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ONE-WORD ANSWER RECOGNITION USING AN EFFICIENT APPROACH

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ABSTRACT:

Over the past few decades, researchers and analysts have been concerned to solve Handwriting recognition problems. The handwritten text requires different applications to recognize its cursive nature. To create an efficient OCR system, it is necessary to pre-process noisy documents, segment the words and characters, and then recognize the written text by identifying it. This research work aims at solving the Recognition problem and explaining how to process the answer script by using an efficient approach. The proposed approach is detailed step by step. the main goal is to choose the right written handwritten answers and to recognize them through the meticulously built tool and by using ML algorithms. Thus built Algol demonstrates how to develop systematic OCR tools using pre-processing, segmentation, and classifiers. The achieved accuracy is 90\% for handwritten Kannada answers.

KEYWORDS: pre-processing, segmentation, classification, word recognition.

Introduction

Although, a great success rate has already been achieved in recognition of automatic printed text. In the current era there is no high accuracy gained for handwritten word recognition. From past duration of time handwritten recognition is an active area in document image analysis, it has vast potential applications. Some of the areas which relates to understanding of text are postal automation, cheque processing, answer script evaluation, automatic form filling in data entry etc... the main aim is to construct a robust and efficient recognition system. the written handwritten characters may be widening in size, unconstrained, slanted, increased in size of a characters, interconnected or overlapped with other characters etc. converting large amount of data is arduous process which bound to be fraught with errors, automated handwritten recognition can drastically take less to convert higher data to text and also provide an architecture for future applications. Recognition of handwritten text is an evolving field of research that surround artificial intelligence, computer vision and pattern recognition. There are two types of handwriting systems online and offline. To progressively implement the applications both types can be used based on user's response. Several methods have been used for the online and offline in the field of handwritten recognition

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[3]. Now also text recognition is considered. In order to convert text to readable form and to recognize it, there are relevant hurdles to overcome due to high variance in styles of Handwriting styles across different people and the low quality of the Handwritten text as compared to printed text. It is an acute problem to solve the many industries like health care, insurance and banking sector [4]. At a Recognition step, a strong and effective enhancement and preprocessing is needed to get a desired Results. Efficiency can be only increased through careful segmentation process. Segmenting is essential to building an efficient OCR system that Recognizes words [31]. Segmentation of Kannada handwritten word into character is also one of the tedious and ongoing challenging task from few decades and as it contains vowels and consonants and apparent mixture of overlapped Ottaksharas, Vyanjanas because of its structured complexity as compared with Latin based languages, Kannada handwritten text is difficult to segment. Moreover, Kannada language has 18511 distinct characters [2], Segmentation of Script into lines, word and characters is of great importance and Handwritten Kannada Script is difficult because the script contains many Modifiers.

Kannada Script has following characterstics:

Kannada is a Dravidian language of India and the administrative language of Karnataka. A linguistically diverse state where Kannada is spoken commonly by the people. It has its own script derived from Brahmi script. Kannada script has base set of 49 characters compromising 15 vowels and 34 consonants. Further there are distinct symbols that modify the base consonants called modifiers [2]. Recognition of Kannada characters is very difficult because of its shape, non-uniqueness, one or more Ottaksharas present below the character, drastic variation in handwritten styles. Example of Kannada handwritten document, answer script are shown in fig 1.

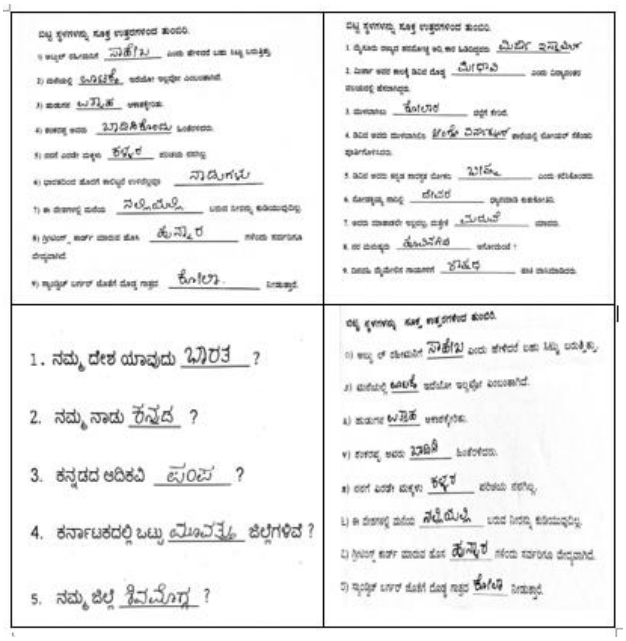

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Figure 1: Samples considered for experimentation.

Challenges in Kannada Handwritten Script

1. Person to person huge changes and ambiguity of strokes and handwritten styles.
2. Due to inconsistent time to time handwritten font may vary.
3. Due to degradation ink smudges present in the document over time.
4. It is difficult to recognize source document because of poor quality.
5. Recognition of cursive handwriting makes separation and it is tedious to analyze.
6. Printed text always easy to understand and to recognize for the system where all the character sits up straight but in the case of handwritten document text can be invariant, different rotation.

The paper is divided into four Sections: The Review of Related Work is presented in section 2. The section 3 provides a brief description of the proposed method. The brief summary of the Results and Discussion of the findings is presented in section 4 and section 5 summarizes the Research work.

Related Work

Recognition of Kannada district names using DTW algorithm is proposed [1], the state Karnataka has 31 districts, from those districts names are written from 60 different writers. To recognize the word, Euclidean, DTW algorithm is applied. to enhance and to preprocess the written handwritten district names. Binarization, noise removal and correction is used. Experimentation results shows considering results. To recognize the word

To Recognize 750 image of Kannada Words [2]. VPP Based Methods Zone Wise Horizontal is used. The Dataset is created in such a manner that it contains 750 image of Kannada language. To train the network neural N/W is used. Features are generated to train the model. Zones are created to treat featured to overcome the dilation and erosion issues. The Systems Wok in such a way that after training and testing through Experimentation Recognition Accuracy is of 97.1\%. To classify and to recognize Feature than Methods is proposed [3], Experimentation conducted on scanned images. A5 model small N/W is used for proposed algorithms. Efficient & robust data transfer is provided by Algorithm. Efficiency is of 80%.

CNN model is used for training & testing Purpose [4], it is divided into two Stages, In the initial stage input document is converted to colour image. In the next Step Noise Removal is processed to denoise the image. In Step 3, To Extract features pre-processing is done to remove Noise. For 77k 99\% Efficiency is produced and for created dataset is 96\%. Recognition of characters for top, bottom, middle is proposed [5], From different age groups and by mouse pen dataset is created. These type of dataset are validated, Segmented and features were Extracted and stored to compare Features. For purpose of Recognition K-Neighbour Classifier is Used. The accuracy

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rate is 92.5\% and for support vector machine for same dataset maximum yielding is 94.35%.

Hidden Markov model is Proposed [6], To develop a Recognition model and to render a suitable data pre-processing stages is involved. To divide each Characters from a word i.e. segmentation process Extraction of word and to segment by which VPP is applied. Baum Welch procedure is carried out to segment. The Procedure follows for 100 trained samples. The efficiency for Built Model is 76%. Recognition of 28 Karnataka District names is proposed [7]. Dataset creation consists of 40 different people handwritten District names are Collected for Experimentation. The Word is Differentiated into Four parts of grids. For better output principal Component analysis is applied to solve classification problems, distance measure techniques are used. The results Obtained is 68%.

K-nearest Neighbour classier is used to classify [8]. Comparison of templates for Recognition purpose by applying correlation method can be seen. To process image and to remove Distortion present in the character Gaussian blur is used. Further, image is segmented into individual single part. If the segmented character is matched with stored image it is calculated on the basis features. The results yield better results.TO Recognize Kannada handwritten Characters [9], hybrid features are used in the editable format the template matching is shown. 3600 samples are collected for Experimentation purpose local and global Features are used for proposed technique. Gained accuracy is 87.33%

In this review paper [10], An algorithm for Kannada character segmentation is presented. A thinning, branch point, and mixture model underpins the proposed method. From touching lines characters are segmented, the proposed method works good for handwritten Kannada words and has shown very well results up to 85.5%. A connected component analysis algorithm is proposed [11], segmentation of handwritten characters and feature extraction is carried out by using feature extraction algorithms. For recognition and classification of characters' sv machine classifier is used. Experiments shows that an improved in correctness and validity for segmentation of characters.

Projection profiles and morphological operations methods is proposed [12], Kannada handwritten scripts is segmented into lines, words and typescript. In pre-processing phase organizing and disintegration is done. The main goal is to concentrate on singular content line, the experiments is done on absolutely unconstrained Kannada handwritten scripts. Recognition based on zoning is proposed [13], feature extraction method is used for character recognition and support vector machine classifier is used for classification. Training phase and testing phase is to compare characters. In the pre-processing stage cropping, resizing and noise removal is done. In order to enhance the image, the median filter is used. In the segmentation stage ON pixel and OFF pixel is taken as X and X1, X and X2 to find all the characters in a word. At last classifier is applied which increases the speed of the accuracy and which in requires less memory to store training samples.

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A twelve directional feature extraction technique is proposed [14], data is collected from 25 different writers having different handwritten styles. A feed forward back propagation neural network is used for classification and recognition of Kannada handwritten characters. Morphology and projection technique is to segment the characters. Experimentation is carried out feature extraction method and classifier gives better accuracy rate. Hidden Markov model method is proposed [15], implicit segmentation technique is used to avoid explicit segmentation. To segment characters and to reduce number of classes in a characters HMM method is used. Experiment is conducted on 74k char dataset, to train character gradient based feature is extracted.

Water reservoir and thinning concept is proposed [16], connected component analysis(CCA) algorithm is to detect the components in a word. Character cutting paths are generated based on touching positions, close loop positions, and morphological structure of touching regions. Proposed concept holds best results. Skew detection, correction and segmentation method is proposed [17], bounding box technique is applied to skew angle detection and correction. It is a way to find the extreme corners of text image. Skew correction is done by rotating the document through an angle with respect to horizontal line. Unconstrained handwritten Kannada script is segmented into lines and words. For line segmentation sobel edge detector is applied which lists the points in an image. Experiment is conducted on 40 document images an average segmentation rate 0f 91% and 70% for lines and words is obtained.

Horizontal projection profile and widowing method is proposed [18], to segment and recognize feedback-based approach is applied. The gap between segmentation and recognition phase is fixed by attempting a proposed method. KHTD standard dataset is used and got recognition accuracy of 95.02%.

Recognition of Kannada Handwritten Words is proposed [19], word extraction from answer scripts using machine learning approach is applied, character segmentation by horizontal projection method and segmented character is stored in a flask trained and tested to compare characters. Real-time school dataset is used for Experimentation purpose. The recognition rate is 90%.

Proposed method

Several methods are discussed in this section, including line detection, handwritten answer extraction, character segmentation, and word recognition. Scanned Kannada handwritten answer scripts are collected for automatic answer script evaluation process which involves image acquisition using scanner.

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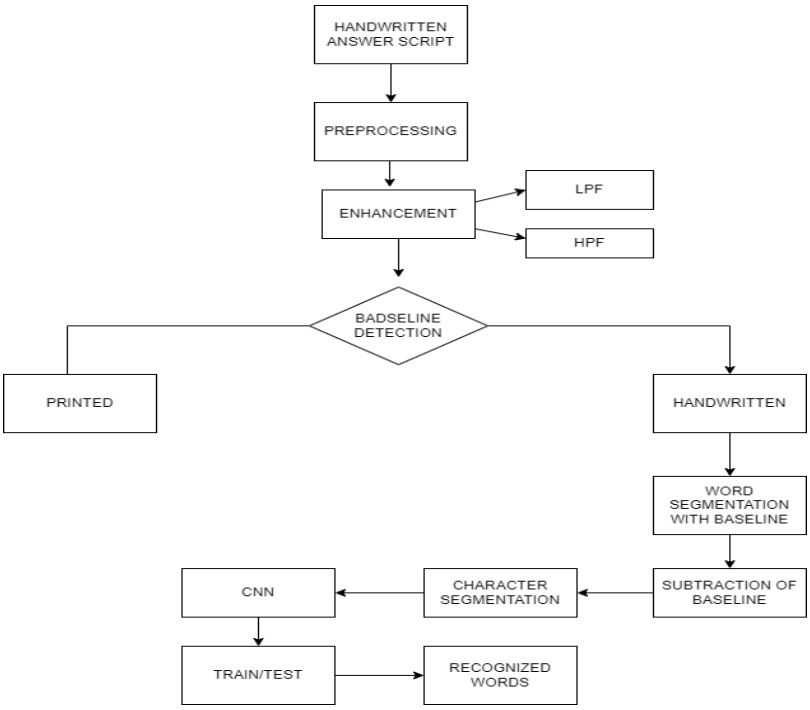

Figure 2: Dataflow Diagram of Proposed Method.

3.1. PRE-PROCESSING

In the step 2, pre-processing is done which contains certain stages to process the document, pre-processing is a stage to eliminate the unabiguties and to remove the uninformative variations in hand-writing styles. The main aim of pre-processing an answer script is to improve the image data that suppress unwanted distortions like ink smudges, noise present while using scanner and to enhance some images features important for further processing, depending on the answer script. Some pre-processing we used are:

3.2. Smoothing

The goal is to smooth the data sets by dividing them into individual segment of the same size. The Gaussian function for smoothing is

$$g(x,y) = \frac{\sum_{s=-a}^{a}\sum_{t=-b}^{b} w(s,t) f(x+s, y+t)}{\sum_{s=-a}^{a}\sum_{t=-b}^{b} w(s,t)} \qquad (1)$$

where w (s, t) denotes the mask elements, a = (m 1)/2, and b = (n 1)/2. If the sum of the mask elements is more or less than one, the result will be brightened or darkened.

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3.3. Dilation

It is a morphological image processing operations. It is a procedure for modifying to geometric structure. Dilate operation is used to remove noise, identify intensity. The operation is performed by using the cv2.dilate() method.

3.4. Erosion

Dilation is very similar to erode, the Neighbour pixels with specified window is examined. Dilation function is applied to remove shades where the handwritten document contain noise. The operation is carried out by using cv2.erode().

3.5. Min and Median

Min method is used to thicker the letter of characters. If the text is lightly written on a document. The function is bitmap. transforms. Minimum (2). Median is most common and fruitful image transformation method. It is used to preserve the edges while removing noise.

3.6. Skew and Slant correction

Skew detection and correction in an image processing became a mandatory in the field of DIP and pattern recognition which takes important role in automation of documentation. Slant is the angle in degrees clockwise from vertical at which the characters were drawn. It is process of the characters in a line or document. Skew and slant is corrected and sent to further stage to get better results.

3.7. Augmentation

To process any real time document or text. It involves conversion of instruction to readable format and to enhance its predictive power and depth of understanding the required information. Augmentation is mainly used when we don’t have sufficient amount of data to train a learning model, this efficacious method can be used.

3.8. Binarization

To normalize a Text and to convert raw data i.e Text to standard information, Binarization plays a vital

role. it is important to process if the text contains unwanted information or distortion. so to preprocess

abbreviations, mistakes are removed by the method. The Formula for the line is Y= MX + C and it can

be mention in such a way that each pair points of image (X, Y) can be represented using parameters r and

r=X cos + Y sin. Horizontal line detection is applied to extract exact handwritten answers and word is segmented with baseline from answer script. In the step 4, subtraction of baseline by using line detection method is used which helps to segment

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word and after removing the baseline, the word is passed to further stage i.e. segmentation.

3.9. Enhancement

Enhancement is a technique to improve any distorted image of low-graded image. The content of an image must be analyzed and understood. so, From the literature we found many image enrich method to compute to increase the quality of the image. The most frequently used method is spatial and frequency domain. As we are processing student written Handwritten Answer script, Enhancement helps system to understand the written answers without any noise. For the purpose of

effective recognition of answers. A proven domain frequency method is used which gives considerable results to move for further stages. comparison of different quantitative methods has been shown in the table 7.

4. SEGMENTATION

A crucial step in the recognition of handwritten documents is the segmentation of a document image into its constituent text lines and words. The segmentation process is a difficult undertaking due to the issues that arise with handwritten papers. These are some examples of the text line segmentation process the variation in skew angles between lines on a page or even inside a single text line, which overlaps neighboring text lines and words touching. Additionally, the prevalence of accents in several languages renders the segmenting text lines. The emergence of challenges in the word segmentation process includes The text line's slant, the punctuation marks present there, and the irregular spacing of words [7]. Vertical Projection Profiles (VPP) [12] can be used to detect perfectly horizontal text lines in an image. VPP is calculated by projecting an image onto a vertical axis and summing up its pixels.

$$VPP = (f(x,y),w)\begin{bmatrix} \sum_{i=0}^{w} f(0,i) & \cdots & \sum_{i=N-1-w}^{N-1} f(0,i) \\ \vdots & \ddots & \vdots \\ \sum_{i=0}^{w} f(M-1,i) & \cdots & \sum_{i=N-1-w}^{N-1} f(M-1,i) \end{bmatrix} \quad (2)$$

It is chosen so that w is small enough to allow linear separation between the text lines and large enough to render peaks in the VPP. [3].

4.1. Word Segmentation

The main aim of word segmentation is to extract whole word image in a handwritten document. It is necessary that word segmentation is very important in a retrieval system. To build a proper character segmentation and to get a good result, line and word segmentation is necessary. There are several segmentation methods available in literature such as projection profile method, connected component analysis etc. Horizontal Projection Profiles (HPPs) are used for word segmentation.

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$$HPP(fx,y)) = \sum_{i=0}^{M-1} f(i,0) \ldots \sum_{i=0}^{M-1} f(i,N-1) \quad (3)$$

An HPP that's Smoothed is obtained by applying an averaging filter with width wf so as to close the gaps within words, but leave the gaps between them open. The accuracy of the segmentation can be measured by using no of strategies that sum to get high results as compared with early experiments. In this paper, methods have been proposed to extract answer and to segment an answer scripts into sentences, words and then finally characters for isolated character. More number of Experiments is carried out to pre-process the image in a systematic manner that consumes less memory required by the model to do further stages.

4.2. CNN

Convolutional neural network is one of the common neural model used for recognition analysis. It consists of number of multiple layers. There are three important layers in CNN they are Convolutional, pooling and fully connected layer. The Convolutional neural network has the advantage of extracting and using features information. For text classification CNN plays a main role in processing structured arrays of data such as images. It vastly used in computer vision and visual application.

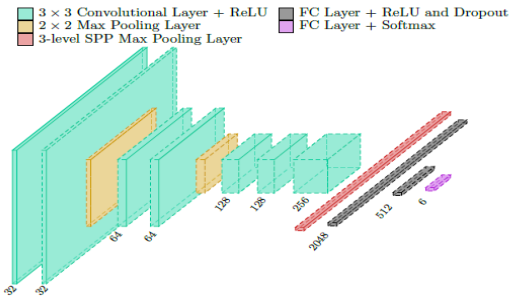

Figure 3. Outline of our CNN Architecture.

1. Configuration of convolution layer is configured for every set of max pooling layers.

2. To implement lateral inhibition normalization layer is added.

3. The epoch is fixed to 100.

4. The batch size is to 100.

For experimentation purpose sequential model is used to build a CNN model. A learning rate of 0.01 and epsilon is set to le-0.8. loss is as categorical-cross entropy. To find metrics accuracy function is used. These are the python code to configure CNN. The model is differentiated into different layers. Layer 1: A 5× 5 filters is applied to extract sub regions of convolution layer and function tanh is used to activate. Model. add (conv2D (64, (5,5), activation='tanh')). Layer 2: A pooling layer is configured with size of

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5× 5 and 5× 5 strides. Model. Add (max-pooling 2D (pool size= (5,5), strides (5,5))). In the next step Convolutional layer is configured as said in the above step. A dropout of 0.5 and flatten layer is added for normalization. Model. Add (LRN2D (alpha=0.1, beta=0.75)). Layer 3: A model of number of classes and Softmax function is added to activate. Model. Add (Dense (numofclasses, activation='Softmax')) In the next stage to compile cross entropy categorical is used and optimizer Adam of lr=0.001, beta1=0.9, epsilon of le -08 is set. CNN approach mainly works in two stages namely training and testing, for training the system dataset used is real-time handwritten segmented characters from Kannada words. Data-set contains set of categorical images belong to 100+classes. Each class consists of 75 handwritten characters. Various pre-processing techniques has been applied that helps to enhance the dataset. The trained images stored in the cnnmodel.h5. Next step is to pass test images pickle and load function is used for test images. A set of test images is passed to compare with trained images, the features of label matches which in evaluates test and train labels. The accuracy is find out by summarize the history at last the loss and epoch is find out and saved in model. Save file.

Algorithm

Input: Handwritten Kannada Answerscript

Output: Word Recognition

Begin

Step 1: Load the Answerscript.

Step 2: preprocessing is done to remove noise. Dilation and erosion is applied to the image.

Step 3: Histogram is constructed for the binarised image.

Step 4: Horizontal and vertical projection profile is applied to segment.

Step 5: Characters is segmented based on x, y, w, h coordinates given using bounding box method.

Step 6: Segmented characters are stored and trained for further recognition stage.

Step 7: Pass CNN to train the characters and test image is passed to compare.

Step 8: Trained image is compared and word is recognized, if the written answer is matched.

End

5. RESULTS AND DISCUSSION

For experimentation purpose, handwritten word recognition dataset is created in such a way that initially questions are formulated from higher school kannada text book syllabus. Questions is opted from 8th, 9th standard. We have formulated 10 questions that is in the form of printed and for all questions baseline is provided at the end of the question, to write answers above the baseline. Experimentation conducted on different cases i.e. case 1: which contains handwritten answers without ottaksharas and which contains ottaksharas, case 2: Real time datasets containing noise as these type of dataset is complicated in the case of word recognition. In this way we have created 1000 documents. All the answer script is written by different students from various schools.

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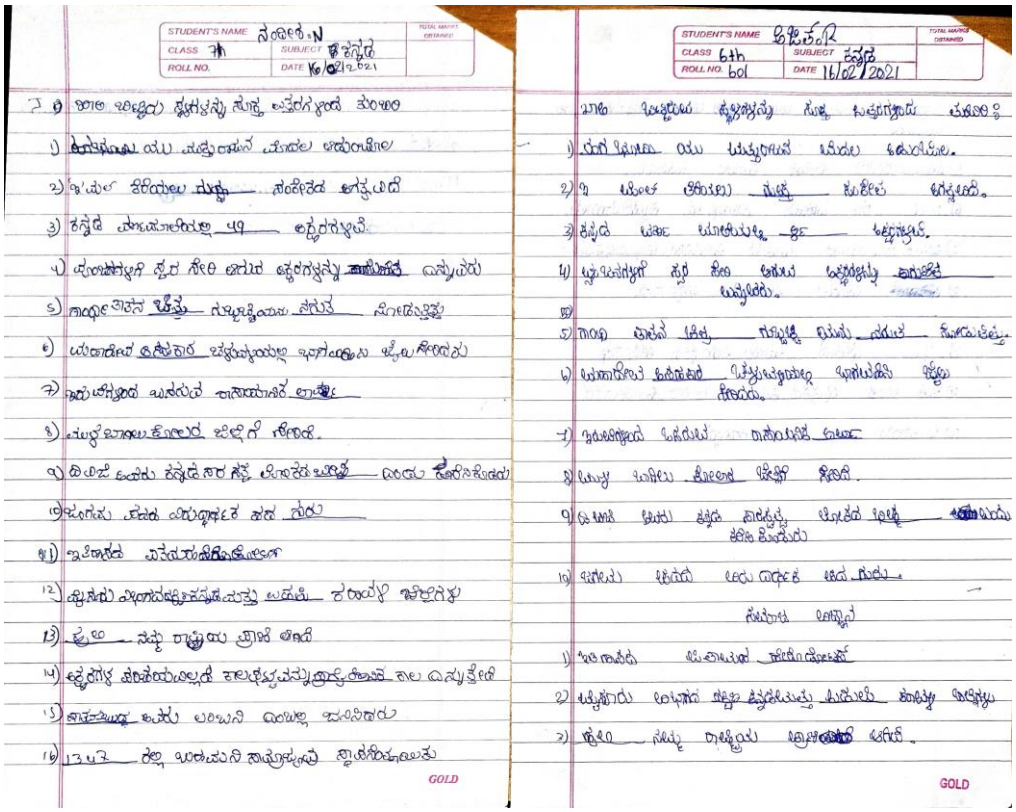
CASE 1: Handwritten Answer Scripts containing both question and answer written in a handwritten type. Answer scripts containing kannada handwritten answer with and without ottakshara present in a word is collected for experimentation from different schools. The main difficulties of the dataset are that due to non-uniqueness and one or more ottakshara present below the character and drastic variation in handwritten styles.



(a) (b)

Figure 4: (a) Answer sheet. (b)Scanned answer Image.

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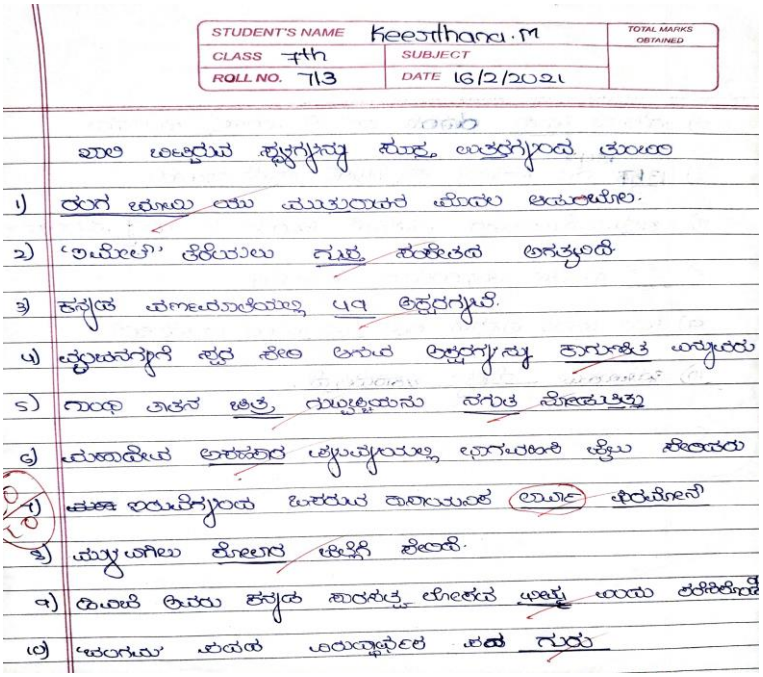
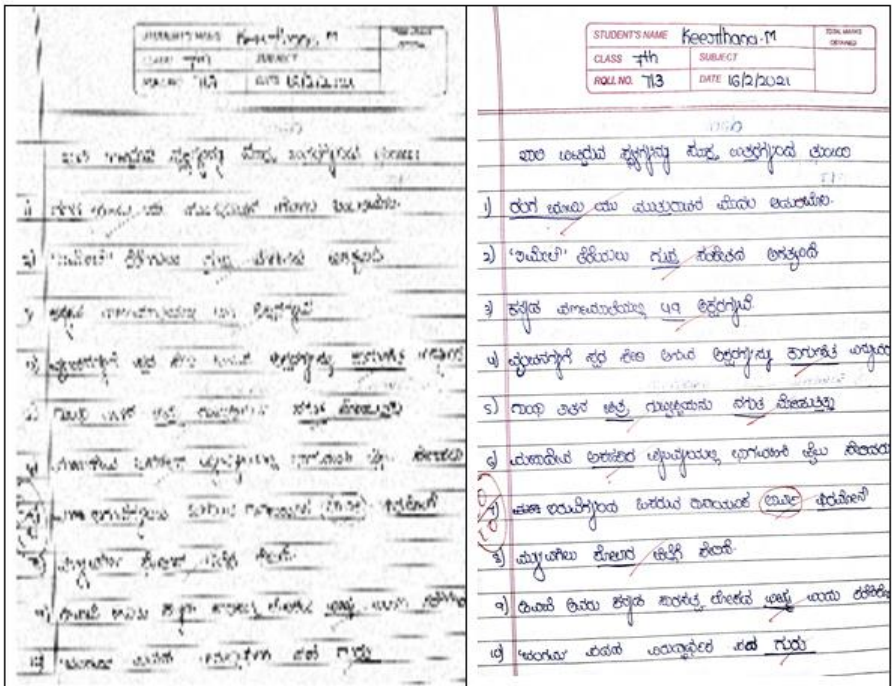


Figure 5: (a)



(a) (b)

Figure 6: (a) Input Image. (b)Output Image.

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Table 1: Quantitative comparison of different approaches.

Methods	Entropy	MC	PSNR	SSIM	AMBE	MSE	NRMSE
HE	16.88	1.0	0.7	0.0	233.27	55337.99	1.0
AHE	21.12	0.95	0.71	0.01	233.03	55225.44	1.0
Gamma	4.6	15.93	29.13	0.99	7.17	78.32	0.04
LogT	2.18	1.0	15.72	0.9	11.84	1744.02	0.18
CS	1.07	1.0	20.01	0.93	13.33	649.3	0.11
LT	4.23	1.0	17.97	0.98	3.21	1038.6	0.14

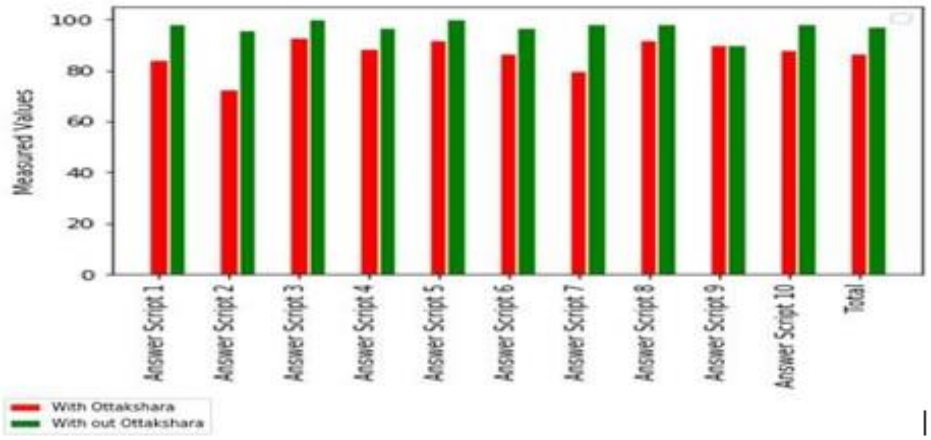

Figure 7: Graph Representing the Results of Both Handwritten Type.

The bar graph 3 shows that the samples ranging from answer scripts 1to10. The number of answers matched by proposed system. The answers ranging from 1,5,7,8 almost coincide with each other which shows high accuracy. For answer script like 1,3,4,9 are doesn't match noticeable result. so, there is a difference in number of answer matched.

CASE 2: Match the following with printed questions and handwritten answers.

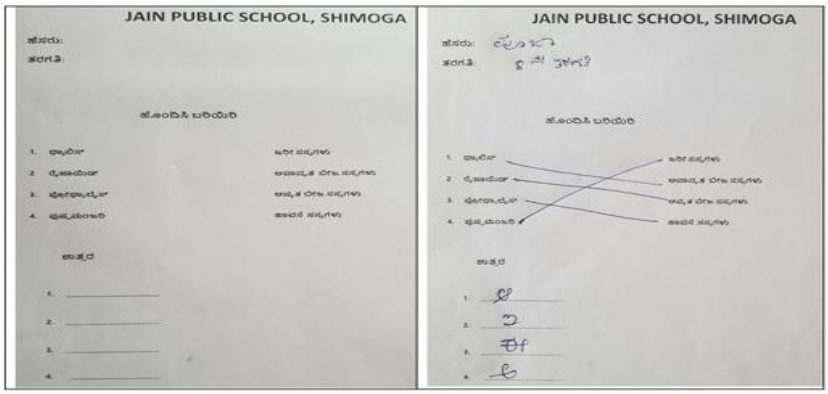

Figure 8: Sample Answer script of match the following.

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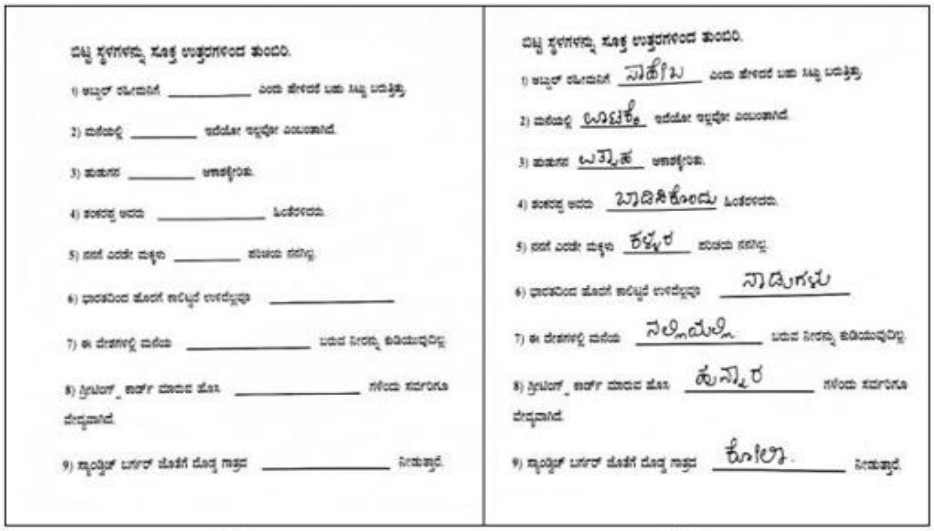
The figure 5 shows sample of match the following where around 200 answer scripts is collected from different schools. In the same way as mentioned above for one- word answer. In case of match the following also. In the step1, noise is removed and line detection method is applied to remove baseline and to extract the answer. The extracted answer is stored and trained. In the last step comparison is done with stored answer and recognition is done on the basis of answer matched.

CASE 3: Handwritten Answer Scripts with ottakshara and Without Ottaksharas.

Answer scripts containing Kannada handwritten answer with and without ottakshara present in a word is collected for experimentation from different schools. The main difficulties of the dataset are that due to non-uniqueness and one or more ottakshara present below the character and drastic variation in handwritten styles.



(a) **(b)**

Figure 9: (a) QP. (b) Answer1 .

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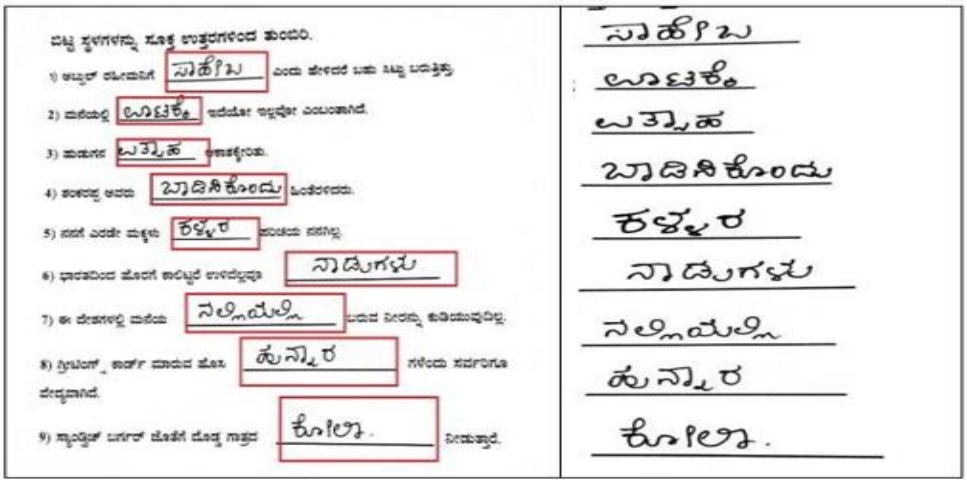
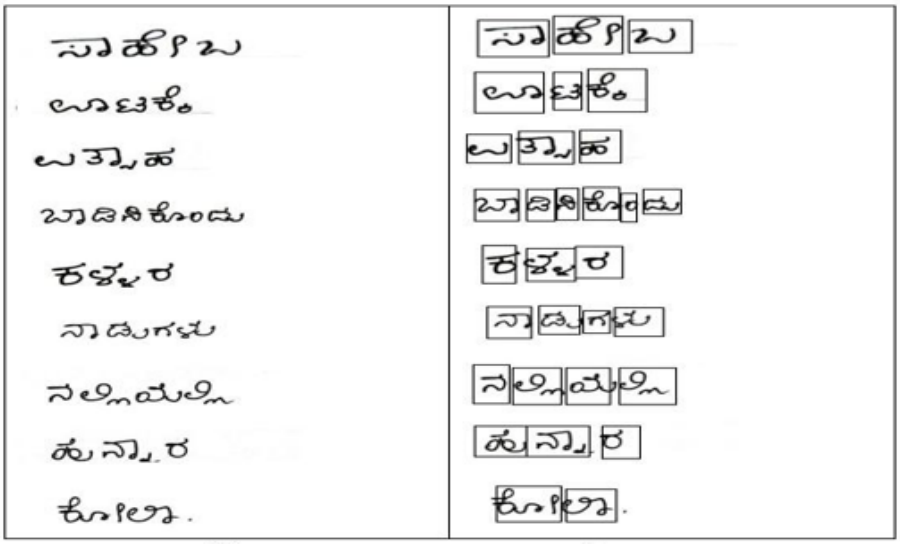


(c) (d)

Figure 10: (c) Detected words. (d). Extracted answers



(e) (f)

Figure 11: (e) Baseline removed. (f)Each character segmented.

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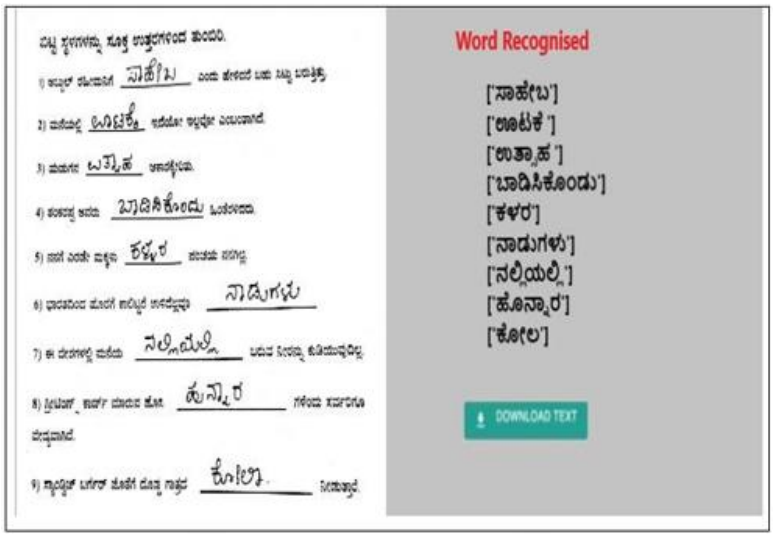

(g) (h)

Figure 12: (g) Real-time QA. (h)Digital converted Image.

Here, combination of questions is in the form of printed and baseline is provided to write the answer above the horizontal line and answers is in a handwritten format written by different students, which consists of around 500 scripts of Kannada language. To prove the effectiveness of the proposed method, teachers need to evaluate and recognize answer scripts with handwritten answers written by more students. The extraction of answers from baseline and to segment the character individually is a challenging task. Word recognition uses machine learning and CNN. The obtained word recognition accuracy is 98.6%.

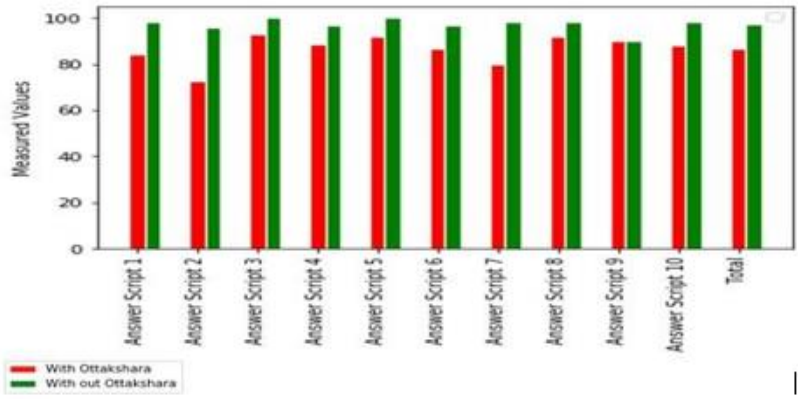

Figure 13. Graph Representing the Results of Both Question & Answers Written in a Handwritten Type.

Graph shows that the samples ranging from answer scripts 1to10. The number of answers matched by proposed system. The answers ranging from 1,5,7,8 almost

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coincide with each other which shows high accuracy. For answer script like1,3,4,9 are doesn't match noticeable result. so, there is a difference in number of answer matched.

Table 1. Results of built method is compared with the existing method.

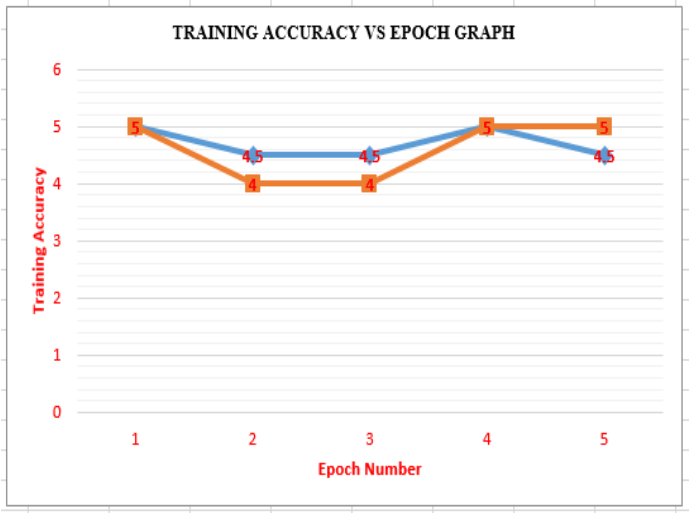

Figure 14: Graphical representation of training accuracies for each epoch.

Qualitatively, the results of word Recognition stages are promising. The achieved accuracy represents An impressive level of accuracy, even when presented with different Kannada handwritten datasets, for such a complex problem.

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SL NO	WORDS	NUMBER OF ANSWERS	RECOGNIZED ANSWERS	RECOGNITION RATE	AVERAGE
1	ಸಾಹೇಬ	200	185	92.5%	90.0%
2	ಒತ್ತಕ್ಕೆ	160	150	93.45%	
3	ಉತ್ಸಹ	150	142	94.66%	
4	ಬಾಡಿಸಿಕೊಂಡು	150	125	83.33%	
5	ಕಲ್ಲರು	150	128	85.33%	
6	ನಾಡುಗಳು	150	148	98.6%	
7	ನಲ್ಲಿಯಾ	150	122	81.3%	
8	ಹೊನ್ನರ	150	122	81.3%	
9	ಕೂಲಿ	160	150	93.45%	
10	ಒತ್ತಕ್ಕೆ	150	125	83.33%	

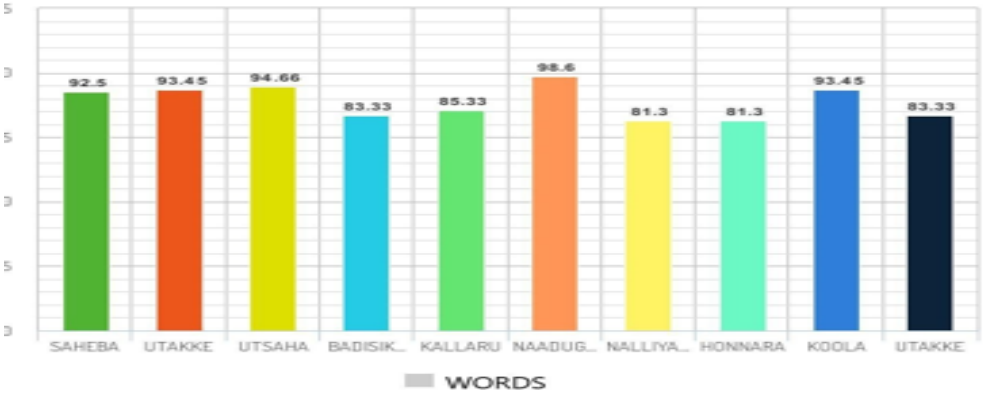

Figure 15: Recognition Accuracy of Handwritten Kannada Word.

6. CONCLUSION

A technique for extracting answers from scripts and identifying Kannada answers has been put forth. For better results the bounding, detection method, extracting the features is used to train and test hand-written word, CNN is used. Experimentation is conducted on our own dataset of 1000 single-word answer scripts, and the approach produces considerable results for word recognition. Overall accuracy of 96.12% is obtained.

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