TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING

Khwopa College Of Engineering
Libali, Bhaktapur
Department of Computer Engineering

A PROPOSAL ON

NEPALI NUMBER PLATE RECOGNITION USING CNN

Submitted in partial fulfillment of the requirements for the degree

BACHELOR OF COMPUTER ENGINEERING

Submitted by

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2021-22

Certificate of Approval

The undersigned certify that the final year project entitled **"Nepali Number plate recognition using CNN"** submitted by Anish Shilpakar, Anjaan Khadka, Sachin Shrestha, Sudip Shrestha to the Department of Computer Engineering in partial fulfillment of requirement for the degree of Bachelor of Engineering in Computer Engineering. The project was carried out under special supervision and within the time frame prescribed by the syllabus.
We found the students to be hardworking, skilled, bona fide and ready to undertake any commercial and industrial work related to their field of study and hence we recommend the award of Bachelor of Computer Engineering degree.

.....
Er. Dinesh Gothe
(Project Supervisor)

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Acknowledgement

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Abstract

Keywords: *Neural Network, Convolutional Neural Network, Machine Learning, Image Processing, Image Segmentation*

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List of Symbols and Abbreviation

ML	Machine Learning
DL	Deep Learning
NLP	Natural Language Processing
RNN	Recurrent Neural Network
ARNN	Attention Based Recurrent Neural Network
DNN	Deep Neural Network
DCNN	Deep Convolutional Neural Network
SSD	Single Shot Multibox Detector
OKM	Optical K-Means
LP	License Plate
LSTM	Long Short-Term Memory
CNN	Convolutional Neural Network
RPG	Rapid Population Growth
CTC	Connectionist Temporal Classification
ANPR	Automatic Number Plate Recognition
ALPR	Automatic License Plate Recognition
STN	Spatial Transformer Network
ACID	Atomicity, Consistency, Isolation, Durability
SQL	Structured Query Language
RDBMS	Relational Database Management System

Chapter 1

Introduction

1.1 Background

Number Plate Recognition (NPR) system was first in 1976 at the Police Scientific Development Branch in Britain [1] .This system uses the Optical character Recognition (OCR) on image taken by camera. In last few years, Number Plate Recognition (NPR) has been one of the useful approaches for vehicle monitoring and management.In Nepal, there is high increase in numbers of vehicles. Due to insufficient spaces and techniques, there is hazard in parking management system. This Number Plate Recognition (NPR) can be useful system to eradicate those problems.
Nepali number plate character are selected from the pool of 29 characters in a specific orders. Order defines various characteristic of the number plates such as vehicle type, vehicle load, etc. The number plates used in Nepal are usually of two formats one containing all the characters in a single row and the other containing two rows of characters. Characters are selected from Devanagari script.Nepali vehicles have license numbers encoded in the both rear and front side with two different sized rectangular plates. The front sized plates are usually in 4: 1 ratio and the back sized plates are in 4: 3 ratio. [2]
Historically, This type of system were used in unidentified crimes but later, it was proposed in the traffic management along with road management. Approximately 1.3 million people die each year as a result of road traffic crashes. [3] This condition are the consequences of the inadequate and insufficient vehicle management system.

1.2 Problem Statement

The Rapid Population Growth (RPG) in major cities of Nepal over years has demanded special attention in vehicle management and monitoring.Over the few years, number of road accidents, traffic congestion, and vehicle theft has increased. NPR system has two parts. Firstly, it consists camera or video that has vehicle number plate images.Secondly, a software that extracts the number plates by performing following steps: color conversion, color masking, number plate localization, character segmentation and finally character recognition, storing in the database.

Vehicles are classified under three categories(heavy and medium size, light size and 2-wheeler & 3- wheeler). For this categories, there is 16 Devanagari letter along with 14 zonal Devanagari letter and Nepali numbers(0-9). Since this project is based on Nepali letter i.e Devanagari Letter, we may encounter challenges on regard of number plate localization and character segmentation. Besides Nepali Number Plate has 6 different coloured plate system, it also gives challenges in color conversion. The possible solution to this problem is managed by the use of Convolution Neural Network (CNN). In major cities of Nepal like Kathmandu, Lalitpur & Bhaktapur, there is large number of 2-wheeler vehicle running in congestion manner. Therefore, this NPR system may face problem in Vehicle counting and Number plate detection resulting in low accuracy of NNPR system. Moreover, the efficiency of NNPR system may decrease during the night time. To ensure the high effieciency of this system, the high quality survillence camera and high processing system must be introduced in the field.
Different Research shows that Number Plate Recognition(NPR) are used bu the Police department to investigate in different activities.According to a 2012 report by the Police Executive Research Forum, approximately 71 % of all US police departments use some form of Automatic Number Plate Recognition (ANPR) [1]. This system have become the intelligence partner and policing strategies for police department for identification of stolen cars and vehicle identification for certains investigation. In the United Kingdom, The Home Office states the purpose of automatic number-plate recognition (ANPR) in the United Kingdom is to help detect, deter and disrupt criminality including tackling organised crime groups and terrorists [1].
Nepali Number Plate Recognition (NNPR) system manages the traffic with high accuracy eliminating the different problems arised due to vehicle congestion. This system helps Nepal Traffic Police (NTP) in management of huge traffic in major cities in significant manner.

1.3 Objectives

The main aim of Nepali Number Plate Recognition (NNPR) system are:

- To identify Number Plate automatically.
- To recognize Devanagari characters in Nepali number plates.
- To record the identified number plates
- To be robust enough to handle different scenarios
- To test various models for image processing and character recognition.

Chapter 2

Literature Review

Automatic Number Plate Recognition system is in state of research and development but in context of Nepal due to lack of proper dataset only small number of researches have been made. In past the systems proposed for ALPR were mostly based on image binarization or gray-scale analysis. However with the rise of DL, Automatic Number Plate Recognition(ANPR) systems have been developed using deep learning techniques like Support Vector Machine(SVM), Convolutional Neural Network(CNN), Deep Neural Network(DNN) e.t.c along with good image processing algorithms for number plate localization and character segmentation. In this project, we planned to use CNN due to its high accuracy for generic object detection and recognition in past.

The paper "Automatic Nepali Number Plate recognition with Support Vector Machines" by Pant et al. [4] used support vector machines for character recognition and achieved overall accuracy of 75%. However due to use of incomplete dataset this system may fail to recognize number plates of all the zones. Manish K. Sharma and Bidhan Bhattarai [5] proposed a system that performs optical character recognition for Devnagiri characters in Nepali language by using CNN(Convolutional Neural Network). This system translates images of handwritten or printed texts to machine editable electronic texts and achieved an accuracy of 96%. This system was not only able to recognize basic characters but also characters obtained from combination of vowels, consonants and special symbols. However this system hasn't been tested for recognizing characters from a number plate and for recognizing different fonts. The paper entitled "LPRNet: License Plate Recognition via Deep Neural Networks" by Sergey Zherdev and Alexey Gruzdev [6] proposes an end to end method for Automatic License Plate recognition without preliminary character segmentation. They proposed a segmentation free model based on variable length sequence decoding driven by CTC loss also utilizing methods like CNN, RNN, STN. Devising an algorithm that uses a single deep neural network to solve both license plate detection and license plate recognition problems they achieved accuracy of 95% on Chinese license plates. The paper by Sergio Silva and Claudio Rosito Jung [7] proposed a complete ALPR system focusing on unconstrained capture scenarios. This system introduces a novel Convolutional Neural Network (CNN) that is capable of detecting and rectifying multiple distorted license plates in a single image which are then fed to OCR for final result and achieved accuracy of 96% on Taiwanese license plates which is quite fascinating.

The paper entitled "Real-Time Bangla License Plate Recognition system using Faster R-CNN and SSD: A Deep Learning Application" [8] by Tarquil Islam and Risul Islam Rasel uses deep convolutional neural network for license plate detection and characters recognition from a live video stream in real time. This system uses two seperate DCNN models one for detecting the license plate from live video stream and another for recognizing the characters on detected license plate. Trained on the dataset BanglaLekha-Isolated which is similar to Devnagari characters this system achieves 100% precision on detecting license plate and 91.67% precision for detecting characters on the license plate. The paper by Arun Vaishnav and Manju Mandot [9] shows the use of template matching algorithm for recognizing multi language fonts. This sytem can recognize both English as well as Devnagari characters and achieved segmentation accuracy of 97% and recognition accuracy of 98%.A recent paper by Pustokhina et al. [10] showed the use of Optimal K-Means with Convolutional Neural Network and achieved a very high accuracy of 98%. They proposed a novel deep learning based model using Optical K-means(OKM) clustering based segmenation and CNN based recognition called OKM-CNN model. This system operates on 3 stages namely LP localization and detection using Improved Bernsen Algorithm(IBA) and Connected Component Analysis(CCA) models then OKM clustering with Krill Herd(KH) algorithm for image segmentation and finally LP recognition with CNN model. By using 3 different datasets the authors have highly increased the accuracy of the system. They have also evaluated the comparitive study of their approach with other methods and showed effective performance of the OKM-CNN model over other methods.

There are numerous methods that can be used for number plate detection and recognition with each method having its own merits and demerits. So in our system we are planning to use a deep learning approach using Convolutional Neural Network for Devnagari character recognition as this appraoch has been promising and has yielded good performance and accuracy in past systems. We have decided to use the Nepali number plate dataset available from github [11] and will also try to add our own data later.

Chapter 3

System (or Project) Design and Architecture

Chapter 4

Methodology

4.1 SOFTWARE DEVELOPMENT METHODOLOGY

Agile method 4.1 of Software Development uses iterative approach. Agile method cycles among Planning, Designing, Development and Testing stages. These cycle is called sprints. Each sprints are considered as a miniature project on itself. Using this method allows us to update various parts of project at any point of project development.

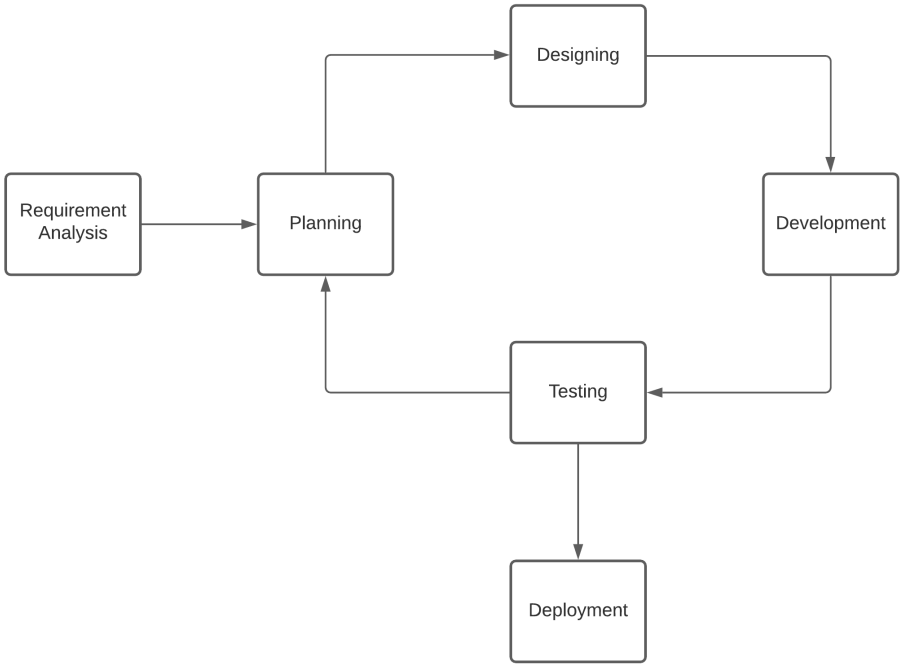

Figure 4.1: Agile Model For Software Development

4.2 Data Collection

We have collected data from various websites like kaggle.com, github.com and other sources. This data majorly includes Nepali number plate photos and some devanagari characters in scanned form.

4.3 Image Processing

We process collected data in several sub-processes such as: Colour Space Conversion, Colour Masking, Number-plate Localization, Character Separation, and Character recognition.

4.3.1 Number-plate Localization

In this process we will locate number-pate from the still frame of video-feed and snaps it out for further processing. It snaps rectangular snip of image containing just the number-plate.

4.3.2 Colour Space Conversion

In This process we will convert widely used RGB image format to HSV image format. This allows us to easily recognize colour of the number-plate and hence allows us to classify number-plates into various types such as: Private vehicle, Public Vehicle, Government vehicle, Diplomatic Vehicle, Tourist Vehicle and National Corporation.

4.3.3 Colour Masking

In this process we will convert snapped image of number-plate in HSV format and recognize general foreground colour by looking at the hue value. By reducing saturation we can easily convert colourful image into monochromatic image. Alongside this depending upon foreground colour we can change hue to get black text on white background.

4.3.4 Character Separation

Here we will separate different characters onto their own. Thus this black and white single character image can be forwarded for character recognition process.

4.3.5 Character recognition

In this process we will recognize characters separated before one by one to get number-plate data. This process is done using Convoluted Neural Network (CNN)

Chapter 5

Implementation Plan

5.1 SOFTWARE REQUIREMENTS

5.1.1 Python

Python [12] is one of the widely used general-purpose programming language that emphasizes on code readability with its use of significant indenatation. It is an interpreted, high level language that supports both procedural and object oriented paradigm. In 1991 released by Guido van Rossum as Python 0.9.0 which then evolved to Python 2.0 in 2000 and now into Python 3.10. [13]. It is an open source high level interpreted programming language used for Artificial Intelligence, Machine Learning, Deep Learning, Image Processing, Web development, app development e.t.c.

5.1.2 PostgreSQL

PostgreSQL [14] is an open-source relational database management system that emphasizes on extensibility and SQL compliance. It supports SQL and is mostly used for app and web development and is frequently used by Python applications for data storage and recovery. It has ACID properties and is evolved from Ingres project. It is considered most advanced and powerful SQL RDBMS that uses multi-version concurrency control(MVCC) which allows several readers to work on the system at once. Due to its capabiltity of handling complex queries it can also be used for data warehousing and data analysis.

5.1.3 Keras

asdasdasdadada

5.1.4 TensorFlow

asdasdsadadadad

5.2 FUNCTIONAL REQUIREMENTS

Functional requirements are the requirements specified by the end user as per the facilities provided by the system. These requirements define the main functionality of the system or one of its subcomponents and describes about the services the software or program should provide to the user. Our system includes the following functional requirements.

5.2.1 Number Plate Recognition

This system tracks number-plate and recognizes vehicle-number form the image.

5.2.2 Number plate specification

It is system to categorize vehicle depending on number-plate colour.

5.2.3 Number plate tracking and recording

This system record vehicle number along with its passage time and location.

5.2.4 Vehicle counting

This system counts vehicles passing by a road within set time period.

5.3 NON FUNCTIONAL REQUIREMENTS

Non Functional Requirements are the requirements that specify criteria that can be used to judge the operation of a system rather than specific behaviors of the system. They serve as constraints on design of the system and define system attributes like security, reliability, performance, maintainability, scalability, usability e.t.c.

5.3.1 Security

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5.3.2 Reliability

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5.3.3 Performance

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5.3.4 Maintainability

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5.3.5 Scalability

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5.3.6 Usability

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5.3.7 Portability

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5.4 FEASIBILITY STUDY

The feasibility of this system can be studied under following points.

5.4.1 Economic Feasibility

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5.4.2 Technical Feasibility

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5.4.3 Operational Feasibility

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Chapter 6

Expected Outcomes

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