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RESEARCH ARTICLE

Digitization and Recognition of Kannada Inscription Dynasty

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Abstract

Indian inscriptions are incredibly diverse in content. They range from royal edicts announcing new laws or victories, to grants of land or money to temples and scholars, to records of trade guilds, merchant routes, tax regulations, and treaties. Many inscriptions are poetic in nature, composed in Sanskrit, Prakrit, Pali, Tamil, Kannada, and Telugu, and they often blend political history with literary beauty. They not only inform us about the rulers but also about the lives of ordinary people — farmers, artisans, merchants, priests, and poets — who together created the cultural fabric of India. Equally important is the role inscriptions played in tracing the evolution of languages and scripts. From Brahmi and Kharoshthi in early centuries to Nagari, Grantha, and Kannada in later times, inscriptions show how written communication changed with society. Without them, much of India's linguistic history would remain obscure. However, these invaluable records face challenges of erosion, vandalism, neglect, and environmental damage. Palm-leaf manuscripts decay in humid climates, paper becomes fragile with time, and even the hardest stone carvings wear away under centuries of exposure to natural elements. Therefore, preservation and digital documentation are urgent needs of the present era. The goal of this research is to identify the era of ancient Kannada language inscription using machine learning techniques. The Dynasty Prediction system is designed to provide end-to-end functionality, including real-time prediction, model deployment, and dataset handling.

Keywords: OCR, KNN, DSAL. Inscriptions, Script.

Introduction

The Kannada script finds its roots in the Brahmi script, historically utilised in the inscriptions of Emperor Ashoka during the 3rd century BCE. Ashoka's edicts, found in Karnataka (at Brahmagiri, Siddapur, Jatinga-Rameshwara, etc.), were written in Prakrit language using Brahmi script. The early Brahmi script underwent a gradual evolution, establishing the groundwork for regional scripts in South India, such as Kannada, as illustrated in Figure 1.

By the 4th–5th century CE, the Kadamba dynasty of Banavasi made a major contribution to Kannada script. The Kadamba king Mayurasharma encouraged the use of Kannada in administration and inscriptions. This period gave rise to the Kadamba script, which was the earliest form of Kannada script distinct from Brahmi. The letters became slightly rounded and were better suited for Kannada sounds.

During the 6–8th centuries, the Badami Chalukyas played a vital role in further shaping the script. Kannada inscriptions from this period, for instance, the Aihole inscription of Pulakeshi II (634 CE), show a more developed form of Kannada script. The script became clearer, more structured, and different from Telugu. Under the Chalukyas and later Rashtrakutas, Kannada became not just a spoken language however, this is also a prestigious written medium.

In the modern period, particularly under the rule of the Mysore Odeyars (16th–20th centuries), the Kannada script reached its final standardized form. The Odeyars encouraged literature, printing, and education, which helped stabilize the shapes of Kannada letters.

Literature Review

Researchers in digital epigraphy and computational linguistics have been very interested in studying Kannada inscriptions and turning them into modern script. Many studies have investigated ways for digitising, recognising, and interpreting ancient scripts using the integration of image processing, pattern recognition, and language mapping methodologies. Earlier studies in Optical

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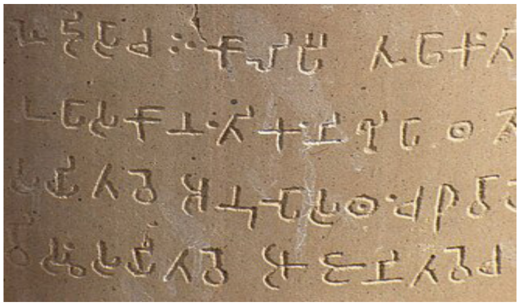
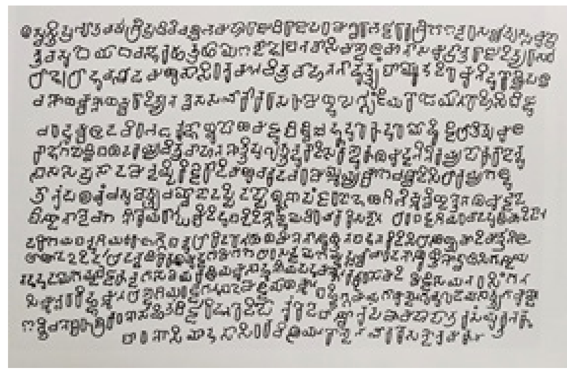


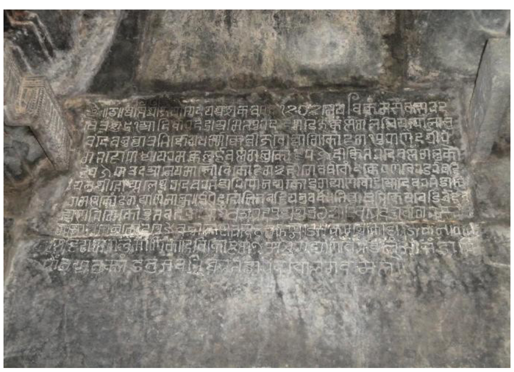
Ashoka Brahmi Script Inscription

Kadamba Script

Badami Chalukya Script

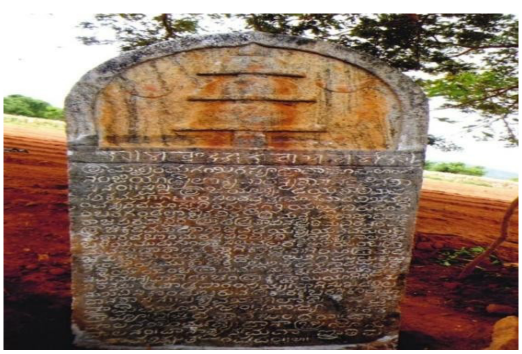


Rashtrakuta Script



Hoysala Dynasty

Shatavahana Inscription



Mysore Wodeyar Script

Figure 1: Karnataka Kannada Inscription Samples

Character Recognition (OCR) for Indic scripts predominantly concentrated on printed or handwritten contemporary Kannada. So many methods frequently used preprocessing techniques, including noise reduction, segmentation, and feature extraction, succeeded by classification by algorithms such as Support Vector Machines (SVM) or K-Nearest Neighbours (KNN). Those approaches worked well for crisp, modern text, but they had a hard time with deteriorated inscription images, uneven shapes, and changes in the shapes of ancient characters. Deep Learning, and specifically Convolutional Neural Networks (CNNs), have made character recognition much more accurate. CNNs are great for recognising images because they automatically learn how features are arranged in space, which makes them more resistant to the distortions and changes that might happen in stone-carved inscriptions. Research indicates that CNN-based models surpass conventional feature-engineering methods in the recognition of complicated scripts. Digital humanities projects like the Digital South Asian Languages (DSAL) and the Sanskrit Heritage Project have shown how important it is to combine computer science with history.

They stress that automated transliteration technologies not only protect cultural heritage but also make it easier to use for research and learning. keep cultural heritage alive and make it easier for people to learn and do research. This research is inspired by previous works that integrate CNN-based image classification for character recognition with script mapping principles to facilitate end-to-end transcription from Kannada inscriptions. Ramakrishnan, R., and others, wrote on how to use convolutional neural networks to read Kannada script. Presents a CNN-based methodology for Kannada OCR, demonstrating superior accuracy relative to conventional techniques. Rajashekar, M. S., *et al*. elucidated the recognition of handwritten Kannada characters utilising Zernike moments and an SVM classifier. Uses SVM for classification and Zernike moments for feature extraction.

Prasanna Kumar *et al*. elucidated the recognition of ancient Kannada script via deep convolutional neural networks. Improvements in Intelligent Systems and Computing. Uses CNN models to sort ancient Kannada letters from inscription datasets. Shashidhar *et al*. elucidated the Automated Recognition of Ancient Kannada Script Utilising Deep Convolutional Neural Networks. International Journal of Smart Systems and Applications. Concentrated on the mapping of Kannada characters from ancient to present times using deep learning. Gowda *et al*. employed CNN and transfer learning to identify handwritten Kannada characters. Employs transfer learning to improve recognition accuracy in limited Kannada datasets. Sridhar *et al*. Using image processing techniques to turn Kannada inscriptions into modern writing. Investigates rule-based mapping from inscription text to Hosagannada. Gowda *et al*. employ transfer learning to enhance recognition accuracy on constrained Kannada datasets with elevated precision. Reddy *et al*. A conventional neural network was used to recognise Kannada digits and get the right answer. Shridhar *et al*. Investigates rule-based mapping from inscription text to Hosagannada. Praveen *et al*. [10] Uses both zoning and chain codes to extract features from inscription OCR. Bhat *et al*.Transliteration of Kannada into English employing statistical and rule-based methodologies. Rajithkumar *et al*. A Hybrid CNN-RNN Model for the Automated Recognition of Kannada Characters in Historical Inscriptions Proposes a hybrid CNN-RNN model that attains approximately 95% accuracy on deteriorated stone inscriptions. Agarwal *et al*. Optical Character Recognition employing Convolutional Neural Networks for Ashokan Brahmi Inscriptions Assesses LeNet, VGG-16, and MobileNet for the optical character recognition of Brahmi inscriptions; MobileNet achieves approximately 95.9% accuracy. Preeti *et al*. Region-Based Convolutional Neural Network for Segmenting Text in Epigraphic Images Utilises RCNN models (e.g., InceptionV3) for character segmentation in intricate, noisy inscription images. Susheelamma K H *et al*.Identification of Kannada Inscript and Its Temporal Classification Utilising Deep Learning Concentrates on the identification of era-specific Kannada inscriptions through machine learning methodologies.

Daggumati *et al*. conducted a Convolutional Neural Networks investigation that identifies three potential sources of Bronze Age writings between Greece and India, utilising a CNN+SVM-based examination of script similarity, including Brahmi, within ancient Indo-Greek settings. Magina *et al*. examine Convolutional Neural Networks for Ancient Tamil Character Recognition from Epigraphical Inscriptions, highlighting their methodological relevance for Tamil inscription recognition. Tippeswamy *et al*. Deep Convolutional Neural Networks for Recognition of Historical Handwritten Kannada Characters examines CNN-based recognition of handwritten historical Kannada scripts. Giridhar *et al*. OCR utilising image recognition-based classification for ancient Tamil inscriptions in temples. Utilises image-classification-based OCR specifically designed for temple inscriptions. G S Gai. Books like Introduction to Indian Epigraphy and Historical Grammar of Old Kannada give us basic information on how scripts change and how they are built. H. S. Mohan *et al*.Identification and Recognition of Ganga and Hoysala Phase Kannada Stone Inscriptions Characters Using Advanced Recognition Algorithm. B K Rajithkumar *et al*. acknowledged the recognition of Old Kannada Stone Inscriptions Characters by a novel algorithm. G. S. Veena *et al*.Handwritten Off-Line Kannada Character/Word Recognition Utilising the Hidden Markov Model. To learn about our predecessors, it's crucial to be able to read characters on stone. The research presents a novel feature termed Positional Distance Metric to enhance character recognition on textured surfaces. It employs a Nearest Neighbour classifier and combines this feature with others, getting good results with 350 characters. The Tesseract tool gets 86% of the answers right, and the Convolution Neural Network CNN gets 87% of the answers right.

Methodology

The proposed system follows a deep learning–based architecture for the recognition and classification of Kannada inscriptions spanning different historical periods (Ashokan Brahmi, Badami Chalukya, Kadamba, and Mysore Wodeyar scripts). The architecture consists of the following major components:

- • Input Layer: Pictures of ancient texts from the inscription images taken from epigraphical sources, textbooks and online sites.
- • Preprocessing Module: These Techniques for preparing images are used such as grayscale conversion, binarization, adaptive thresholding, and noise removal with Gaussian filtering. Segmentation is used for picking out specific characters or groups of words.
- • Feature Extraction Module: Convolutional Neural Network (CNN) is used to learn hierarchical features from pictures that have already been processed. For the purpose of feature learning more effective, transfer learning methods that use models that have already been taught, like VGG16, ResNet50, and MobileNet, are used.
- •Sequence Modeling: The CNN outputs are sent to Recurrent Neural Networks (RNNs) with Long Short-Term Memory (LSTM) units to find contextual relationships between letters in inscription text that depends on the order in which they appear.
- •Classification Layer: The Characters are put into one of four ancient scripts: Ashokan Brahmi, Badami, Kadamba, or Mysore Wodeyar. That can be done with a fully connected layer followed by a Softmax.

The above drown system architecture of the Kannada Language Inscription Dynasty Prediction or to find out the era of the inscriptions system is designed to support end-to-end functionality from dataset handling to model deployment and real-time prediction. This will be divided into three major modules are Data Loading and Preprocessing, CNN Model Training, and Deployment via Streamlit Web Application. Each module interacts with the others in a structured workflow to ensure seamless operation and high prediction accuracy**.** The Data Loading and Preprocessing Module is the first stage of architecture. In this module, images of Kannada inscriptions are arranged into folders, each corresponding for a certain category of Era or dynasty. These Inscription images are read using Keras' Image Data Generator, which automates loading images from directories, creating batches, and applying essential preprocessing such as rescaling pixel values to a 0–1 range. Additionally, these pictures have scaled or resized to a fixed 224x224 dimension to ensure consistency and compatibility with the CNN model. Class labels for each dynasty are taken out of the folder structure and kept in a separate file (class_names.txt) to maintain a mapping between model outputs and dynasty names.

Results and Discussion

A research study was carried out using the system that was proposed to find out the predicted dynasty of the uploaded Kannada inscription image, along with a confidence score. After the input image is preprocessed and passed through the trained CNN model, then the softmax layer provides chances to generate a probability distribution across all dynasty classes. The expected dynasty is the one from the most probable class.

The confidence score indicates how certain the model is about its prediction and is expressed as a percentage. For example, if the model predicts "Hoysala" with a confidence

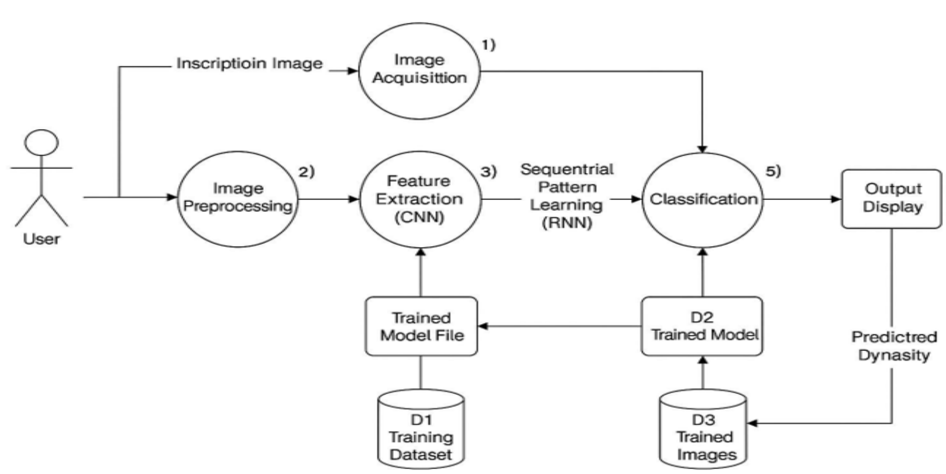


Figure 2: System Architecture for Recognition of Dynasty from inscription

of 92%, it means the model is 92% certain that the uploaded inscription belongs to the Hoysala dynasty and the other metrics are often used to evaluate the performance of a classification model. These metrics help understand the model's reliability and how well it handles different classes. Common metrics include:

Accuracy

Measures the percentage of correctly classified images out of all predictions.

Example: If 95 out of 100 inscription images are classified correctly, the accuracy is 95%.

Precision

Measures how many of the predicted images for a particular dynasty are actually correct.

Example: If the model predicts 20 images as Hoysala and 18 are correct, the precision is 18/20-= 90%.

Recall (Sensitivity)

Measures how many of the actual images of a dynasty are correctly identified.

Example: Assuming the dataset contains 25 Hoysala images and the model accurately predicts 18 of them, recall is 18/25 = 72%.

Figure 3: Input

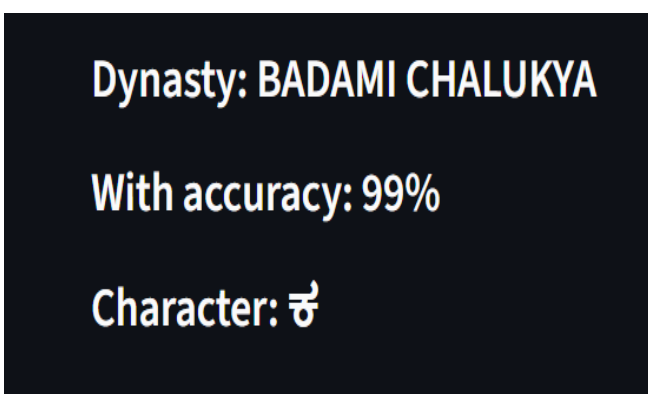


Figure 4: Output

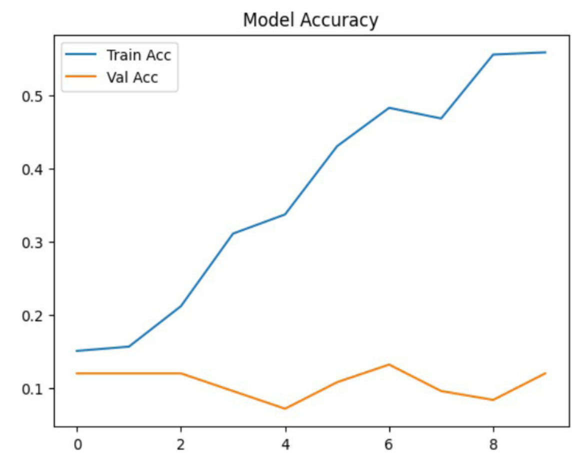


Figure 5: Model Accuracy

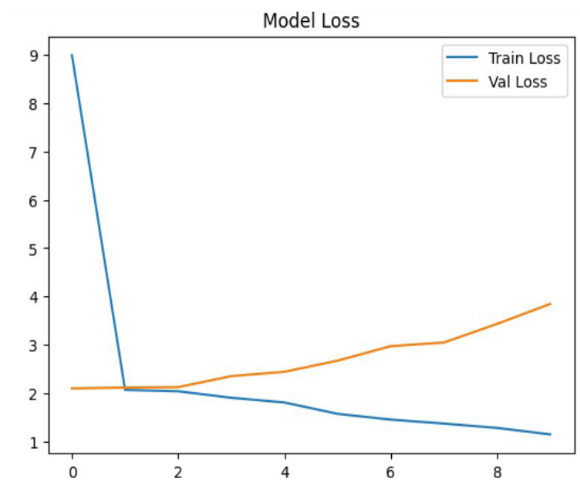


Figure 6: Model Loss

F1-Score

The harmonic mean of precision and recall, providing a balanced measure.

Example: For the Hoysala class,

F1-score = 2 × (Precision × Recall) / (Precision + Recall) = 2× (0.9 × 0.72) / (0.9 + 0.72) ≈ 0.8 (80%).

Conclusion

The usage of machine learning algorithms for the purpose of classifying Kannada inscriptions is a big step forward in the areas of epigraphy, historical linguistics and cultural preservation. The system leverages a carefully curated and organized dataset, along with effective preprocessing steps including image resizing, RGB conversion, and normalization. The CNN model acquires spatial features such as curves, strokes, and character patterns, which are unique to inscriptions of a particular dynasty or time period .This ensures that the model can consistently extract meaningful features from varied inscription images, leading to high classification accuracy and reliable confidence scores for each prediction.

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