**CHAPTER TWO**

# **LITERATURE REVIEW**

## **2.1 Background of Vehicle License Plate Identification System**

License Plate Recognition was first invented by the British Police in 1976. License plate recognition has its roots in the UK. License plate recognition had undergone numerous experimentations by various researchers. Many approaches were implemented and had undergone many changes in the view of improvising accuracy in license plate extraction; some of the approaches developed by researchers are reviewed below.

Sarbjit et. Al (2014) has proposed an algorithm for automatic number detection and recognition using morphological operations for pre-processing, Sobel operator for vertical edge detection, connected component analysis for segmentation and recognition. The algorithm have attained an overall accuracy of around 97%.

Serkan et. al. (2007) had propped a simple algorithm using edge detection algorithms, smearing algorithms and template matching based recognition approach for character recognition. The algorithm is specifically designed for the recognition requirements of Turkish license plates and had achieved an overall accuracy of around 97%.

Bailey et. al (2002) had designed a modular structure interface for evaluation and comparison analysis of various for number plate recognition algorithms. Johnson et al had devised an algorithm for number plate recognition by employing optical character recognition techniques.

Naikur et.al (2006) has propped an approach on car license plate detection using histogram based approach, it processes each frame individually and provides the co-ordinates of location with maximum probability of having a number plate.

Rinku et.al (2013) has proposed a method of automatic license plate recognition, in which license plate is extracted based on some features like color, the boundary, or the existence of the characters. In the license plate segmentation stage, the characters are extracted by projecting their color information, by labeling them, or by matching their positions with template.

Kumar et.al (2010) has contributed an approach on Indian vehicle license plate extraction and character segmentation based on the morphological algorithms and connected components analysis.

Sandra et.al (2002) has contributed a methodology on automatic vehicle identification through edge detection and morphological operations, a Scan line algorithm for segmentation and recognition of segmented characters.

Chetan et.al (2011) has devised a method on Indian Vehicle license Plate Extraction using histogram equalization method, morphological operations and edge Detection techniques.

Pratishtha et.al (2014) has developed an automated system using SIMULINK model in Mat lab which extracts the number plate and recognize alphanumeric characters and recognition is performed using template matching.

Ronak et.al (2013) has proposed an approach on automatic licenses plate recognition using morphological operations and edge detection techniques.

A.Akoum et.al (2010) has proposed a new approach for detection and identification of vehicle number by combining features of horizontal gradients and method symmetry.

The list of experimentations on extraction and recognition of vehicle license plate are very wide. It is clearly noticeable that many methodologies are devised using techniques of pre-processing like morphological operations, canny edge detection and histogram matching etc.

Moderate improvement were made and working models were implemented some years back in Wokingham, England. This subsequently led to the successful development of commercial contracts and applications for early adopter usage. This technology has greatly evolved and prior limitations incurred from vehicle speed, light fluctuation, angular skew, character segmentation and recognition have been solved with today’s algorithm technology.

Additionally, prior cost prohibitive fees have made way for more reasonably priced implementation allowing application to thrive in multiple industries.

### **2.1.1 Review of License Plate Identification Techniques**

License plate identification algorithm of LPR system comprised of three stages such as, identification, segmentation and recognition of license plates. Almost all the algorithms developed so far work by following similar steps. Seven general processing steps have been identified as being common to all number plate recognition algorithms

These are:

***Trigger:***This may be hardware or software trigger. Hardware trigger is the old approach where inductive loop is used for triggering and this tells when the image should be captured by detecting the presence of vehicle. Hardware trigger is now-a-days being replaced by software trigger and in operational in many places. In software trigger, image is divided into zones and by image analysis the detection of vehicles is performed.

***Image Capture:***Hardware or software trigger activates the image capturing device to capture and store image for further analysis.

***Vehicle’s Presence:***This step is needed only if trigger is done after definite time intervals without knowing that a vehicle is present in the captured image. This step compares the captured image with the background image and detects if there is any significant change. If not, the captured image is just ignored, otherwise it moves to the next step.

***Finding Plate:***This step is for locating the number plate in the captured image. A number of techniques can be used in this step e.g. color detection B. H. Cho & S. H. Jung 1998,

## **2.2 Image Acquisition**

Image Acquisition is the first step in a VLPI system and there are a number of ways to acquire images, the current literature discusses different image acquisition methods used by various authors. Yan et. al.(2001) used an image acquisition card that converts video signals to digital images based on some hardware-based image preprocessing. Naito et. al. (1999) developed a sensing system, which uses two CCDs (Charge Coupled Devices) and a prism to split an incident ray into two lights with different intensities. The main feature of this sensing system is that it covers wide illumination conditions from twilight to noon under sunshine, and this system is capable of capturing images of fast moving vehicles without blurring. Salgado et. al. (1999) used a Sensor subsystem having a high resolution CCD camera supplemented with a number of new digital operation capabilities. Kim et. al. (2000) uses a video camera to acquire the image. Comelli et. al. (1995) used a TV camera and a frame grabber card to acquire the image for the developed vehicle LPR system.

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**Figure 2.1: Input Vehicle Image (Salgado, 1999)**

The image acquisition stage receives a signal from a motion sensor and captures an image using a camera. In order to reduce motion blur it should use a high speed shutter.

## **2.3 Preprocessing**

Vehicle Image Preprocessing Stage, after the acquisition of image, pre-processing of image is done. When an image is acquired, there are certain kind of noises present in an image which affect the recognition rate greatly. So these noises are required to be removed from the images. The input images are converted from 24-bit color image to 8-bit grayscale image using surveillance camera.

Preprocessing is very important for high performance recognition, the character is binarized and the noise is eliminated in the preprocessing stage. Preprocessing is mainly used to enhance the processing speed, improve the contrast of the image, and to reduce the noise in the image. In order to reduce the problem of low quality and low contrast in car images, images are enhanced by using histogram equalization on gray scale image. Pre-processing stage consist of the following major phases. Nomura (2005).

1. Gray processing

2. Median filtering

### **2.3.1 Gray Processing**

It involves conversion of color image into a gray image. The method is set on different color transformation. In RGB format, each Pixel has three color components: Red, Green, and Blue. In pre-processing step, the color image is given as an input and it is converted into grayscale image. The first step to digitize a “black and white” image composed of an array of gray shades is to divide the image into a number of pixels, depending on the required spatial resolution. This range is represented in abstract way as a range from 0 (black) and 1 (white), with any fractional values. According to the value of R, G, B in the image, it calculates the value of gray color and simultaneously obtains the gray image. Rinku (2013).

### **2.3.2 Median Filtering**

When images are acquired, there are lot of noises associated with the image. The noise is impossible to be eliminated in gray processing. To remove noise from the image ‘median filters’ are used so that image becomes free from noise. Noise removal is a mandatory step in License plate recognition system because it greatly and directly affects the recognition rate of the system. Johnson (1990).



**Figure 2.2(a): Color vehicle Image (Yasin, 2009).**



**Figure 2.2(b): Gray scale vehicle Image (Yasin, 2009).**

## **2.4 License Plate Extraction**

License plate extraction is the most important phase in a VLPR system. This section discusses some of the previous work done during the extraction phase. Hontani et. al. (2001) proposed a method for extracting characters without prior knowledge of their position and size in the image. The technique is based on scale shape analysis, which in turn is based on the assumption that, characters have line-type shapes locally and blob-type shapes globally. In the scale shape analysis, Gaussian filters at various scales blur the given image and larger size shapes appear at larger scales. To detect these scales the idea of principal curvature plane is introduced.

By means of normalized principal curvatures, characteristic points are extracted from the scale space x-y-t. The position (x, y) indicates the position of the figure and the scale (t) indicates the inherent characteristic size of corresponding figures. All these characteristic points enable the extraction of the figure from the given image that has line-type shapes locally and blob-type shapes globally. Kim et. al. (2000) used two Neural Network-based filters and a post processor to combine two filtered images in order to locate the license plates. The two Neural Networks used are vertical and horizontal filters, which examine small windows of vertical and horizontal cross sections of an image and decide whether each window contains a license plate.

Cross-sections have sufficient information for distinguishing a plate from the background. Lee et. al. (1994) and Park et. al. (1999) devised a method to extract Korean license plate depending on the color of the plate. A Korean license plate is composed of two different colors, one for characters and other for background and depending on this they are divided into three categories. In this method a neural network is used for extracting color of a pixel by HLS (Hue, Lightness and Saturation) values of eight neighboring pixels and a node of maximum value is chosen as a representative color. After every pixel of input image is converted into one of the four groups, horizontal and vertical histogram of white, red and green (i.e. Korean plates contains white, red and green colors) are calculated to extract a plate region. To select a probable plate region horizontal to vertical ratio of plate is used.

Cho et. al. (1998) presented histogram based approach for the extraction phase. Kim G. M (1997) used Hough transform for the extraction of the license plate. The algorithm behind the method consists of five steps. The first step is to threshold the gray scale source image, which leads to a binary image. Then in the second stage the resulting image is passed through two parallel sequences, in order to extract horizontal and vertical line segments respectively. The result is an image with edges highlighted. In the third step the resultant image is then used as input to the Hough transform, this produces a list of lines in the form of accumulator cells. In fourth step, the above cells are then analyzed and line segments are computed. Finally the list of horizontal and vertical line segments is combined and any rectangular regions matching the dimensions of a license plate are kept as candidate regions. The disadvantage is that, this method requires huge memory and is computationally expensive.

## **2.5 License Plate Segmentation**

This is the second stage of VLPI system, this section discusses previous work done for the segmentation of characters. Many different approaches have been proposed in the literature and some of them are as follows, Nieuwoudt et. al. (1996) used region growing for segmentation of characters. The basic idea behind region growing is to identify one or more criteria that are characteristic for the desired region. After establishing the criteria, the image is searched for any pixels that fulfill the requirements. Whenever such a pixel is encountered, its neighbors are checked, and if any of the neighbors also match the criteria, both the pixels are considered as belonging to the same region. Morel et. al. (1995) used partial differential equations (PDE) based technique; Neural network and fuzzy logic were adopted in for segmentation into individual characters.The characters inside the license plates are segmented, both binary and gray scale image processing techniques are used to segment the characters.

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### **2.5.1 Segmentation Using Binary Image Processing**

In the binary image processing techniques, several methods such as horizontal and vertical projection and mathematical morphology are used to segment the license plate.

#### **2.5.1.1 Projections**

Computing the horizontal and vertical projections of the pixel are said to be the most common and simplest method to segment character used by *Shi et al.,* (2005), *wang et al.,* (2004). The projections are computed using a binary image of the license plate. They are computed using the Equation 2.8 and 2.9. The horizontal projection is used to separate the rows of the license plate and the vertical projection is used to segment the characters and the digits of the rows.

#### **2.5.1.2 Mathematical Morphology**

Research work by Nomura et. Al (2005) presented an algorithm based on mathematical morphology. They described an adaptive approach for seriously degraded plate images. After converting the license plate into a binary image, they reduce the noises by using morphological operation, such as thickening and pruning. Thickness operation was used to detect boundaries between overlapping characters and pruning operation was used for cleaning up parasitic objects in the thickened image.

### **2.5.2 Segmentation Using Gray Scale Processing**

In the gray scale processing, methods like local and adaptive threshold, histogram processing and classifiers are the most commonly used techniques.

**Local and Adaptive Threshold**

This method is based on converting a gray scale license plate image into a binary image. This conversion can be done by employing global and local thresholds.

**Classifiers**

This method was based on exploiting prior knowledge such as the predetermined number of character in the plate and their equal segmented width.

## **2.6 License Plate Recognition**

The third stage of a VLPI system is the character recognition stage. This section presents the methods that were used to classify and then recognize the individual characters. The classification is based on the extracted features. These features are then classified using either the statistical, syntactic or neural approaches. Some of the previous work in the classification and recognition of characters is as follows, Hasen et. al. (2002) discusses a statistical pattern recognition approach for recognition but their technique found to be inefficient. This approach is based on the probabilistic model and uses statistical pattern recognition approach. Cowell et. al. (2002) discussed the recognition of individual Arabic and Latin characters. Their approach identifies the characters based on the number of black pixel rows and columns of the character and comparison of those values to a set of templates or signatures in the database. Cowell et. al. (2002) discusses the thinning of Arabic characters to extract essential structural information of each character which may be later used for the classification stage. Mei Yu et. al. (2000) and Naito et. al. (1999) used template matching. Template matching involves the use of a database of characters or templates. There is a separate template for each possible input character. Recognition is achieved by comparing the current input character to each of template in order to find the one which matches the best. If I(x,y) is the input character, T„(x,y) is template n, then the matching function s(l,Tn) will return a value indicating how well template n matches the input. Hamami et. al. (2002) adopted a structural or syntactic approach to recognize characters in a text document; this technique can yield a better result when applied on the recognition of individual characters.

This approach is based on the detection of holes and concavities in the four directions (up, down, left and right), which permits the classification of characters into different classes. In addition, secondary characteristics are used in order to differentiate between the characters of each class. The approaches discussed in this paragraph are based on the structural information of the characters and uses syntactic pattern recognition approach. Hu (2006) proposed seven moment that can be used as features to classify the characters. These moments are invariant to scaling, rotation and translation. The obtained moments acts as the features, which are passed to the neural network for the classification or recognition of characters. Zernike moments have also been used by several authors for recognition of characters. Using Zernike moments both the rotation variant and rotation invariant features can be extracted. These features then uses neural network for the recognition phase. Neural network accepts any set of distinguishable features of a pattern as input. It then trains the network using the input data and the training algorithms to recognize the input pattern (In these case characters).

Different types of Artificial Neural Networks (ANN) such as multilayer perceptron (MLP), Feed forward back propagation (BP), Hierarchical NeuralNetwork (HNN), etc.

Hidden Markov Model (HMM) and Support Vector Machine (SVM) are mainly used to classify the characters. Other than neural network, pattern, template matching, open source OCR techniques are also used to recognize the characters.

### **2.6.1 Support Vector Machine**

A support vector machine (SVM) is a type of supervised learning methods that analyze data and recognize patterns. The SVM is used for classification and regression analysis. Four SVM base character recognizer was used in the system to recognize the characters and digits in four different parts of the license plate, such as upper character, upper numbers, lower character, and lower numbers.

### **2.6.2 Neural Networks**

Multilayer feed-forward neutral networks have been used in many research works to recognize the characters and digits of the license plate. The network has to be trained for many training cycles to achieve good recognition rate over unknown test data.

### **2.6.3 Template Matching**

Template matching is a techniques for finding small parts of an Image which match a template image. This is suitable techniques for the recognition of single front, non-rotated and fixed-size characters.

## **2.7 Adopted Algorithm and Technique**

We will use a number of existing technique and algorithms, such as edge detection, image binarization, projections, median filters, multilayer perception neural network and back propagation in the VLPR system for Nigeria vehicles.

**2.8 Related Works**

Automatic vehicle identification system using vehicle license and number plate recognition. The LNPR software of the system uses series of image processing algorithms for number plate recognition and finally identifying the vehicle from the database stored on the PC. The SQL database will be used to store different achieved records of vehicles. We have evaluated the system performance on real images. Both the simulation and practical results revealed that the LNPR system can robustly detect and recognize the vehicle using license plate in different lightening and weather conditions and can be implemented on the entrance of highly restricted areas.

## **2.9 Summary**

This chapter reviewed material relevant to the license plate identification system. The relevant techniques used in the four phases of a VLPI system were discussed. Several commercially available and developed VLPI systems are also presented. In the case of image acquisition, a sensing system using two Charge Coupled Devices along with a prism gives better input to the system. Because the main feature of this sensing system is that it covers wide illumination conditions from twilight to noon under sunshine. In the case of license plate extraction, Hough transform was used to extract the license plate by using the horizontal and vertical edge information. But the disadvantage is that, this method requires huge memory and is computationally expensive. Various segmentation techniques were presented in the segmentation stage. Then the literature for recognition of characters using various approaches was also discussed. Lastly, some of the number plate recognition systems which have been developed commercially were presented.