Final Year Thesis/Project Report Template

by

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A thesis submitted to the Department of Computer Science and Engineering
in partial fulfillment of the requirements for the degree of
B.Sc. in Computer Science and Engineering

Department of Computer Science and Engineering
Brac University
Month Year.

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Declaration

It is hereby declared that

1. The thesis submitted is my/our own original work while completing degree at Brac University.
2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
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This is optional, if you don't have an ethics statement then omit this page

Abstract

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Dedication (Optional)

A dedication is the expression of friendly connection or thanks by the author towards another person. It can occupy one or multiple lines depending on its importance. You can remove this page if you want.

Acknowledgement

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Chapter 1

Introduction

1.1 Background

Review of literature and background study

[**In case of internship - Company Background**] Describe the company where you completed your internship. Include information such as the company's history, mission, vision, key products or services, and its position in the industry. Highlight any relevant details that provide context for the project or tasks you worked on.

1.2 Rational of the Study or Motivation

This section discusses the significance and relevance of the research gap and its impact.

1.3 Problem Statement

Nowadays, Automatic license-plate recognition (ALPR) systems are built on law enforcement, smart transportation and traffic-safety surveillance infrastructures.However, due to movement of vehicles at high speed, the amount of motion blur and geometric distortion is induced into the images and there is also a significant difficulty to address non-Latin scripts, such as Bangla compared to standard english digits where the structural complexity of the numerals and the contacts between the characters (Matra) place a greater thinking burden on the observer[1]. Even though few researchers have addressed a solution, there remains some technical gaps.Even the previous studies focus on restoration of images using GFPGAN which specially targets low-resolution motion blur but not the high frequency motion blur[1]**Hossain2024BengaliLPR**.Moveover,Other studies by Wang et al. [2], uses YOLOv5 to ensure environment interference and lilted plates are restored which do not include a fast moving car's licence plate distortion fixing Where as low-light enhancement studies that use URetinex-Net [3] and U-Net or YOLOv10 [4], [5] Handles atmospheric noises illumination changes fails when there is motion-induced blur for more demanding character level integrity. So to overcome this gap our study will propose a powerful multi-stage deep learning architecture which will handle the motion-blurred and geometrically distorted Bengali license plates.Our suggested design uses the YOLOv8 to identify the object accurately, DeblurGANv2 to evaluate the high-speed image enhancement specifics, and a Bangla-trained OCR model to consider the script-specifics.This system offers a real world reliability which involves heavy traffic and environments aimed at preventing crime,thus providing for Bangladesh's intelligent transportation infrastructure an adaptable approach.

1.4 Objective

Our goal for this research is to design a multi-stage, multifaceted deep learning system which is designed to detect and recognize Bangla license plates in extreme motion blur and geometric distortion in images. This study deals with the significant decrease in performance of license plate detection for a fast moving vehicle in uncontrolled condition. For complex urban backgrounds our research uses state-of-the-art YOLOv8 architecture to make sure the detection is highly sensitive. One of the important stages of our study is to use DeblurGANv2 to reduce the loss of character-level accuracy, which is a denoising assistant to restore high-frequency texture detail in the image of a license plate when in motion. Additionally, to address the unique problems of the non-Latin character structure and matra relations that cannot be solved by the traditional models, our study intends to give a specialized optical character recognition (OCR) system which will be trained on complex Bengali script. Therefore, the ultimate goal of this study is to build an effective pipeline which significantly increases reliability and recognition accuracy in real world systems such as highway surveillance and criminal investigations. In order to improve the effectiveness of law enforcement operations and intelligent transportation systems in Bangladesh, our research may offer an effective In order to improve intelligent transportation systems and the effectiveness of law enforcement operations in Bangladesh, this study may offer a scalable and effective way to address the academic gap between current fixing techniques and the unique script requirements of this nation.

1.5 Methodology in Brief

This research follows a practical, step-by-step methodology to design, develop, and evaluate a robust automatic Bangla license plate recognition (ALPR) system for fast-moving vehicles under real-world conditions.

1. **Dataset Preparation**
   - (a) Existing publicly available license plate datasets will be reviewed and utilized for initial model training and benchmarking.
   - (b) Additional Bangla license plate images will be collected from traffic surveillance footage, roadside cameras, and publicly available sources.
   - (c) The dataset will include images captured under challenging conditions such as:
     - i. High vehicle speed and motion blur
     - ii. Low illumination and nighttime scenarios

iii. Rain, fog, and partial occlusion

(d) All collected images will be annotated with:

i. License plate bounding boxes

ii. Corresponding Bangla text labels

(e) The dataset will be organized in a structured format to support detection, enhancement, and OCR training.

2. **Preprocessing and License Plate Detection**

(a) Input images or video frames will be resized and normalized for efficient processing.

(b) The YOLOv8 object detection model will be employed to localize license plate regions in each frame.

(c) Detected license plate regions will be cropped and forwarded to subsequent processing stages.

(d) Data augmentation techniques such as rotation, scaling, and brightness adjustment may be applied to improve model robustness.

3. **Image Enhancement and Deblurring**

(a) Cropped license plate images will be processed using DeblurGANv2 or ESRGAN to reduce motion blur and distortion.

(b) The enhancement model will aim to:

i. Restore edge sharpness

ii. Improve character visibility

iii. Increase resolution for better OCR performance

(c) Enhanced images will be standardized to a fixed resolution before recognition.

4. **Bangla License Plate Recognition (OCR)**

(a) The enhanced license plate images will be passed to a Bangla-trained OCR model for text recognition.

(b) A segmentation-free recognition approach will be used to handle complex Bangla characters.

(c) The OCR output will generate Bangla characters in digital text format.

(d) Post-processing techniques such as character validation and format checking may be applied to improve accuracy.

5. **System Integration and Real-Time Processing**

(a) All modules detection, enhancement, and recognition will be integrated into a unified pipeline.

(b) The system will be optimized to support real-time or near real-time inference

   (c) Processing latency and memory usage will be monitored to ensure practical deployment feasibility.

6. **Evaluation and Performance Analysis**

   (a) The proposed system will be evaluated using quantitative metrics, including:

      i. Detection accuracy

      ii. Recognition accuracy

      iii. Precision, recall, and F1-score

      iv. Processing time per frame

   (b) Qualitative evaluation will be conducted through visual inspection of recognition results under different traffic conditions.

   (c) The system's robustness will be tested across variations in speed, lighting, weather, and camera angles.

1.6 Scopes and Challenges

1.6.1 Scope of the Research:

This research focuses on the development of a robust, deep learning–based automatic license plate recognition (ALPR) system for Bangla license plates captured from fast-moving vehicles. The scope of the research includes:

1. Designing a multi-stage deep learning pipeline for Bangla license plate detection, enhancement, and recognition.
2. Implementing a real-time license plate detection module using YOLOv8 for accurate localization in complex traffic environments.
3. Integrating an image enhancement module using DeblurGANv2 or ESRGAN to reduce motion blur, distortion, and low-resolution effects.
4. Developing or adapting a Bangla-trained Optical Character Recognition (OCR) model for recognizing non-Latin Bangla characters.
5. Evaluating the system under challenging real-world conditions such as high-speed motion, low illumination, rain, and partial occlusion.
6. Assessing system performance in terms of detection accuracy, recognition accuracy, processing time, and robustness.

This research is primarily focused on still images or video frames captured from traffic surveillance systems, with an emphasis on practical applications in traffic monitoring, law enforcement, and intelligent transportation systems in Bangladesh.

1.6.2 Challenges:

Despite its potential impact, the proposed research faces several technical and practical challenges:

1. **Motion Blur and Image Distortion:** License plates captured from fast-moving cars often suffer from severe motion blur and geometric distortion, which significantly degrade detection and recognition accuracy, even for advanced deep learning models.

2. **Variability in Bangla License Plate Design** Bangla license plates exhibit variations in font style, character spacing, background color, and plate condition, making consistent recognition more challenging.

3. **Limited Bangla License Plate Datasets** There is a lack of large-scale, publicly available datasets specifically for Bangla license plates, particularly those containing blurred and distorted samples, which affects model training and generalization.

4. **Real Time Performance Constraints:** Ensuring that the complete pipeline detection, enhancement, and OCR operates in real time or near real time is challenging due to the computational cost of image enhancement models such as DeblurGANv2 or ESRGAN.

5. **Environmental and Lighting Variations:** Changes in illumination, weather conditions, camera angles, and occlusion from other vehicles can negatively impact system performance and robustness.

6. **Deployment and Scalability Issues:** Deploying the system in real-world traffic environments requires careful optimization to balance accuracy, speed, and hardware limitations, especially for edge or low-resource devices.

Chapter 2

Literature Review

2.1 Preliminaries

Chapter 2 2.1 Preliminaries 2.1.1 Foundations of License Plate Recognition (LPR) Automatic License Plate Recognition (ALPR) is fundamental in intelligent transportation systems (ITS), practical uses around us such as traffic surveillance, law and order, toll gathering, and smart parking management(1) . The ALPR pipeline usually consists of four main phrases: image learning, license plate localization, character segmentation, and optical character recognition (OCR)(1). While traditional ALPR systems run on hand-crafted features and heuristic-based computer vision techniques, the field has shifted towards deep learning, which offers superior and adaptation to real-world variability (2). The performance of ALPR systems is highly sensitive to environmental factors for instance, images often suffer from motion blurness (due to vehicle or camera's motionlessness), low-light factors (night-time, shadows), different weather type (rain, fog, snow, storm), and different plate designs (fonts, scripts) (1). These challenges are particularly some-what common for non-Latin scripts such as Bangla, which feature complex structure and different words(symbols) (3). Addressing these basic problems requires advanced models and preprocessing pipelines capable of enhancement of image quality and extracting core features under challenging conditions mentioned above. 2.1.2 Deep Learning Models for LPR Convolutional Neural Networks (CNNs) have become unavoidable of current LPR systems due to their ability to learn hierarchical features from raw images provided (4). CNNs is capable of capturing both low-level (edges, textures) and high-level (shapes, objects) patterns in image, making them best for both license plate detection and character identification. Architectures such as VGG, ResNet, and physically coded lightweight CNNs have been used by losing accuracy and computational cost. The YOLO (You Only Look Once) has a different version which has made changes in real-time object detection, including license plate identification (7). YOLO's single-stage identification architecture enables high-speed inference, making it best/ ideal for real-time applications for ALPR. Sequential versions have introduced improvements for example, offer optimized accuracy-speed trade-offs and improved small object detection, which is critical for recognizing license plates in unconstrained environments. Generative Adversarial Networks (GANs) have been introduced as powerful tools for image restoration, including deblurring, super-resolution, and data augmentation (8). GANs has a generator and adversarial training, enabling the making of realistic images from degraded inputs. In

LPR, GANs are used to restore motion-blurred or low-resolution license plates, generate synthetic training data, and enhance image quality prior to recognition (8,9). Variants such as ESRGAN, CycleGAN, and LPSRGAN have restored fine details and improved downstream OCR accuracy.(8,5) Sequence modeling is necessary for recognizing the order of characters on a license plate. LPRNet is a lightweight, segmentation-free CNN architecture that identifies character sequences directly from license plates , using CTC (Connectionist Temporal Classification) loss for alignment (4,10). CRNN (Convolutional Recurrent Neural Network) combines CNNs for feature extraction with RNNs such as LSTM, GRU for sequence modeling, to ensure robust identification of variable-length strings without explicit segmentation(2,5). Recently, transformer-based models have been discovered for both detection and recognition, leveraging up for self-attention mechanisms to get long-range dependencies and global context, which is particularly helpful for complex scripts and distorted images (5,7). 2.1.3 Optical Character Recognition (OCR) for Bangla and Non-Latin Scripts The process of converting an image to machine code is called OCR. While for Latin scripts, OCR for Bangla presents unique challenges due to its complex nature(curvy), compound characters (3). Traditional OCR frames such as Tesseract and EasyOCR have adopted Bangla text but usually struggle with low-quality images, complex layouts, and script-specific features. Hybrid model combining YOLO for character detection and advanced CNNs (e.g., EfficientNet, ResNet) for identification have achieved state-of-the-art results in Bangla OCR.(3)

2.2 Review of Existing Research

Perform a literature survey and find relevant materials and information.

2.3 Summary of Key Findings

Discuss key results, patterns or trends, and implications.

Chapter 3

Conclusion

3.1 Summary of Findings

3.2 Contributions to the Field

3.3 Recommendations for Future Work