

LICENSE PLATE DETECTION AND RECOGNITION USING DEEP LEARNING

Associate Professor ¹Sri K.Srinivas

²Pachigolla V.V.S.S.S.Pavan Kalyan ²Raavi Sriram ²G.Dheeraj Kumar ²Ch. Jayanth

[1] Associate Professor of SRKR Engineering College, Dept of IT, Bhimavaram-534204, AndhraPradesh,India

[2] Students of SRKR Engineering College, Dept of IT, Bhimavaram-534204, Andhra Pradesh, India

Abstract: The escalating number of vehicles and the inefficiency of manual license plate recognition necessitate an automated solution. This project develops a deep learning-based system employing the InceptionResNetV2 architecture and Pytesseract for Optical Character Recognition (OCR) to detect and extract license plate information from vehicle images. Designed to enhance traffic management, law enforcement, and toll collection processes, the system significantly improves efficiency and accuracy over traditional methods. It showcases the feasibility and effectiveness of applying advanced machine learning techniques in real-world scenarios, offering a scalable and reliable solution for automated vehicle identification. This innovative approach not only reduces manual labor but also paves the way for further research and development in intelligent traffic systems.

Introduction: This project aims to revolutionize vehicle identification in urban areas, addressing the challenges posed by manual license plate checks which are slow, error-prone, and increasingly ineffective as vehicle numbers rise. It leverages advanced deep learning and Optical Character Recognition (OCR) technologies to automatically detect and read license plates from vehicle images, enhancing traffic management and safety. With cities facing growing traffic and safety issues due to increasing car numbers, this project offers a modern, efficient solution. It employs state-of-the-art algorithms like InceptionResNetV2 for plate detection and pytesseract for OCR, ensuring accuracy and speed. The methodology encompasses collecting a diverse dataset, rigorous data preparation, exploratory analysis with tools like OpenCV, and preprocessing steps for model training. The project's significance extends beyond technical merits, promising to improve public safety, traffic flow, and urban livability for a broad audience including law enforcement and traffic authorities. It represents a proactive approach to urban challenges, setting a new standard for technological innovation in societal service.

Deep Learning's Impact on License Plate Recognition Efficiency: Machine learning is essential for the advancement of license plate recognition technology, facilitating the creation of more refined and effective models. This improvement dramatically increases the system's ability to accurately identify and process license plates from various environments.

Enhanced Recognition and Localization Techniques: For this project, the InceptionResNetV2 algorithm was employed to masterfully identify license plates against diverse settings, while Pytesseract OCR was used for the accurate extraction of characters from the identified plates. These advanced algorithms and deep learning strategies allowed for the precise recognition of license plates, demonstrating exceptional accuracy in character extraction from images captured under different conditions.

System Flexibility and Data Management: The machine learning models used in this project are distinguished by their ability to adapt and learn from new data, which is vital for maintaining high performance in the face of changing license plate designs and conditions. These models are also capable of processing vast datasets with efficiency, highlighting the system's scalability in managing large volumes of image data for license plate recognition.

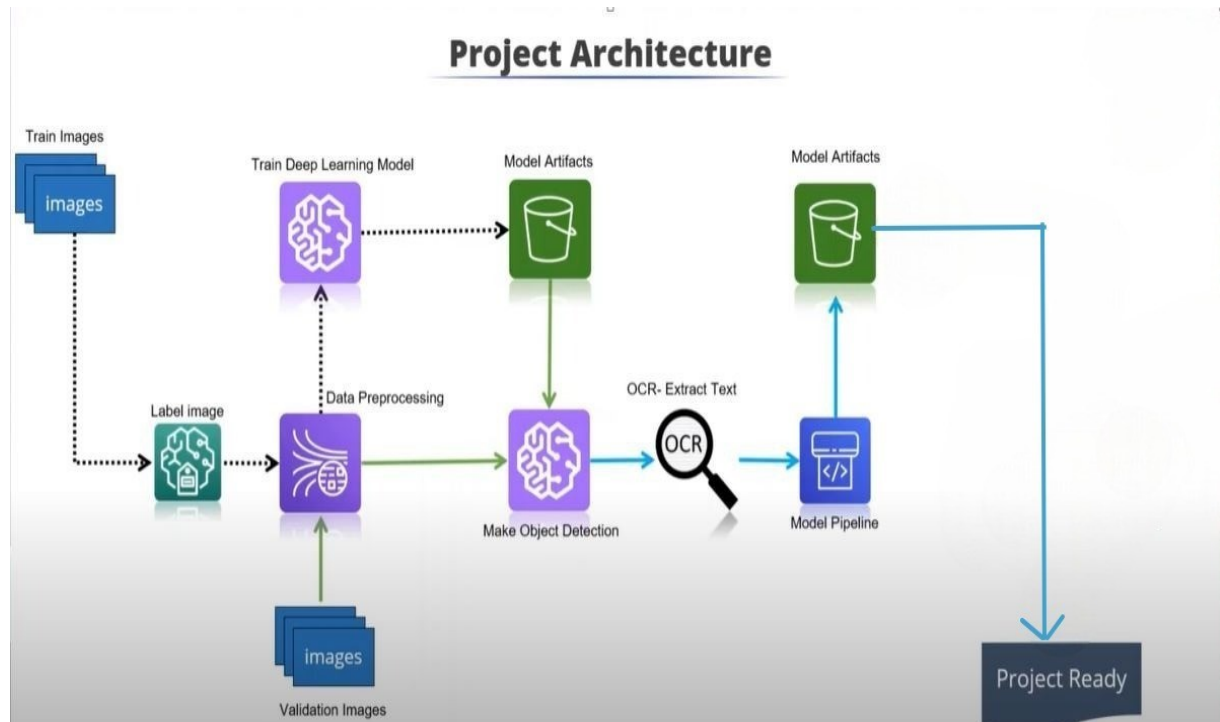
I. LITERATURE SURVEY

1. Jawale, M.A., William, P., Pawar, A.B., Marriwala, N. introduced an ALPDR system combining IoT with CNN for streamlined vehicle registration, enhancing license plate recognition efficiency.
2. Shashidhar R., Roopa M., Manjunath, A S., Puneeth S B. leveraged YOLO V3 and OCR for vehicle number plate detection and recognition, achieving 91.5% accuracy in diverse conditions.
3. Rajebi, S., Pedrammehr, S., Mohajerpoor, R. developed a license plate recognition system using Hopfield's Neural Network, ensuring robustness against adverse conditions.
4. Slimani, I., Zaarane, A., Okaishi, W.A., Atouf, I., Hamdoun, A. utilized two-dimensional wavelet transform techniques for automated license plate detection and recognition, showcasing high accuracy.
5. Usama, M., Anwar, H., Anwar, A., Anwar, S. explored deep learning models for toll collection, highlighting YOLOv4's effectiveness in vehicle and license plate recognition.

II. PROBLEM STATEMENT

The increase in global vehicle numbers presents significant challenges for traffic management and law enforcement, necessitating efficient and accurate vehicle identification methods. Traditional manual approaches to license plate recognition are time-consuming, error-prone, and increasingly insufficient for handling the volume of vehicles on the road. This project aims to develop an automated license plate detection and recognition system leveraging deep learning and optical character recognition (OCR) technologies. By accurately identifying and extracting license plate information from vehicle images, the system seeks to enhance the efficiency and reliability of traffic monitoring, security measures, and administrative procedures, offering a scalable solution to meet the demands of modern traffic management and law enforcement initiatives.

III. ARCHITECTURE



ALGORITHMS

InceptionResNetV2 Architecture

Description: The InceptionResNetV2 architecture is an advanced convolutional neural network (CNN) that combines the strengths of Inception networks with the residual connections of ResNet. It's designed for high accuracy in image recognition tasks, including the ability to discern intricate details within images. This makes it particularly effective for detecting license plates in a variety of settings and lighting conditions. The architecture's depth and complexity allow it to learn detailed feature representations, making it adept at identifying the specific patterns and shapes characteristic of license plates among numerous other objects within a vehicle image.

Pytesseract for Optical Character Recognition (OCR)

Description: Pytesseract is an OCR tool that acts as a Python wrapper for Google's Tesseract-OCR Engine. It's designed to convert images containing typed, handwritten, or printed text into machine-encoded text. For license plate recognition, once the InceptionResNetV2 model detects a license plate within an image, Pytesseract is employed to extract the alphanumeric characters from the plate. It analyzes the pixel data of the image, recognizes the characters present, and converts them into a digital text format. This process enables the system to output the license plate numbers accurately, facilitating their use in various applications such as traffic monitoring and vehicle identification.

IV. IMPLEMENTATION

Data Collection

We gathered a dataset from Kaggle for license plate detection, consisting of about 250 images, each with a corresponding XML file. These XMLs provide critical metadata like image dimensions and license plate coordinates, essential for model training.

Data Preparation

We processed XML data into a structured DataFrame using `xml.etree.ElementTree`. This involved extracting filenames, paths, and license plate coordinates (xmin, xmax, ymin, ymax), setting the stage for efficient data manipulation.

Exploratory Data Analysis (EDA)

Histogram and Distribution Plot: Analyzed bounding box coordinates (xmin, xmax, ymin, ymax) to understand license plate position variability within images.

Box Plot Analysis: Identified outliers in bounding box coordinates, crucial for refining detection accuracy.

Image Size Distribution: Assessed image height and width distribution to ensure model scalability and identify preprocessing needs.

Data Preprocessing

Null Value and Outlier Handling: Checked for missing data and employed Z-score for outlier detection, validating data integrity.

Image and Coordinate Normalization: Resized images to 244x244 pixels and normalized pixel values and bounding box coordinates for consistent model input.

Color Space Conversion: Converted RGB images to BGR, adhering to specific algorithm requirements.

Model Training

Utilized the InceptionResNetV2 architecture, training over 200 epochs with both training and validation sets. We initialized with pretrained ImageNet weights, optimizing with Adam and using MSE as the loss function.

Object Localization

Post-preprocessing, images were input into InceptionResNetV2, predicting license plate coordinates. These coordinates were denormalized to match original image dimensions for accurate localization.

OCR Phase

Applied preprocessing techniques (resizing, grayscale conversion, Gaussian blur) to the license plate regions before employing Pytesseract for character extraction, translating image data to text.

Testing and Evaluation

Calculated Intersection over Union (IOU) to measure model performance, applying a threshold to differentiate between true positives and false negatives. The overall system accuracy was evaluated at 85.085%.

Pipeline Development

The pipeline streamlined from data preprocessing to OCR application, integrating model loading and object localization to automate license plate number extraction efficiently.

This implementation showcases a comprehensive approach from data collection through analysis, preprocessing, model training, and evaluation, culminating in an efficient pipeline for license plate detection and text extraction.

V. VISUALIZATION OF DATA

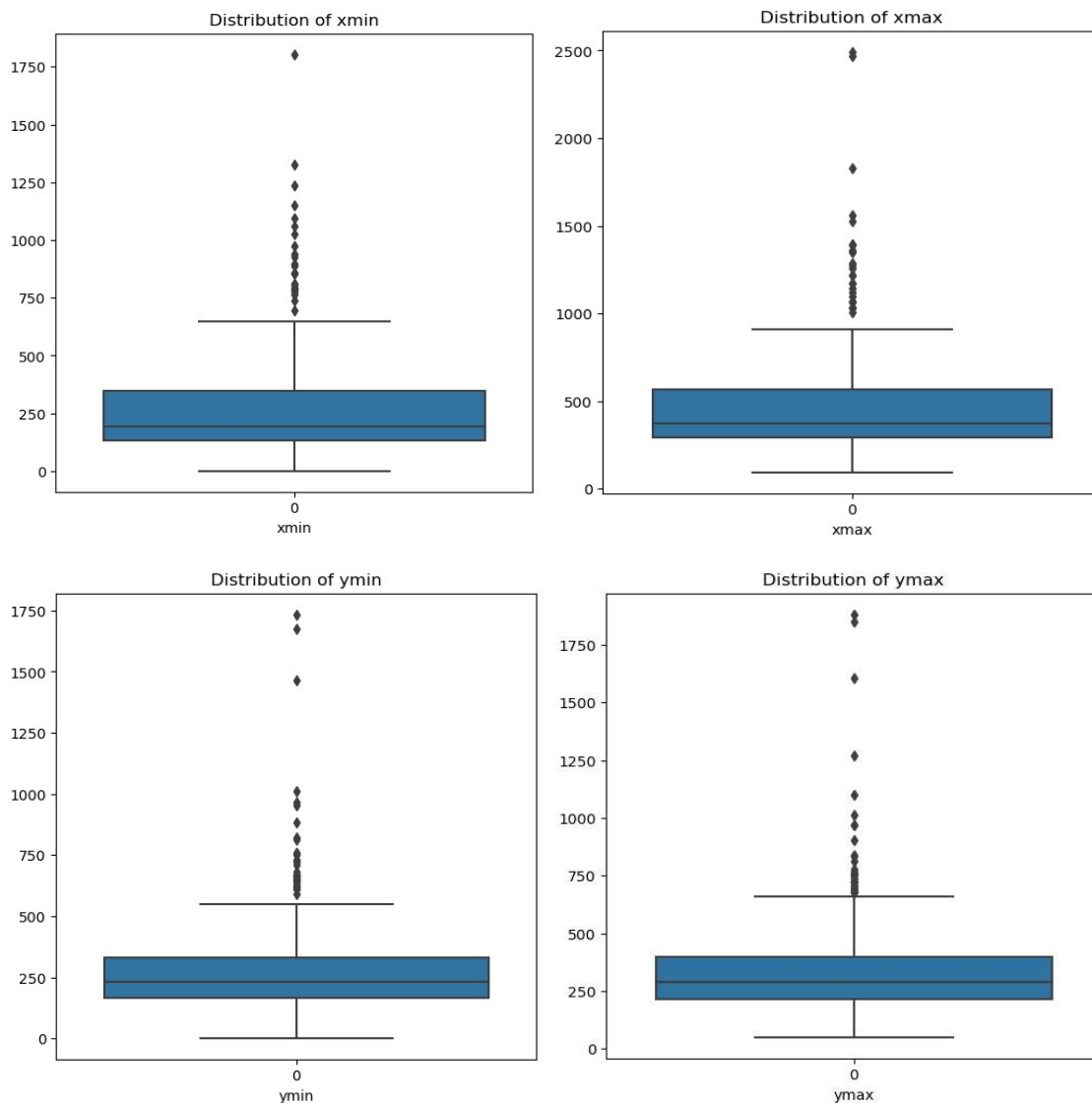




Fig:Region Of Interest



Fig:Resizing and changing from RGB toBGR



Fig:Grey Scale Conversion



Fig:Gaussian Blur

VI. CONCLUSION

This project highlights the effective use of convolutional neural network (CNN) algorithms for detecting license plates and recognizing characters, achieving an average Intersection over Union (IOU) score of 0.68 and 80.085% accuracy in character prediction. Preprocessing techniques, including image conversion to grayscale and smoothing, significantly improved OCR accuracy, emphasizing the importance of preprocessing in OCR systems. Challenges for future Automatic Number Plate Recognition (ANPR) research include developing algorithms for non-standardized plates, integrating high-resolution cameras for faster processing, and enhancing obscure character recognition to address similarities that can confuse OCR, especially under various impairments or viewing angles. Additionally, the exploration of RFID-based vehicle verification presents an alternative to ANPR, offering advantages like speed detection and tracking without requiring direct camera visibility. This project's advancements in license plate detection technology underscore its potential to improve traffic management, surveillance, and law enforcement, pointing towards further innovation and refinement in the field for more secure communities.

VII. REFERENCES

1. M.A. Jawale, P. William, A.B. Pawar, Nikhil Marriwala, "Implementation Of Number Plate Detection System for Vehicle Registration Using IOT and Recognition Using CNN," MEASUREMENT: SENSORS, Volume 27, June 2023.
2. Shashidhar R, Roopa M, A S Manjunath, Puneeth S B, "Vehicle Number Plate Detection and Recognition utilizing YOLO V3 and OCR Methodology," 2021 IEEE International Conference on Mobile Networks and Wireless Communications.
3. Saman Rajebi, Siamak Pedrammehr, Reza Mohajerpour, "A License Plate Recognition System with Robustness against Adverse Environmental Conditions Using Hopfield's Neural Network," Axioms, 2023.

4. Ibtissam Slimani, Abdelmoghith Zaarane, Wahban Al Okaishi, Issam Atouf, Abdellatif Hamdoun, "An Automated License Plate Detection and Recognition System," ARRAY, December 2020.
5. Muhammad Usama, Hafeez Anwar, Abbas Anwar, Saeed Anwar, "Vehicle and License Plate Recognition with Novel Dataset for Toll Collection," arXiv, November 2022.