

# Copper Plate Image Character Recognition System Using Extreme Deep Learning Machine

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## Abstract

Tamil is conceivably the oldest language on the earth, spoken in Tamil Nadu, South India, which is assimilated from Brahmi Script. The primary wellspring of data about history are the stone engravings. OCR helps in digitizing Tamil contents from the old era to the most recent, making its access simply through Internet. Antiquated Tamil character acknowledgment from stone engraving is a test because of the huge inconsistencies of composing style. Efficient feature extraction and selection is basic steps to understand the Ancient Tamil character recognition framework. The principle objective for an OCR is to build the recognition rate and to adapt to the low quality of scanned images. Investigating the best feature extraction methods and choosing a proper selection algorithm and classification techniques lead to prevalent recognition precision and low computational overhead. This paper presents, first time, a new methodology by adopting two approaches. The first is Extreme Deep Learning Machine (EDLM), algorithm for classification that has a short processing time. Also, EDLM keeps away from numerous troubles looked by gradient based learning strategies, such as learning epochs and local minima. The subsequent calculation is a Statistical based feature selection that has better convergence and spread of measures. EDLM accentuates non-dominated elucidations and explicit diversity preservation mechanism. Comparison with the experimental results of other methodologies revealed the proficiency of the proposed system and demonstrated that the feature selection approach increased the accuracy of the classification process.

**Keywords:** Copper Plate character recognition (CPCR), Region Of Interest (ROI), Extreme Deep Learning Machine (EDLM), Extreme Learning Machine (ELM), American Standard Code for Information Interchange (ASCII)

## I. Introduction:

Copper Plate Character acknowledgment upgrades the handling of copper plate pictures by permitting you to naturally perceive and extricate content substance from various information fields.

Tamil character segment from Copper plate tamil content is a significant task for recognition System. Segmentation is the technique for partitioning the image into content lines, words and afterward into characters which are especially helpful for classification. Sectioning character from Copper plate original copy is very challenging, while the characters structure and substance contrast altogether. The accuracy of the OCR framework relies upon the segmentation. On the off chance that the characters are sectioned accurately the recognition framework gives best outcomes. Regions or portions are partitioned from a picture in segmentation stage. Predominantly segmentation, attempts to separate fundamental part of the content, which are unquestionably characters. This is attractive in light of the fact that the classifier perceives these characters just [1]. Segmentation stage is likewise basic in adding to this mistake because of contacting characters, which the classifier can't

effectively perceive. Indeed, even in great quality reports, some close by text style contact each other because of ill-advised checking goals [2].

Tamil is a customary language which is extensively spoken in most piece of the south India. There are 12 vowels, 18 consonants and one exceptional character present in remarkable Tamil Script. Every vowel joined by unadulterated consonant to make an estimation of 216 consonant-vowel (CV) blends. These signify a sum of 247 Tamil characters. Tamil Language alphabetic framework is gotten from the ancient Brahmi content which fills in as a base for the greater part of the Indian dialects. The vowels and consonants of Tamil letters in order set are given in the table 1 and taxonomy of classification techniques given in table 2:

Table 1 Modern Tamil Character Set

<b>Vowels</b>	அ, ஆ, இ, ஈ, உ, ஊ, எ, ஏ, ஐ, ஒ, ஓ, ஔ
<b>Constants</b>	க, ங, ச, ஞ, ட, ண, த், ந், ப், ம், ய், ர், ல், வ், ழ், ள், ற், ன்
<b>Grantha</b>	சக்ஷ, வ்ஷ, ஸ்ரீ
<b>Aytam</b>	ஃ

A very much created manually written character Recognition framework is as yet not accessible for Tamil language. The principle purposes behind this are: 1. Tamil Language has an extremely huge character set 2. Letter structure is unpredictable 3. Because of complex letter structure, composing styles of individuals fluctuate altogether 4. There is no Tamil character database that exists for testing purposes in the open area.

The vast majority of the recognized verifiable copper plate scripts are principally influenced by atmospheric environment; particularly with long haul introduction of articles over earth, organic defilement, and so on. The negative impact is seen for the most part in outdoor atmospheric environments[3-5].

Table 2. Taxonomy of Classification techniques

<b>Algorithm</b>	<b>Advantages</b>	<b>Disadvantages</b>
Support Vector Machines (SVM)	<ul style="list-style-type: none"> <li>• Flexible to handle classification and regression tasks of varied complexities.</li> <li>• Automatically select their model size.</li> </ul>	<ul style="list-style-type: none"> <li>• SVM is not very scalable in dealing with large data.</li> <li>• Long training and testing time.</li> </ul>
Artificial Neural Networks (ANNs)	<ul style="list-style-type: none"> <li>• Adaptive, robust, non-linear.</li> <li>• Generalization.</li> <li>• Can learn multiple outputs at the same time.</li> </ul>	<ul style="list-style-type: none"> <li>• The training time is relatively long.</li> <li>• Susceptible to local minimum traps.</li> <li>• Cannot be retrained.</li> </ul>
Fuzzy Cluster Algorithm	<ul style="list-style-type: none"> <li>• High Accuracy.</li> <li>• Flexibility.</li> <li>• Interpretability.</li> </ul>	<ul style="list-style-type: none"> <li>• Small training sample</li> <li>• Number of clusters must be specified beforehand.</li> </ul>
Evolutionary Algorithm (EA)	<ul style="list-style-type: none"> <li>• Very easy to understand and does not demand the knowledge of mathematics.</li> <li>• Easily transferred to existing simulation.</li> <li>• Variation prevent trapping in one part of the solution space.</li> </ul>	<ul style="list-style-type: none"> <li>• Not feasible for real time use.</li> <li>• Cannot find the exact solution but it finds best solution.</li> <li>• Initial guess biases the final output.</li> <li>• Genetic Algorithm (GA) is slow.</li> </ul>

At present, Genetic Algorithm (GA) is viewed as the most impressive fair improvement method for inspecting a huge elucidation, and is utilized to locate the most streamlined and optimal solution for a given issue [6-7]. Along these lines, the proposed framework uses an effective multi-objective hereditary classification called Extreme Deep Learning Machine in the feature extraction and selection method. Since EDLM diminishes the computational multifaceted nature of customary hereditary calculations, it can locate a superior spread of arrangements and better union close to the genuine Pareto optimal [15] [16]. Furthermore, the recommended framework utilized a proficient summed up Multi hidden Layer Feed-Forward Networks (MLFN) calculation, called Extreme Learning Machine (EDLM), as a grouping classification. The principle commitment of this exploration is to manufacture another copper plate OCR framework that manages division free pictures of Tamil words, by embracing both factual based component choice and EDLM in a Tamil OCR framework just because. The framework expects to arrive at the least acknowledgment mistake, the littlest running time, and the most straightforward structure.

## II. PROPOSED SYSTEM

Figure 1 shows the square graph that abridges the fundamental segments of the proposed Tamil OCR framework model. The framework uses factual based element choice calculation to choose the ideal highlights, and Extreme Deep Learning Machine (EDLM) classifier for acknowledgment of the Tamil OCR framework. The framework comprises of two primary similar stages: training phase and testing phase. The two stages incorporate five procedures executed successively in each preparation stage and testing stage. The five procedures are image acquisition, pre-processing, segmentation, feature extraction and selection and finally classification.

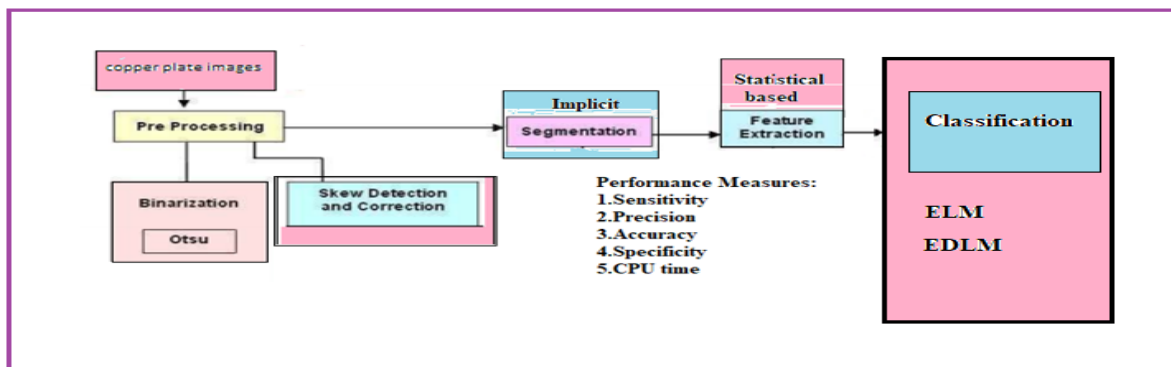


Figure 1: Proposed Architecture for copper plate images character recognition

### 2.1. OTSU IMAGE BINARIZATION

Thresholding is a fundamental system in image segmentation applications. Otsu method is somewhat worldwide thresholding in which it depend just dark estimation of the picture[8-10]. The essential recommendation of thresholding is to settle on a best dark level edge an incentive for isolating objects of enthusiasm for a picture from the foundation dependent on their dim level dissemination. The dark level histogram of a picture is commonly considered too composed apparatuses for development of thresholding calculations. By turning all pixels beneath some limit to zero and all pixels about that edge to one, thresholding makes twofold picture. In the event that  $g(x, y)$  is an edge record of  $f(x, y)$  at different global theshold edges  $T$ , it very well may be characterized as [4]  $g(x, y) = 1$  if  $f(x, y) \geq T = 0$  in any case

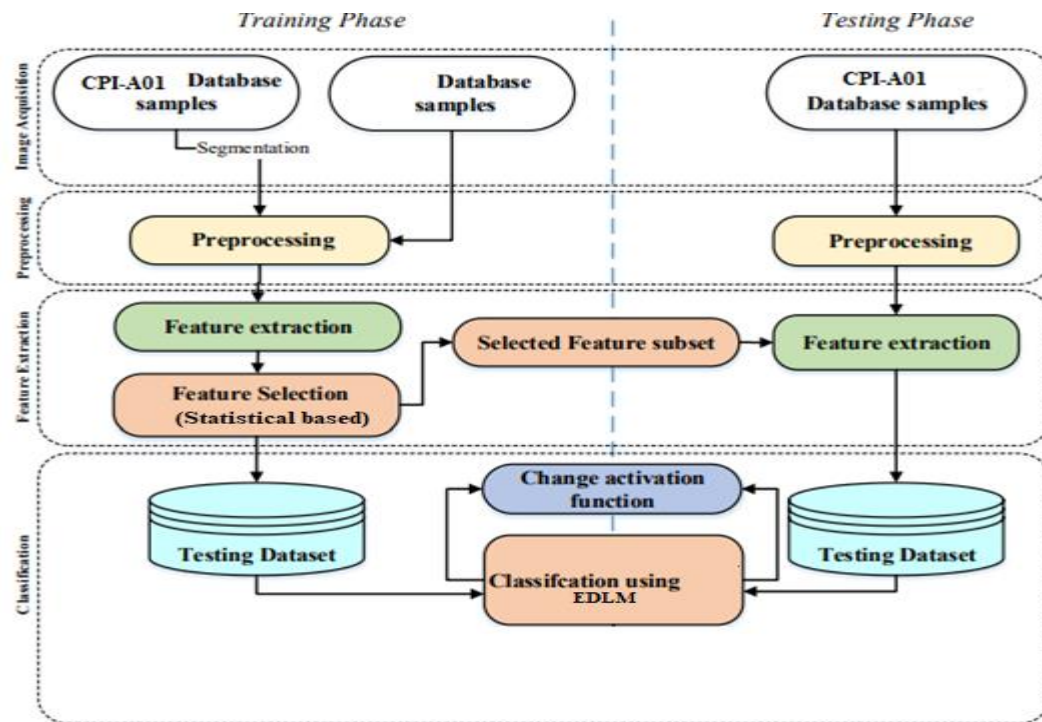


Figure 2: detailed Architecture for copper plate images character recognition

## 2.2 SKEW DETECTION AND CORRECTION

Manually written copper plate composition may at first be slanted or skewness may present in copper content checking process. This impact is inadvertent in numerous genuine cases, and it ought to be killed in light of the fact that it successfully diminishes the exactness of the sequential procedures, for example, division. Skewness is remedied by utilizing projection profile Analysis[11-15]. A twofold picture into one-dimensional exhibit (projection profile) change is known as projection. Each line in projection profile has a worth that produce various dark pixels in the relating column of the picture and lines on record are spoken to as level histogram profile. For those pictures contain zero slanted edge, the flat projection profile has channel which is equivalent with the space between the lines. And furthermore the most extreme pinnacle tallness which is equivalent to content lines stature present in archive pictures. In this way, this strategy computes the distinction in projection profile at various divergent edges is equivalent to point that have the most contrast.

## 2.3. SEGMENTATION

Segmentation is the route towards separating the report picture into content lines, words and subsequently into characters. It is incredibly important for gathering reason. Right now verifiable methodology propose a strategy to decrease the quantity of classes by character division and show that it brings about better character acknowledgment [21-23]. The character recognizer is a structure hinder for freestyle penmanship acknowledgment since similar models can be utilized to perceive words. The words are perceived totally without dividing them into letters. This is best and feasible just when the arrangement of potential words is little and known ahead of time, for example, the acknowledgment of bank checks and postal location

## 2.4. FEATURE EXTRACTION

The highlights removed from this parallel picture are measurable based descriptors. Such highlights have seen as valuable in manually written content acknowledgment, human discovery and hand motion acknowledgment. The thought behind utilizing these highlights is that nearby shapes can be

portrayed utilizing edge headings or by the dissemination of neighborhood slope forces without knowing the exact areas of the relating inclination focuses and edges. In Tamil text style all the characters are of about a similar stature [16-17]. Thus, we rescale the detached character pictures to a standard tallness. We actualize the calculation by first partitioning this picture into vertical portions of width  $w$  pixels.

## 2.5 CLASSIFICATION:

11<sup>th</sup> century written by hand Tamil contents are regularly assembled into four classes to be specific Vowels, Consonants, Composite characters and Aaydam. These four classes are taken for characterization reason right now. Customary calculations are far more slow than required in light of the fact that the slope based learning calculation and the parameters must be tuned iteratively. What's more, in this way Extreme Deep Learning Machine (EDLM) is utilized for arrangement.

Feature extraction and selection procedures produce the element vector utilized in the arrangement organize. Characterization is the dynamic procedure in the OCR framework that utilizes the highlights removed from the past stages. The characterization calculation is educated with the preparation dataset, at that point it is encouraged with the testing dataset to perceive the various classes (each class is a word) [18-20]. Accomplishing a high acknowledgment rate requires a ground-breaking order system that beats its counterparts' methods as far as speed, straightforwardness and acknowledgment rate. The proposed framework uses EDLM, a quick and effective learning calculation, characterized as a summed up Multi concealed Layer Feed forward Network (MLFN). Basics of ELM methods are made out of twofold: all inclusive guess capacity with irregular concealed layer, and different learning strategies with simple and quick usage [30].

$$f_L(x) = \sum_{i=1}^L \beta_i g_i(x) = \sum_{i=1}^L \beta_i G(a_i, b_i, x), \quad x \in R^d, \beta_i \in R^m$$

Where  $a_i$  and  $b_i$  are the learning parameters of hidden nodes and  $\beta_i$  is the weight connecting the  $i^{\text{th}}$  hidden node to the output node,  $\beta_i G(a_i, b_i, x)$  is the output of the  $i^{\text{th}}$  hidden node with respect to the input  $x$  [31].

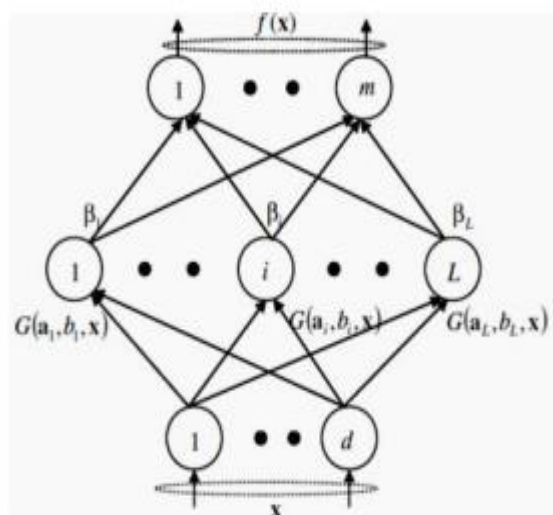


Figure 3: ELM Feed Forward Network Architecture

For  $N$  arbitrary samples  $(x_i, t_i) \in \mathbb{R}^d \times \mathbb{R}^m$ , the MLFN with  $L$  hidden nodes is modeled as:

$$\sum_{i=1}^L \beta_i G(a_i, b_i, x_j) = t_j, \quad j = 1, \dots, N$$

The above equation can be written compactly

$$H\beta = T$$

$$H = \begin{bmatrix} h(x_1) \\ \vdots \\ h(x_N) \end{bmatrix} = \begin{bmatrix} G(a_1, b_1, x_1) & \dots & G(a_L, b_L, x_1) \\ \vdots & \dots & \vdots \\ G(a_1, b_1, x_N) & \dots & G(a_L, b_L, x_N) \end{bmatrix}_{N \times L}$$

$$\beta = \begin{bmatrix} \beta_1^T \\ \vdots \\ \beta_L^T \end{bmatrix}_{L \times m}, \quad \text{and} \quad T = \begin{bmatrix} t_1^T \\ \vdots \\ t_N^T \end{bmatrix}_{N \times m}$$

$H$  is called the hidden layer output matrix of the MLFN and  $T$  is called target labels. The essence of EDLM tends to minimize  $\|H T - \beta\|$  and  $\|\beta\|$ , so the most extreme number of shrouded hubs required isn't bigger than the quantity of preparing tests. we have grown Extremely Deep Learning Machine with Multi Layered Forward Network including measurable element determination for getting higher precision and quick calculation

The performance of ELM is contrasted and Probabilistic Neural Network (PNN) and it is seen that 70.19%, 78.73% of exactness is accomplished by PNN and ELM individually. So as to expand the exactness of order further, EDLM is utilized. The exhibition of EDLM is estimated by contrasting it and ELM. EDLM gives the most noteworthy pace of grouping precision of 80.30% when contrasted with ELM. So as to build the exactness and to lessen the number concealed neurons utilized and to diminish the time taken for preparing, an EDLM has been proposed to be used in this research work.

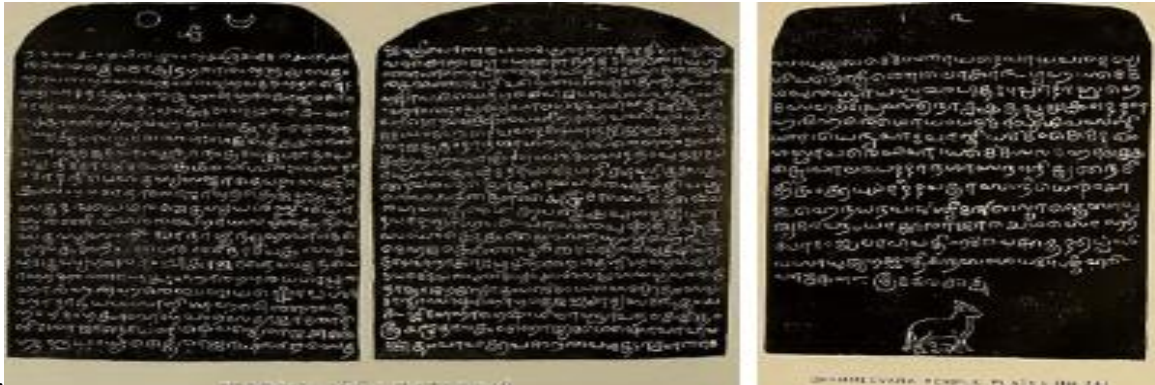
### III. EXPERIMENTAL RESULTS

To check the productivity and legitimacy of the proposed framework, the framework was tried for precision and the outcomes were contrasted and the aftereffects of past frameworks on similar databases.

So as to ensure the nature of pictures, all pictures were gathered from continuous copper plate pictures taken by us and furthermore from different sources. Preparing sets contained in excess of 70 preparing pictures and in excess of 50 testing tests from CPI-A01 [22]. The individual content lines of CPI-A01 database were portioned physically to isolate them into words. Instructional courses were 25 distinctive tamil words in various sizes, directions, clamor degrees and textual styles. The examinations were led on an AMD Quad-center, 2 GHz processor, 4 GB DDR3 Ram PC and Windows 8.1 working framework. The code was written in MATLAB language utilizing MATLAB 2011Rb programming. The proposed Copper plate character spotting technique is tried on the pictures of various copper plate engravings gathered from different pieces of Tamil Nadu, India. Copper plate



engravings made by different lines that managed over Tamil Nadu show extraordinary highlights in their style concerning the sort of stone, cleaning, piece of content, recording on copper plate with shading, etching the content on copper plate, and furthermore dependent on the situation of raising the copper plate in a suitable spot. A considerable lot of these engravings are disintegrated so gravely that it is hard to distinguish the important information, especially when the surface is consumption or carved. Because of hundreds of years of decay, dominant part of these antiquated writings are in poor condition, and numerous content bits are as of now absent. The harm has happened to such a degree, that either the pieces don't exist, or segments are never again conspicuous and past recuperation. The presentation aftereffect of the character spotting process on such pictures is likewise announced right now.



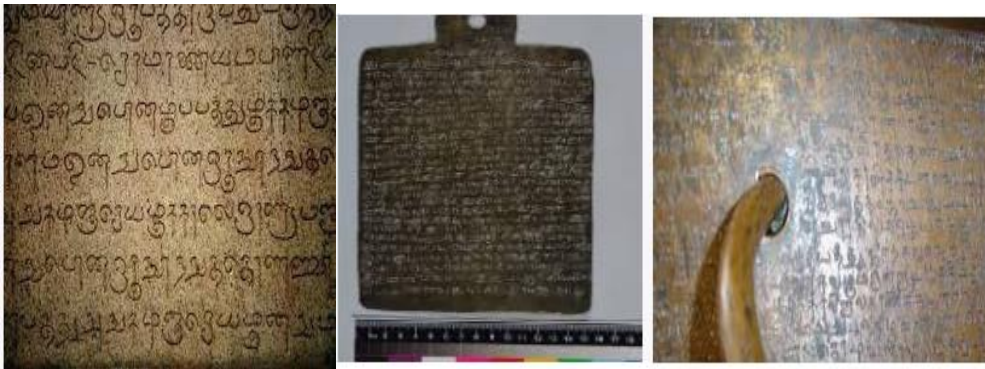


Fig.4: Sample Copper Plate images





Figure 5: Desktop performance (in %) and average CPU time (per spotting per template) for the inscription images shown in above Figures.

At first, the element dataset contains full 14 highlights, the preparation dataset is of measurements 102x14 and the testing dataset is of measurements 22x14. The two sets are applied to EDLM arrange. In the principal explore, ELM is applied with various actuation capacities: Sigmoidal, Sine, Hardlim, Linear, Triangular, and Radial premise. An activation function is any nonzero function used to transform the activation level of a neuron into an output signal. The beginning number of concealed neurons was self-assertively picked to be 50, as 50 is practically 50% of the preparation dataset. Be that as it may, numerous criteria were utilized in assessment of the framework, these criteria are preparing time, as characterized as the time spent on preparing ELM, testing time, which is the time spent on anticipating all testing information, and preparing/testing exactness, which is the root mean square of right characterization.

Table 3. EDLM applied with different activation functions.

S.NO	Activation Function	Training Time	Testing Time	Training Accuracy	Testing Accuracy
1	Sigmoidal	0.00961s	<b>0.00012s</b>	0.4554	0.4091
2	Sine	<b>0.00521s</b>	<b>0.06250s</b>	<b>0.9703</b>	<b>0.9091</b>
3	Hardlim	<b>0.00761s</b>	<b>0.06250s</b>	<b>0.2376</b>	<b>0.2376</b>
4	Triangular	<b>0.23440s</b>	<b>0.00000s</b>	<b>0.1584</b>	<b>0.1364</b>
5	Radial basis	<b>0.15630s</b>	<b>0.00014s</b>	<b>0.2376</b>	<b>0.3182</b>

Table 4. Comparison between the proposed system classifier and different classifiers on the CPI –A01 Databa

S.NO	System Classifier	Max Test Accuracy
1	Probabilistic Neural Network (PNN)	70.18%
2	Support Vector Machine (SVM)	<b>72.4%</b>
3	Extreme Learning Machine(ELM)	<b>78.13%</b>
4	Extreme Deep Learning Machine(EDLM) Proposed System	<b>85.87%</b>

In addition, the classifier framework in [18] relies upon some heuristic punishments and division procedures that incredibly influence the Sift descriptor exactness, yet our framework is free of any component descriptors and it utilizes an amazing arrangement of interpretation and scale invariant highlights.

#### IV. CONCLUSION

Copper Plate Optical Character Recognition (CPOCR) for composed content is an extremely testing and open territory of research. This paper built up a copper plate Tamil OCR for manually written words dependent on a blend of the Extreme Deep Learning Machine (EDLM) classifier with Multihidden Layer Feed Forward Network and factual based component determination. Toward the start, the framework utilized a 14 highlights dataset. At that point information was sustained into EDLM organize, which is a quick and basic multi concealed layer feed forward system (MLFN). The framework accomplished high acknowledgment precision of 85.87% for various examples in an extremely brief timeframe. EDLM stays away from the nearby least snares and long preparing time of conventional neural systems, and the concealed layer of MLFNs needs not be tuned. In addition, Statistical based element determination chooses the most characterizing highlights that diminished datasets multifaceted nature by 57%, and improved the exhibition fundamentally.

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