ICA ALGORITHM FOR IMAGE ENHANCEMENT AND IMPROVEMENT OF WORD AND CHARACTER RECOGNITION IN EPIGRAPHS

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Abstract
Epigraphs are important sources for reshaping the history. They tell about the culture, art and social status of several generations. Main problem arising during the digitization of such epigraphs is its clarity. Epigraphs have eroded over time, they have lost their original shape, color and texture. Distortion and hard distinguishing between letters over the background creates problem to identify the text. There exists hardly few methods to enhance such images. Even such methods too fail to extract text from the background. Hence we propose different types of Independent Component Analysis algorithms which separates the text from stone depending on its characteristics. Independent analysis method separates the foreground object, background object and noise images based on the dependent components of RGB. The proposed method improves word and character recognition accuracies of the OCR system.
Index Terms: ICA, OCR, Epigraphs, Image Enhancement.

I. INTRODUCTION

Kannada language, one of the 5 ancient Dravidian languages has a history of more than 2000 years. In this period Karnataka was mainly ruled by many dynasties starting from Kadambas, Rashtrakutas, Gangas, Chalukyas, Hoysala and Vijayanagara empire. Rich heritage of the empires have been carried over generation through the manuscripts and historic writings. The first written record in Kannada can be traced back in the time of Ashoka's Brahmagiri edict(3rd century B.C) whereas Halmidi inscription(4th century A.D) of Kadamba's is treated as the first stone inscription in Kannada. These inscriptions generally found on stones, temple walls, coins, palm leaves, pillars and copper plates. Analysis of these inscriptions is very important to through light and to understand the history, culture, socio-economic status, administration and literature of that period. Epigraphy is the art of identifying the inscriptions on rocks, plates, palm leaves etc. And Palaeography is the study of ancient inscriptions and the practice of deciphering and reading of historical manuscripts. Palaeographer must have the knowledge of the language, corresponding text of that period and various styles of handwriting and customs which were in use.

Palaeography is the study of ancient handwriting and the practice of deciphering and reading historical manuscripts. The palaeographer must have the knowledge of the language of the text and the historical usages of various styles of handwriting, common writing customs, and scribal abbreviations. Prediction of the period of a given ancient script is a follow-on member of an ancient script recognition system and can be used as a component of the OCR system for ancient scripts. This knowledge can be used by archaeologists, historians and palaeographers for further explorations. Any language can be written in any script. Presence or absence of a script for any language is not an impedent or a hurdle for the language. There were three different varieties of ancient scripts from which the current 20+ different scripts of present day in India have been evolved. They were Indus valley script, Brahmi and Kharoshti scripts. Scripts of all modern languages have been developed from one of the scripts over centuries.

Kannada script has been used to write in Kannada language. Kannada which belongs to the Dravidian family is the official language of the state Karnataka and one of the most ancient languages of India with a long historical heritage. Their earliest records date back to around second century BCE and Kannada script has developed gradually from the ancient script o Brahmi while it has undergone several modifications, twins and turns. Linguists have marked the evolution of Kannada script in three different phases. First, the 'Halegannada' started with the Halmidi inscription of 4th century in the Kadamba's era covering the time period of almost 8 hundred years. Though first written records of Kannada was found in the era of Maurya's which dated back to 3rd century B.C is generally treated as Pre-ancient Kannada. 'Halegannada' gradually developed into 'Nadugannada' with different changes and evolutions in script under the rule of many dynasties from Gangas to Rashtakutas to Chalukyas. 'Nadugannada' in the era of Hoysalas, Vijayanagara and Mysore dynasties over five centuries has undergone many changes so far which is now categorised as 'Hosagannada'.

II. LITERATURE SURVEY

Digital imaging or digital image acquisition is the creation of digital images, such as of a physical scene or of the interior structure of an object. The term is often assumed to imply or include the processing, compression, storage, printing, and display of such images. The stored image is then used for further processing. The image acquired should be of high resolution and good quality. The image should not tilt in any angle and all character should be clearly visible.

Enhancement is the process of adjusting the digital image so that result are more suitable for display and further image analysis. The problem encountered during digitization and preservation of inscriptions such as perspective distortion and minimal distinction between foreground and background. Hence enhancement is necessary to extract foreground object over background object. If background and foreground has same color then we use ICA algorithm for enhancement followed by edge detection and dilation. Otherwise we use thresholding followed dilation and morphological operation. The output of the enhancement is binarized image.

III. METHODOLOGY

Enhancement is the process of adjusting the digital image so that result are more suitable for display and further image analysis. The problem encountered during digitization and preservation of inscriptions such as perspective distortion and minimal distinction between foreground and background. Hence enhancement is necessary to foreground object over background object. The different algorithm like NFICA, morphological operations where used for enhancement.

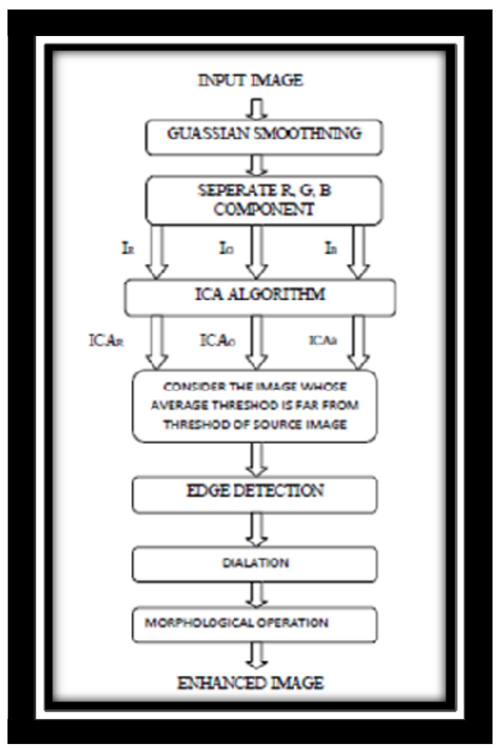

Fig 1: Proposed system

IV. ICA ALGORITHM

Independent component analysis (ICA) is a computational method for separating a multivariate signal into additive subcomponents.

The R, G, B component of image is mixture of foreground, background and noise. Hence it can be considered as dependent component. The independent component i.e. foreground, background and noise can be obtained from ICA algorithm. The equation for dependent component is given by

X=AS…………………………………......(1)

X=3x3 matrix of the dependent component.
S=3x3 matrix of independent component.
A=3x3 mixing matrix.

The equation for independent component is given by

$Y=W^TX=W^TAS$……..…………………..…..(2)

Y=3x3 matrix of independent component and it will be approximate of S.
W=3x3 de-mixing matrix.

Signal mixtures tend to have Gaussian probability density functions, and source signals tend to have non-Gaussian probability density functions. Each source signal can be extracted from a set of signal mixtures by taking the inner product of a weight vector and those signal mixtures where this inner product provides an orthogonal projection of the signal mixtures. The remaining challenge is finding such a weight vector. One type of method for doing so is projection pursuit.

Projection pursuit seeks one projection at a time such that the extracted signal is as non-Gaussian as possible. This contrasts with ICA, which typically extracts 3 signals simultaneously from 3 signal mixtures, which requires estimating a 3 × 3 de-mixing matrix.

We can use kurtosis to recover the multiple source signals by finding the correct weight vectors with the use of projection pursuit. The kurtosis of the probability density function of a signal, for a finite sample, is computed as.

$$K=\frac{E[(Y-\bar{Y})^4]}{(E[(Y-\bar{Y})^2])^2}-3$$

Where $\bar{Y}$=the sample mean of Y the extracted signals. The constant 3 ensures that the Gaussian signals have zero kurtosis, Super–Gaussian signals have positive kurtosis, and Sub-Gaussian signals have negative kurtosis. The denominator is variance of Y, and ensures that the measured kurtosis takes amount of signal variance. The goal of projection pursuit is to maximize the kurtosis, and make the extracted signal as non-normal as possible.

Using kurtosis as a measure of non-normality, we can now examine how the kurtosis of a signal $Y=W^TX$ extracted from a set of 3 mixtures $X=(x1,x2,x3)^T$ varies as the weight vector W is rotated around the origin. Given our assumption that each source signal S is super-Gaussian we would expect:

1] The kurtosis of the extracted signal Y to be maximal precisely when Y = S.
2] The kurtosis of the extracted signal Y to be maximal when W is orthogonal to the projected axes S1 or S2, because we know the optimal weight vector should be orthogonal to a transformed axis S1 or S2.

For multiple source mixture signals, we can use kurtosis and Gram-Schmidt Orthogonalization (GSO) to recover the signals. Given 3 signal mixtures in an 3-dimensional space, GSO project these data points onto an 2-dimensional space by using the weight vector. We can guarantee the independence of the extracted signals with the use of GSO.

In order to find the correct value of W, we can use gradient descent method. We first of all whiten the data, and transform X into a new mixture Z which has unit variance, and $Z=(z1,z2,z3)^T$. This process can be achieved by applying Singular value decomposition to X,

$$X = UDT^T$$

Rescaling each vector $U_i = U_i/E(U_i^2)$ and let Z = U. The signal extracted by a weighted vector W is $Y=W^TX$. If the weight vector W has unit length, that is $E[(W^TZ)^2]=1$, then the kurtosis can be written as:

$$K=\frac{E[Y^4]}{(E[Y^2])^2}-3=E[(W^TX)^4]-3$$

The updating process for W is:

$$W_{new}=W_{old}-\eta E[Z(W_{old}^TZ)^3]$$

Where η is a small constant to guarantee that W converge to the optimal solution. After each update, we normalized $W_{new}=\frac{W_{new}}{|W_{new}|}$, and set $W_{old}=W_{new}$ and repeat the updating process till it converges.

ICA output image can be considered as a foreground, background and noise image. We compared the average threshold of each of these output images with that of original image. The one which is farthest from original image is identified as the foreground as it had only text.

The image is further enhancing using edge detection and then dilation using disc and morphological operation.

V. RESULT

Fig 2: Input Image

Fig 3: Binarized Image

Fig 4: Dilated Image

Fig 5: Enhanced Image.

Fig 6: GUI of Enhancement Output

VI. CONCLUSION

The proposed system here has various modules like Pre-processing, enhancement (involves binarization, Noise removal) and finally classification of input epigraphical documents into their respective eras using Support Vector Machine. ICA method automatically specifies the desired output that provides the optimal enhancement and preserves the mean brightness of the block around each pixel in the image. Experimental results show that the proposed method is very effective for identification Kannada inscriptions characters.

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