Bangladeshi Vehicle License Plate Detection and Recognition

by

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Abstract

Automatic License Plate Recognition (ALPR) is a technology that uses optical character recognition (OCR) to identify vehicles using their license plate. In this project, an algorithm has been proposed to detect and read Bengali license plate.

Nowadays automatic vehicle monitoring system has drawn the importance due to maintain numerous traffic that are increasing rapidly in Bangladesh. Every vehicle has unique identification (license plate).So it is very easy and simple task to track and monitor any particular vehicle using their license plate. Because it is an automatic system that save a lot of time and workers instead of tracking and monitoring manually. For these purpose Automatic Number Plate Recognition (ANPR) is designed and developed.

Automatic Number plate Recognition plays a vital part for controlling and managing vehicle and vehicle related works. This automatic detection system can be efficient for toll collection system, vehicle parking system, traffic control system, vehicle-tracking system, finding lost vehicle as well as detecting guilty vehicle involved in crime for police etc.

There are mainly two types license plate exist in Bangladeshi Vehicle. The green background license plate is for commercial use and the white background license plate is for personal used vehicle. These license plates have four major part ordering in two line. First line describes the area name and type of vehicle and the second line describes vehicle class and registration number.

Many approaches are used for ANPR but it needs a simple method with low complexity for detecting vehicle as fast as possible. This algorithm has three major steps- detection, segmentation and recognition.

For detection firstly, it uses the feature of Haar Cascade, which is a machine learning based approach where a cascade function is trained from a lot of positive and negative images. It is used to detect objects in other images. It is well known for being able to detect faces and body parts in an image, but can be trained to identify almost any object. Then boundary box approach is use to segment these characters separately for area name, type, class and registration number and convert to text file from image. Finally, with the help of Template matching algorithm it recognizes the word and number used in Bengali license plate.

This system has less complexity and high efficiency for number plate detection and recognition.

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Chapter 1

Introduction and Background

In this project, we have exhibited a detection algorithm that will detect any image or video data from the Bangladeshi license plate. It's real-time monitoring. For define the number plate, we applied the HAAR classifier and the Adaptive Boost algorithm.

1.1 Research Topic and Motivations

License Plate Recognition (LPR) is complexion of computer vision. Now it is used to identify vehicles by license plates. In recent years, LPR has been widely applied as a core technology. It is used comprehensively for security or traffic applications such as traffic monitoring, parking lot access enforcement, and information management**.** (2).

This project is aimed at detecting Bangladeshi's license plates from images and videos in real time. This will help us to identify and register vehicles and it will also provide the basis for further vehicle's identification and activity assessment. In the project, our approach to license plate recognition has two key steps. First, certain features that represent video images or frames need to be disabled. Firstly, in order to decide whether an object or frame region is a license plate, we need to create a detector that is used as a classifier in our case.

1.2 Challenges

The main challenge in LPR is that the quality of the camera image can be compromised. Because there are few issues like severe weather status, poor lighting conditions, and low cam resolution. The opening time of the camera will trigger the blurry impact of the moving vehicle. Another problem that we need to gear in LPR is the wide variation of camera perspectives when taking the license plate image.

1.3 Background and Related Work

License plate detection is an essential procedure earlier on LPR. Techniques can be categorized into the following groups: Binary Image Processing, Gray Level Processing, Color Processing and Classifiers to identify the license plate region in images or videos from former study [3]. Character segmentation is also a very vital step toward character recognition. The approaches to character segmentation can be severed into methods of binary image processing, gray-level processing, and classification. A variety of algorithms have been developed to recognize segmented characters using matching pattern / template or classification based on reading. (Twenty-four, 19, 15).

1.3.1License Plate Detection

1.3.1.1 Binary Image Processing

Based on summations of edge statistics and morphology, good results can be gained to differentiate license plate regions from background images. In (10), edge operators are used to a gray image after Blanding and normalization to get horizontal and vertical edge maps. Analysis of the statistical edge was then redacted to identify the rectangle of the license plate. The technique was accomplished in a hierarchical manner at different scales. Several license plate regions will be left after the rule-based fusion. The final decision was taken on the basis of the connected element analysis (CCA). They reported that their algorithm could achieve a detection rate of 99.6 percent from 9825 images. Many other license plate detection algorithms (25, 21) often hold similar protocols. However, these approaches are typically based on edge of vertical and horizontal theory of the license plate frames. These algorithms may not raise reliable results if the frames of the license plate were not clear or if an affine transformation grown.

1.3.1.2 Gray-Level Processing

In the broad contrast between the characters and the background is used to differentiate black character white background license plates [8]. While some other algorithms taken that the edge density in the license plate area was greater than other regions when the contrast between the character and the license plate was sufficiently high. They scanned the vehicle images with N-row length in [6, 4] to count the current edges for illustration.

Within the license plate, high-edge density regions are likely to have. A block-based model was suggested and blocks with high edge magnitude and variance are known to be the license plate region [14]. Photo processing approaches based on Hough transform, Gabor filters, and wavelet transform have been used for license plate detection. Hough Transform is a classic algorithm to detect straight lines. Because lines may define the shape of the license plate the transformation of Hough was used to detect the boundary of a license plates [12]. This approach is only possible if the picture context is simple. The downside of this approach

is that the computational complexity of Hough transform is very high. F. Kahraman (11) et al. applied Gabor filters to detect the license plate and tested the algorithm with images at a fixed angle in 2003.

To encode objects for license plate identification, vector quantization (VQ) also was used [27]. In this process, vehicle images are divided into blocks and coded into strips. If a particular block includes high-contrast area or information, it will be split into four sub-blocks. By scanning the structure and mean value of the blocks, the license plate area can be easily located.

1.3.1.3 Color Processing

In the many countries or regions, the form of license plates is strictly enforced. Text and background color are set to allow most algorithms to detect license plates using color information [16, 9]. Nonetheless, if the lighting conditions change, the color of the license plates can also vary.

Hence, license plate detection algorithms that rely only on color information may not achieve high rates of detection. In the many countries like the United States, these strategies can't be applied as there are a wide range of license plates.

1.3.1.4 Classifiers

License plate-based learning detection methods using various classifiers have become very common recently. The basic idea is to apply classifier to group in a positive class (region of license plate) or negative class (region of non-license plate) the characteristics extracted from vehicle images. A variety of computational intelligence systems, such as artificial neural networks (ANNs), genetic programming (GP), and genetic algorithms (GA), have been used to identify license plates. Usually, however, these algorithms need several predefined parameters. The tests may not be appropriate if the parameters have not been properly calibrated. Recently, adaptive boosting (Ada-boost) and support vector machine (SVM) have been widely applied to detect license plate.

Since they do not need a huge amount of parameters to achieve decent efficiency in classification.

The discrete cellular neural networks (DTCNNs) were applied for the identification of license plate [22]. The car's image was extracted into two characteristics of "grayness" and "texture". After applying the Sobel operator, the DTCNNs is applied to identify the pixels in some context and some kind of histogram in the gray quality images. Through their system, over 85 percent of license plates are recognized.

PCNN was applied to segment license plate candidates from vehicle images prior to the Fourier transformation and a numerical approach for finding the license plate area [17]. This method achieved a detection rate of 85 percent. For license plate recognition and a spectacular score, a TDNN is a feed-forward network of multilayers which replicates hidden neurons and output neurons over time. Two TDNNs was used as horizontal and vertical filters to evaluate the color and texture data of the vehicle images. Their system achieved both 97 percent accuracy and high speed detection. Another revolutionary system detection approach was developed based on the convolutional neural network (CNN) [7]. For optical character recognition (OCR) purposes, CNN was widely used. In this post, the convolutional sub-sampling was used to extract feature map. A hierarchical approach also applied to search in the license plate for the text nominee. This software has achieved a detection rate of 98 percent.

SVM has also been widely used to detect artifacts recently [18, 26]. SVM is a pattern classification algorithm that minimizes the upper limit on the generalization error while other classifiers are attempting to reduce the error in practice. Kim et al. implemented SVM to classify the color texture features to detect the license plate field, followed by a continuously adaptive mean shift algorithm (CAMShift) [28]. The detection rate of their process is 92.7% with an error rate of 3.7%.

Ada-boost has been commonly used with hair-like features in a "cascade" for face detection [23]. Using the cascade method, the history field can be largely excluded from further reading. At high detection rates, it was able to process images very quickly.

The purpose of Ada-boost is to combine a weak set of classifiers to create a stronger classifier. The learning error of the strong classifier has been shown to reach zero exponentially with the number of iterations [20]. License plate detection has been applied in the above process, achieving a detection rate of 93%.

Because the hair-like features were used. This effect was invariant to the color, light, locations and also size of the license plates. This algorithm can be applied in a complex sense.

1.3.2 Overview of Our Method

In this project, a hierarchical structure for LPR is created. It is Based on an ada-boost sliding window scanned over the video frames. HAAR features were extracted and sent to the classifier. In our training phase, license plates from certain Bangladeshi's states will be used as constructive classes. Through adding weights to improve performance, the model will be bootstrapped. With an ada-boost classifier, video frames can easily detect license plate regions. A MeanShift algorithm will be implemented to merge the detection regions into one final detection range. The computer is built on a single board processor to make it more portable.

Chapter 2

Classifier Development

2.1 Cascade Classifier Training

2.1.1 Introduction

It is an overview of necessary feature to train classifier. Every step will be checked by the classifier while train data.

It starts form Data preprocessing, analysis, preparation of training data for actual model training.

2.1.2 Data preparation for training

Positive sample are required (Contains real task we need to detect) with a batch of negative images (Contains what we don't want to find) to train a boosted cascade. The negative samples should be prepared manually.

2.1.3 Positive images

A set of Positive samples are generated by application of opencv-createsamples. This procedure uses them determining model will really look while finding the interesting target. There are two route of creating positive dataset.

- From single positive image on object we can create a bunch of positive ones.
- We can find all the positive items ourselves and apply the device for cropping and set those in binary format required for Open-CV

For fixed objects, like very stiff logo's, the first approach works maidenly, it bends to fail very early for less stiff objects.

Commands are given bellow

- **-vec :** Title of output content that including positive training .
- **-img :** Origin image of the Contents.

- **-bg :** Description file; takes sample of images used as background for object versions that are randomly fouled.

- **-bgcolor :** background-color directs to light. Because compression artifacts can exist, this may

  be specify the amount of color sensitivity by –bgthresh. All pixels are represented as transparent

  within the bgcolor-bgthresh and bgcolor+bgthresh ranges

- **-inv:** inverted colors if it is mentioned.

- **-randinv :** Colors will be inverted randomly if it is mentioned.

- **-maxidev <max_intensity_deviation>** : In the foreground images with peak.

- **-maxyangle:** Maximum angle of rotation in radians.

- **-show :** Necessary tool for debugging. Every sample will be shown if it is specified. Pressing Esc will run the process of making specimens without each sample being shown.

- **-w <sample_width> :** Width of samples of this product.

- **-h <sample_height> :** Height of samples of this product.

A text file close to the context summary file defines this collection. Every line in this file matches a photo.

Total 3000 license plates are used for performing the cascade training. Some of the positive image are shown below.

Figure 2.1: Partial Positive images that used for training the classifier.

Due to the legal restriction of Bangladesh, we are unable to capture the vehicle number plate (photo of the number plate) from public and private vehicle. Since we need a collection of photos of vehicle number plate (which is our positive image) for performing the cascade training operation. To overcome this crucial issue, we have generated the vehicle number plate by ourselves. We generate the image of the vehicle number plate by applying the image generation process.

2.1.4 Negative Images

We want negative images, which do not have a number plate. To build a highly accurate classifier from the training dataset, we need many negative images. These images seem like positive image.

We want minimum 5000 of them for better performance. It takes a long time getting them manually by hand.

Figure 2.2: Partial negative Images that used for training the classifier.

We obtained images from Google and taken by smartphone cameras for the number plate classifier. The negative sample size is. Figure 2.2 shows some of negative images. We put negative image in negative image folder to save the relative path list to the directory.

negative description example:

/image

image1.jpg

image2.jpg

image/image1.jpg

image/image2.jpg

The collection is necessary to say the learning step, boosting.

2.1.5 Classifier Training

Two different applications was provided by Open-CV for training Haar classifier. First one is Open-CV Haartraining other one is Open- CV Traincascade. In this project opencv traincascade will be applied as it enables multi-threaded learning, reduces the time to complete. Also it compliant with new Open-CV update.

So let opencv-traincascade point to our positive sample, negative images. It also tells it to write the output in our repository's classifier directory. NumNeg defines the number of negative sample and calculate memory was used for training. -numPos must be lower than the positive samples we created.

More details information about opencv-traincascade are available in openCV documentation [5]. When the training programme starts, it will display its parameters. Then it will begin to train. Some analysis will be printed out at each stage as it is trained.

Each step represents some exploration which is trained are shown in Figure 2.3

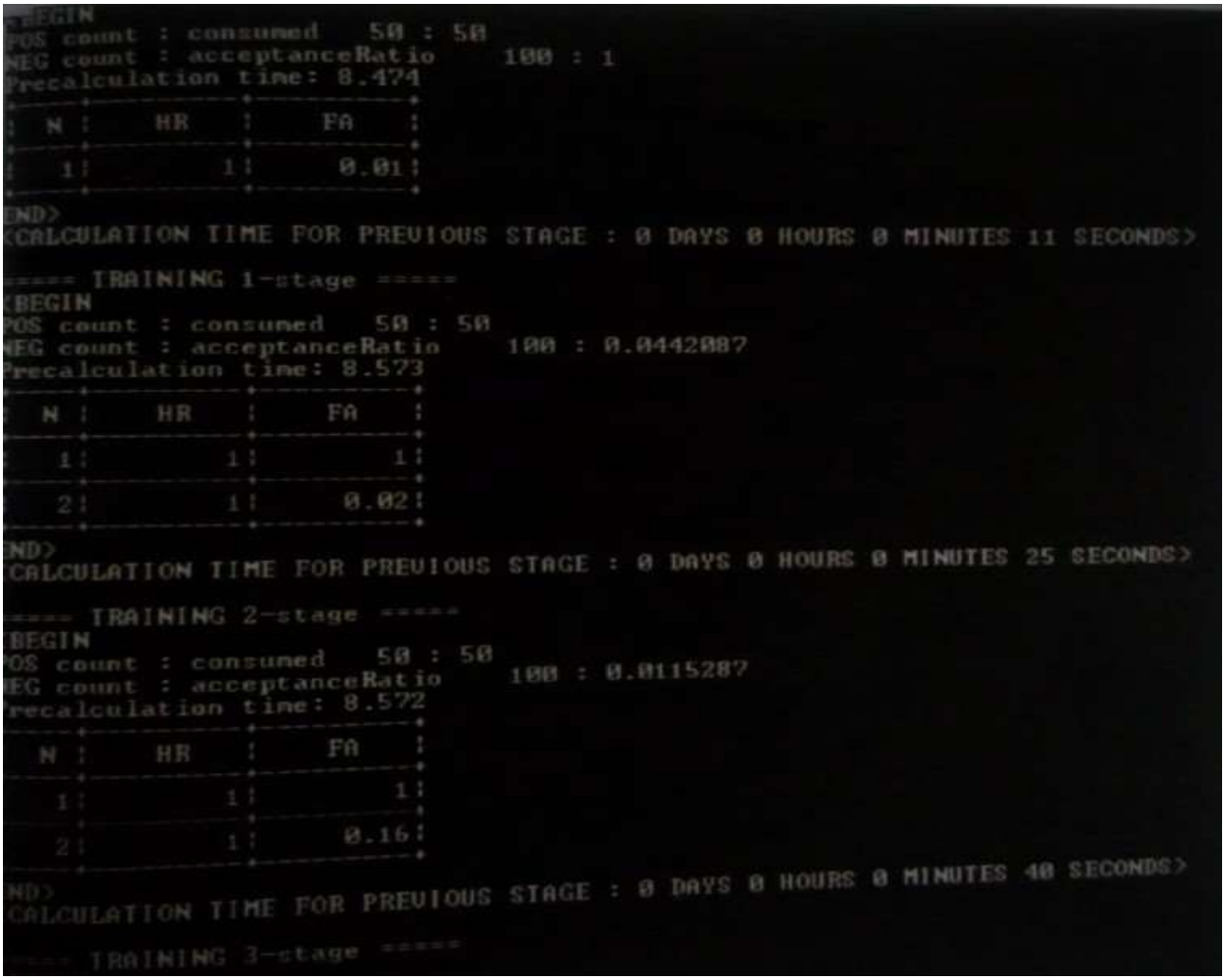

Figure 2.3: Training Process by Open-CV train-cascade.

Each instance in Figure illustrate a feature which is being trained and holds some output about its Hit Ratio and False Alarm ratio.

The classifier is stored in a file at the end of each stage. Also this method be able to shut as well as recommence.

When you adjust a device or settings to improve training duration, this is efficient.

Using this classifier, now we will able use it to find out number plate with OpenCV.

Chapter 3

Applications

3.1 Automatic Toll Collection System

In Bangladesh each year thousands of vehicle crossed important Highway and Bridges. Each Toll plaza in Bangladesh used manual toll collection system. Therefore, it is very time killing process and thousands of working hour is loss due to traffic jam in toll plaza.

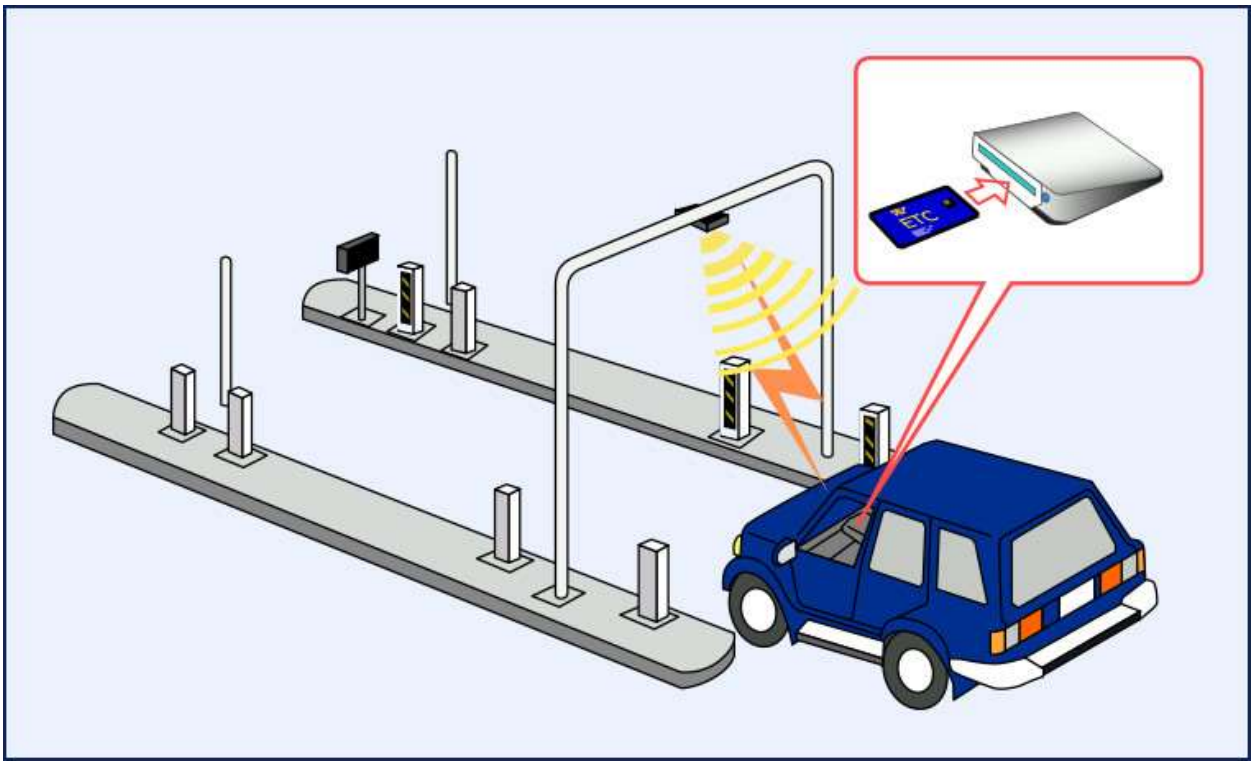

Figure 3.1: Automatic Toll Collection

If we introduce this manual system with automatic toll collection system then we can able to save thousands of working hours and fuel cost of each vehicle.

3.2 Automatic Traffic Control System.

In Dhaka city, millions of bus, private car, cng driven vehicle, bike and other vehicle are driven for passenger into different destination. Each vehicle change dedicated lane illegally. So, the traffic jam is occurring and increase the cost of fuel and lot of time.

Figure 3.2: Automatic Traffic Control

If we can implement this system in important place and using this system, we can fine the guilty vehicle following their license plate then it is possible to reduce this type of problem.

3.3 Vehicle Tracking System in Highway

In Bangladeshi Highway many vehicle can go through with high speed where is speed is limited. Therefore, a lot of accident occur each year and it takes lot of people's life. Since the manpower of our government is limited so it is somehow impossible to look after these type of problem manually.

Figure 3.3: Vehicle Tracking

By implementing this system, we can able to look after these type of problem and fine those over speedy guilty vehicle. If vehicle are fined and crocked then driver are being careful for those occurrence.

3.4 Vehicle parking System

In our country, each vehicle parking company uses manual token system to park vehicle in parking place. It is old and time killing system. The whole world is now used computer based automatic system. To follow the step of automatic parking system parking company such as "Parking koi" can install this portable system for automation.

Figure 3.4: Automatic Parking System

Using this portable system is very easy and important. At the end of month it can sent the parking bill to the users following the license plate that is recognize during parking period.

Chapter 4

System Overview

The system is implemented in the major stage. These stages are License Plate Detection, License Plate Extraction and License Plate Recognition.

4.1 BLOCK Diagram

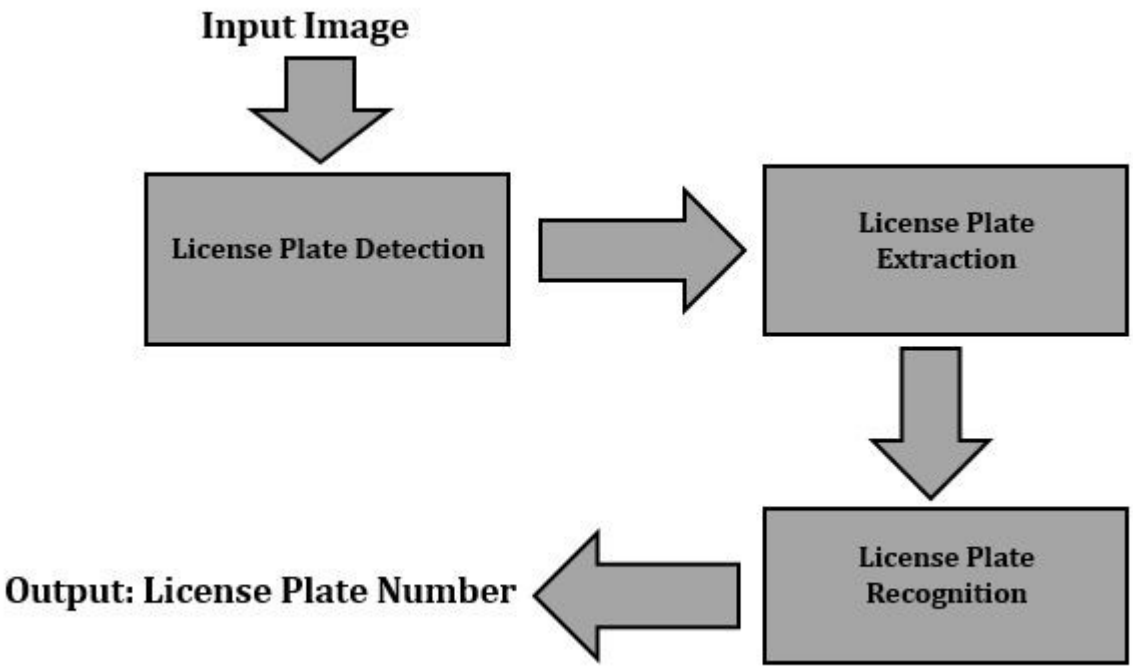

Figure 4.1: Block Diagram

4.2 Demonstration of this System

This ALPR system run through a server. It upload an image to the server page, with necessary program, it crop the vehicle license plate, and then it recognize the actual number from the segmented license plate.

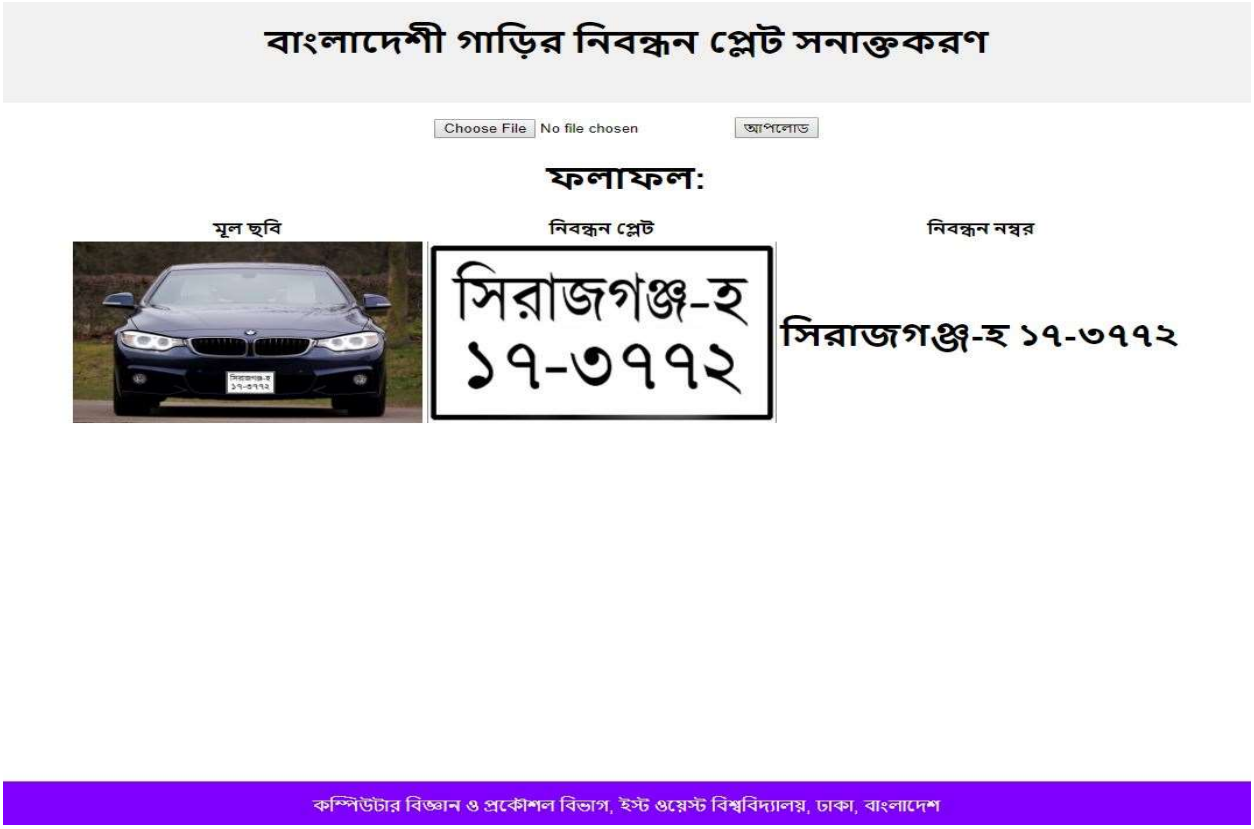

Figure 4.2: System Demonstration

This is a simple Web page. This web page is designed with Bangla front to make it easy to understand.

Chapter 5

System Implementation

5.1 Hardware

We will discuss the necessary hardware lists and implementation details in this chapter. Portable device have been developed as a detector. We could have used UDOO or raspberry pi to construct this device.

5.1.1 UDOO

UDOO is a single board computer. It is an integrated Arduino compatible microcontroller. It is used for computer science education as well as the world of Architect and the IoT. Kickstarter launch it in April 2013."The product line entangles three single board computers – UDOO QUAD/DUAL (2013), UDOO NEO (2015), UDOO X86 (2016) – that differ over various aspects, plus the UDOO BLU and the set of UDOO BRICKS."[1]

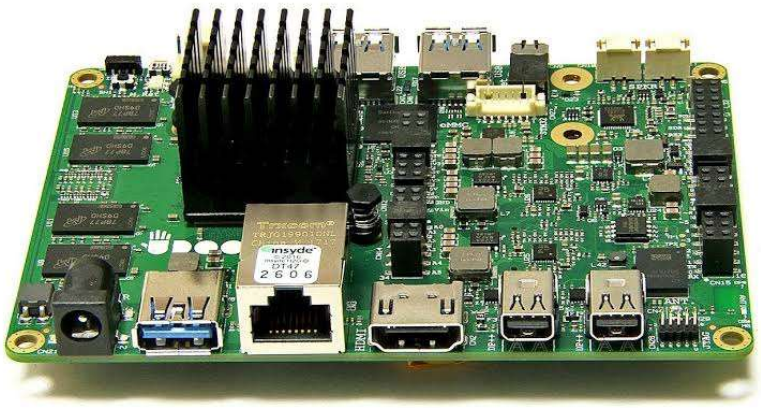

Figure 5.1: UDOO credit card size single board computer

Platform UDOO is a dual core Cortex-A9 I MX 6 CPU, which can run on Android operating systems, and a Due compatible board along with ARM Atmel SAM3X8E CPU. Deck of the UDOO is decorated with 2 CPU. The Freescale I MX 6 is processor based instructions set for ARM v7. Graphics and high-definition videos of the next generation are in I MX 6 series. This series supports video playback of up to 1080p, allowing outstanding best video quality with less power expense for enriched feature Phones. 3D graphics device at the I MX 6 Quad processors will deliver at most 200 Mt / s, allowing realistic, multimedia-critical graphics. Such applications that combined the energy with 3D engine's ability for performing computational tasks until now untapped. If not, Atmel SAM3X allows complete compatibility with the prototype of Arduino. UDOO is used and programmed in the same way as an

Arduino Due microcontroller with this solution. Without any kind of emulation, they both perform their tasks asynchronously. However, they share some channels of communication.

- UART Serial (in Linux)
- OTG Bus (Android connection)
- Arduino pin diagram.

More details about UDOO technical information can be found in [1].

5.1.2 Others Components

Other components that we used to develop the system are:

- USB webcam
- Lipo Battery as a power source
- UDOO Enclosure

5.1.2.1 Application Development

We have developed an application based on OpenCV to detect the Bengali number plate. As programming language, for writing the application python will be used. The application uses our own classification system for main purpose.

5.1.3 Experimental Results

The classifier mentioned in the report was tested using Bengali number plate image sequences. This set includes pictures.

5.1.3.1 Finding the accuracy

		Actual	
		Positive	Negative
Predicted	Positive	True Positive	False Positive
	Negative	False Negative	True Negative

$$\textbf{Precision} = \frac{\text{True Positive}}{\text{Actual Results}} \quad \text{or} \quad \frac{\text{True Positive}}{\text{True Positive + False Positive}}$$

$$\textbf{Recall} = \frac{\text{True Positive}}{\text{Predicted Results}} \quad \text{or} \quad \frac{\text{True Positive}}{\text{True Positive + False Negative}}$$

$$\textbf{Accuracy} = \frac{\text{True Positive + True Negative}}{\text{Total}}$$

Among 200 license plate, the true positive license plate is 183 and false positive license plate is 3. Therefore the precision rate is TP (183) /TP (183) +FP (3) = 98% and Recall Rate is 95% where the TP is 183 and The False Negative (FN) is 10 that is implemented by, TP/TP+FN.

Accuracy is TP(183)+TN(4)/Total(200)= 93%

Chapter 6

Comparison with BRTA Existing System

There is an existing automatic license plate detection system, which is used by Bangladesh Road Transport Authority. Using this system BRTA able to taking action the guilty vehicle with video case. However, this system is only for BRTA personal system. No one outside of BRTA cannot able to access this system. Because BRTA strictly maintain this system.

However, in case of business there is needed a portable system outside BRTA. Our Automatic Bangla License Plate Detection system is very efficient for using business purpose. It is mainly Computer Vision Based Technique. This system can be useful for automatic toll collection, automatic parking, automatic traffic control and numerous other purpose.

BRTA Existing System	ALPR System
1. This system is mainly frequency-based system. 2. High maintain cost. 3. Police and BRTA employee can access this system. 4. There is a possibility to hack this system. 5. Less accuracy.	1. Computer Vision Based Technique. 2. Low maintain cost. 3. Any people access this system using computer vision technique. 4. There is no possibility to hack this system. 5. Higher accuracy.

Table 6.1: Comparison with BRTA existing system

Conclusion

Our System mostly works on Vehicle image. We trained our own cascade classifier using the Ada-boost algorithm to create this. We then implement this on a single board processor as an algorithm. Our quality evaluation is also given. We have not dealt with identification, but detection is the first aspect of recognition. Our Target is to develop a portable Bangladeshi Number Plate Detector Machine in future which works on both image and video of Bangladeshi Vehicle.

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Appendix A

Portable Bangladeshi Vehicle Number Plate Recognizer

Appendix part of our project.

Add additional file and text if necessary. Delete connected components if is it not needed for you from the appendix and the file is Portfile.