic character recognition with good accuracy. The main task of ancient script recognition is to remove noise and some preprocessing applied to it. Ancient Script images contain large background noise. The foreground and background of the ancient script are nearly the same. Therefore many noise removal and preprocessing techniques is not much successful. In the recognition of ancient script using OCR, the slant correction and segmentation was applied. The slant correction smoothen image. It is one of the solutions for it. Sometimes online handwritten character recognition is useful. This follows preprocessing, input stroke with a dotted point, stroke after resampling, the result of low pass filtering, and the final result after resampling. Thresholding algorithms are used to extract binary image character. A novel non-uniform slant correction preprocessing technique is used for improving accuracy of recognition of ancient Marathi Scripts. A new approach is for Recognition of Mosaic Textures by LBP Based on RGB Model. This method of recognition is based on the local binary pattern. The properties of local texture image and their histogram are very powerful texture feature. The local Binary Pattern (LBP) is based on the probability of occurrences of elementary Binary patterns (texels). A novel text detection model based on MCA and sparse representation. it provides two good text detection

results. Classifying ancient manuscripts based on handwritten style is a very important role in the field of paleography. Ancient scripts are multi oriented and also required much effort to recognize it. This problem is solved by Single Layer Hierarchical Graph Neurons. The use of PCA and Radon Transform is helpful to increase the efficiency of character recognition. Radon Transform with PCA is a very fast and efficient method for character recognition.

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