ISSN : 2229-4333(Print) | ISSN : 0976-8491(Online)

Skew Correction and Localisation of Number Plate Using Hough Rectangular Transform

Varun Manchikalapudi

Dept. of Information Tech., V.R. Siddhartha Engg. College (A), Vijayawada, AP, India

Abstract

Skew Correction and Number plate Localization is an image-processing technique used to identify a vehicle by its number plate. Technological intelligence is a highly sought after commodity even in traffic-based systems. These intelligent systems not only help in traffic monitoring but also in computer safety, law enforcement and commercial applications. The violations of traffic rules can also be detected based on the number plate localization technique. In this paper, a number plate localization system for vehicles is proposed. This system is developed based on digital images which are captured before hand. This technique can be easily applied to commercial car park systems for the use of documenting access of parking services, secure usage of parking houses and also to prevent car theft issues. There are several algorithms that can be used in order to detect the number plate in various formats such as Morphology, Thresholding (Adaptive thresholding), Hough transforms, Edge detection and Filtration techniques etc. The proposed license plate localization algorithm is based on a combination of several algorithms that include Thresholding, Edge Detection and Hough rectangular transforms. The process flow is, initially the skew is corrected and Thresholds are performed on a plain image. Then edge detection is applied to the obtained image and finally the Hough Rectangular Transform approach is applied to get the localized number plate from the digital image.

I. Introduction

Computer Vision is the science and technology of machines that see. It is concerned with the theory behind artificial systems that extract information from images. Computer vision seeks to apply its theories and models to the construction of computer vision systems. Applications include:

1. Controlling processes (ex: an autonomous vehicle).
2. Detecting events (ex: for visual surveillance).
3. Organizing information (ex: for indexing databases of images and image sequences).
4. Our present project comes under the application of detecting events, which involves the process of Skew correction and number plate localization form the given image.

Intelligent transportation systems have been developed as a major tool for analyzing and also handling the moving vehicles in cities and roads. These systems attempt to facilitate the problem of identification of cars, via various techniques which mainly rely on automated (rather than manual) algorithms. Image processing is one of these techniques which deal with images and/or video sequences taken from vehicles. One unique property that can be taken into account for identifying all vehicles is their license plate numbers. Security control of restricted areas, traffic law enforcements, surveillance systems, toll collection and parking management systems are some applications for a license plate recognition system. Although human observation seems the easiest way to read car license plate, the reading error due to tiredness, eyesight, lack of concentration is the main drawback for manual systems. This is the main motivation for research in area of automatic license plate recognition. An adequate system for this purpose must deal with severe imaging conditions such as high/low lighting, complex background, plate deficiencies (damaged or dirty) and range of distances and viewpoints by which car is imaged.

Skew correction and number plate Localization is the technique in which the number plate is located from the image which has skew or don't have skew that is captured using the Closed circuit camera (CCTV) or of similar type. Using several algorithms the final image if number plate is obtained. The process involved is first the plain image which is already made available is taken and then threshold technique is implemented, the output of the threshold technique is given as input to the Hough rectangular transform where the geometric rectangles are identified in the obtained output, finally the required number plate is extracted from the image. However the success of implementing the Hough transform is obtained by the undistorted rectangle of the number plate. There are several researches going in this area of computer vision and image processing in order to achieve the robust results irrespective of the environments, illumination, damaged plates, blurred images and many more.

II. Problem

Skew Correction and Localization of vehicle number plate is offline identification of number plate exactly from the obtained image by detecting and correcting the skew in the plain image.

Fig. 1: Localization of vehicle Number plate

There are several problems that we should overcome in order to obtain the number plate in a correct and accurate format. Some of them include:

1. Poor image resolution, usually because the plate is too far away but sometimes resulting from the use of a low-quality camera.
2. Blurry images, particularly motion blur.
3. An object obscuring (part of) the plate, quite often a tow bar, or dirt on the plate.
4. A different font, popular for vanity plates (some countries do not allow such plates, eliminating the problem).

III. Literature Survey

There are several skew correction and edge detection methods that can be used in the localization of the number plate.

A. Skew Correction

Following are two different skew correction methods which can be used to deskew the detected angle in the plain image, if present.

B. Float Forward Rotation & Integer Forward Rotation

This method makes use of the floating arithmetic operations so as to deskew the skew in the plain image.

C. Float Inverse Rotation & Integer Inverse Rotation

This method makes use of the integer arithmetic operations so as to deskew the skew in the plain image. The two methods mentioned above work very slow during implantation so we used fast forward rotation method which is more efficient and fast when compared to other methods.

D. Edge Detection

Following are the different edge detection techniques which can be used to detect the edges in the binary image obtained after thresholding.

E. Sobel Detector

Has very simple calculation to detect edges but has inaccurate detection sensitivity in case of noise.

F. Laplacian Operator

It cannot find the orientation of edge because of laplacian filter. Hence we make use of canny edge detection which is supposed to work in the situation where an image has skew and detects the edges basing on the difference in the intensity variations in the given image after performing thresholding technique to the given plain image.

IV. Proposed Approach

There are several steps involved in the Skew correction and Localization of number plate. According to our approach the steps in sequential order are:

A. Steps Involved:

1 Consider the angled plain image i.e. the image consisting certain skew captured by the cc camera known as candidates.
2 Detection in skew is done here manually on the basis of trail and error method.
3 Considering the determined angle and perform Skew correction algorithm to it.
4 Apply the Threshold technique to the candidate.
5 Perform edge detection to the binary image so obtained.
6 Perform Hough Rectangular transform to the canny image so obtained. The part containing the number plate will be localized.
7 Finally separate the part of the image containing the number plate into a separate window.

B. Plain Image

This is the image that is captured from either the Closed circuit camera or any form of digital camera with required resolution in order to obtain an image of adequate visibility, with least disturbances. For the present work i.e. for Skew correction and Localization we need the image to be with certain skew (angle). For the images without skew the Localization of number plate was already done as the previous work. Hence the image is considered.

Fig. 2 : Real time image captured by the digital camera

C. Skew Detection

The process of skew detection is a technique in which the angle of skew is to be determined. This can be done by taking various algorithms into picture. Some of them include:

1. Conventional Hough Transform in S-I Parameter Space.
2. Conventional Hough Transform in Space.
3. Fast Hough Transform in S-I Parameter Space

But the above stated algorithms are complex in nature. They require a lot of computation that is necessary for the successful execution of skew detection. Since the main motive of the research here is Skew correction and Localization, the Skew detection part is done manually. The method considered for the manual implementation is "Trail and error". Using this method the approximate angle is considered as trail if the estimated angle satisfies the given condition then the angle is considered else another angle is tried based on the human common sense. The main disadvantage of this method is the number of trails may be large which requires high capacity and recompilation of source code again and again.

D. Skew correction

The process of Skew correction is a technique in which the estimated angle is taken and given as input to the proposed algorithm and the corrected image is obtained as an output. It is to be noted that the skew correction in this case is valid for only 2 – dimensional correction of skew but it is not applicable to the 3- dimensional correction of skew. Some of the Algorithms that can be used are:

1. Float Forward Rotation.
2. Integer Forward Rotation.
3. Float Inverse Rotation.
4. Integer Inverse Rotation.
5. Fast Implementation of Forward Rotation.
6. Fast Implementation of Inverse Rotation.
7. Bresenham's Like Algorithm for Fast Forward Rotation.
8. Bresenham's Like Algorithm for Fast Inverse Rotation.

All the above algorithms can be used for the Skew correction but the best method in terms of speed and computation is FAST IMPLEMENTATION OF FORWARD ROTATION. This is best among the choices we have above the accuracy is high compared to the other algorithms above. The complexity is also low which gives us the best output required.
The input given to the algorithm is the initial image taken and the estimated angle which is considered before. After taking the input some computations are performed taking the sine and cosine trigonometric functions that are present in the algorithm. And after final computations we get the output of the Deskewed image

ISSN : 2229-4333(Print) | ISSN : 0976-8491(Online)

that is the image with the skew angle is corrected and the straight is obtained. This obtained image is taken for future methods in Localization of number plate.

E. Thresholding

In order to implement the threshold [5] first we obtain the grayscale image from a binary image. Threshold is the simplest method of image segmentation. From a grayscale image, thresholding can be used to create binary images. During the thresholding process, individual pixels in an image are marked as "object" pixels if their value is greater than some threshold value (assuming an object to be brighter than the background) and as "background" pixels otherwise. This convention is known as threshold above. Variants include threshold below, which is opposite of threshold above; threshold inside, where a pixel is labeled "object" if its value is between two thresholds; and threshold outside, which is the opposite of threshold inside. Typically, an object pixel is given a value of "1" while a background pixel is given a value of "0." Finally, a binary image is created by coloring each pixel white or black, depending on a pixel's label. The key parameter in the thresholding process is the choice of the threshold value (or values, as mentioned earlier). Several different methods for choosing a threshold exist; users can manually choose a threshold value, or a thresholding algorithm can compute a value automatically, which is known as automatic thresholding. A simple method would be to choose the mean or median value, the rationale being that if the object pixels are brighter than the background, they should also be brighter than the average. In a noiseless image with uniform background and object values, the mean or median will work well as the threshold, however, this will generally not be the case. A more sophisticated approach might be to create a histogram of the image pixel intensities and use the valley point as the threshold. The histogram approach assumes that there is some average value for the background and object pixels, but that the actual pixel values have some variation around these average values. However, this may be computationally expensive, and image histograms may not have clearly defined valley points, often making the selection of an accurate threshold difficult.

F. Edge detection

Edge detection is a fundamental tool in image processing and computer vision, particularly in the areas of feature detection and feature extraction, which aim at identifying points in a digital image at which the image brightness changes sharply or more formally has discontinuities. The purpose of detecting sharp changes in image brightness is to capture important events and changes in properties of the world. It can be shown that under rather general assumptions for an image formation model, discontinuities in image brightness are likely to correspond to discontinuities in depth, and discontinuities in surface orientation. The edge detection technique used here is "Canny Edge Detection". Canny edge detection considered the mathematical problem of deriving an optimal smoothing filter given the criteria of detection, localization and minimizing multiple responses to a single edge. It showed that the optimal filter given these assumptions is a sum of four exponential terms. He also showed that this filter can be well approximated by first-order derivatives of Gaussians. Canny edge detection also introduced the notion of non-maximum suppression, which means that given the pre-smoothing filters, edge points are defined as points where the gradient magnitude assumes a local maximum in the gradient direction.In this step the binary image is taken as input and edge detection technique is performed and the canny image is obtained as shown above.

G. Hough Transforms

Hough Transform is normally applied to detect the borders of the license plate. In this system, the focus has been directed to the characters of the license plate instead. In most cases where Hough Transform is applied, the input image is normally an edged image. Then, the horizontal and vertical lines of the license plate borders will be located. However, in this system, an edged image will not be required. In contrast, the Hough Transform is directly applied onto the resultant output of the threshold processes such that the features of the characters are preserved. As usual, once the Hough Transform of the image is obtained, the peaks are then located internally. The located peaks correspond to the location of the straight lines in the image which form closed boxes and it is then plotted against an empty binary image (all 0's). The pixels which are taken up by these lines of the closed box will be converted from zero valued pixels to a value of one in this empty binary image. This will eventually allow the location of the borders of this object to be retrieved easily. Thus, by retrieving the properties of the bounding box of all intersecting lines in the image, the candidate regions bounded by these lines are obtained and can be subsequently displayed on the original image.

Fig. 3: Image performed after performing Hough rectangular transform

H. Isolating the number plate

From the output of the Hough transform only the number plate is isolated using the function ROI that is region of interest in the Opencv. The isolated number plate is now displayed in a separate window. This is not exactly the same as the input plain image. The isolation is done for the canny image because the further steps of automatic number plate recognition can be done easily for the canny image rather than for the plain image. Hence to make the further steps easy we used canny image for the isolation of number plate. Hence the image obtained after isolation is:

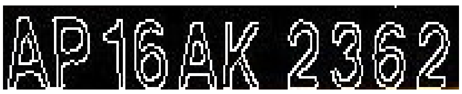

Fig. 4 : Isolated license plate, Image after performing ROI

V. Implementation of the Algorithm:

There are several steps involved in the Localization of number plate. According to our approach the steps in sequential order are:

1. Consider the plain image captured by the cc camera or digital camera.
2. Perform skew correction to the image and remove the skew if present in the given image.
3. Apply the Threshold technique to the candidate.
4. Perform edge detection to the binary image so obtained.
5. Perform Hough Rectangular transform to the canny image so obtained. The part containing the number plate will be localized.

6. Finally separate the part of the image containing the number plate.

A. Skew Detection

To perform skew correction it is essential for the programmer to first detect how much skew does the image taken by the digital camera has.we detect the skew detection manually and provide the observed skew to the program.

B. Skew Correction

The skew present in the captured image is detected and corrected in this step.Initially the image is considered and the amount of skew or angle in the image is detected and the detected skew is corrected or deskewed using the fast forward rotation algorithm. hence after performing this step the skew present in the given palin image is removed and the normal image having no skew will be obtained as the output after performing this method.The image obtained after skew correction is as shown in fig. 3.

C. Threshold

Inorder to implement the threshold first we obtain the grayscale image.Threshold is the simplest method of image segmentation. From a grayscale image, thresholding can be used to create binary images.
During the thresholding process, individual pixels in an image are marked as "object" pixels if their value is greater than some threshold value (assuming an object to be brighter than the background) and as "background" pixels otherwise. This convention is known as threshold above. Variants include threshold below, which is opposite of threshold above; threshold inside, where a pixel is labeled "object" if its value is between two thresholds; and threshold outside, which is the opposite of threshold inside. Typically, an object pixel is given a value of "1" while a background pixel is given a value of "0." Finally, a binary image is created by coloring each pixel white or black, depending on a pixel's label.
The key parameter in the thresholding process is the choice of the threshold value (or values, as mentioned earlier). Several different methods for choosing a threshold exist; users can manually choose a threshold value, or a thresholding algorithm can compute a value automatically, which is known as automatic thresholding. A simple method would be to choose the mean or median value, the rationale being that if the object pixels are brighter than the background, they should also be brighter than the average. In a noiseless image with uniform background and object values, the mean or median will work well as the threshold, however, this will generally not be the case. A more sophisticated approach might be to create a histogram of the image pixel intensities and use the valley point as the threshold. The histogram approach assumes that there is some average value for the background and object pixels, but that the actual pixel values have some variation around these average values. However, this may be computationally expensive, and image histograms may not have clearly defined valley points, often making the selection of an accurate threshold difficult.

D. Edge detection

Edge detection is a fundamental tool in image processing and computer vision, particularly in the areas of feature detection and feature extraction, which aim at identifying points in a digital image at which the image brightness changes sharply or more formally has discontinuities. The purpose of detecting sharp changes in image brightness is to capture important events and changes in properties of the world. It can be shown that under rather general assumptions for an image formation model, discontinuities in image brightness are likely to correspond to discontinuities in depth, and discontinuities in surface orientation.
In this step the binary image is taken as input and edge detection technique is performed and the canny image is obtained as shown above.

E. Hough Rectangular Transforms

Hough Transform is normally applied to detect the borders of the license plate. In this system, the focus has been directed to the characters of the license plate instead. In most cases where Hough Transform is applied, the input image is normally an edged image. Then, the horizontal and vertical lines of the license plate borders will be located. However, in this system, an edged image will not be required. In contrast, the Hough Transform is directly applied onto the resultant output of the threshold processes such that the features of the characters are preserved. As usual, once the Hough Transform of the image is obtained, the peaks are then located internally. The located peaks correspond to the location of the straight lines in the image which form closed boxes and it is then plotted against an empty binary image (all 0's). The pixels which are taken up by these lines of the closed box will be converted from zero valued pixels to a value of one in this empty binary image. This will eventually allow the location of the borders of this object to be retrieved easily. Thus, by retrieving the properties of the bounding box of all intersecting lines in the image, the candidate regions bounded by these lines are obtained and can be subsequently displayed on the original image.

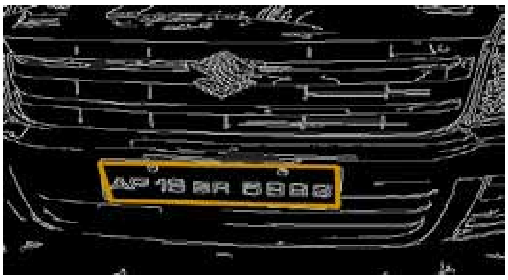

Fig. 5 : Localized number plate

In the above image the grayscale image is taken as input and Hough rectangular transform is performed and the desired output is obtained.
The highlighted red rectangular boxes signify the rectangles in which we have the number plate. It is to be noted that there may be several rectangles that can be detected, but from those the rectangle with proper dimensions containing the number plate is to be sorted out.

F. Isolating the number plate

From the output of the Hough transform only the number plate is isolated and displayed in a separate window. The method used here is the region of interest ROI. By giving the coordinates of the frequent occurrences of the position of the license plate, it can be separated and displayed in another window. Hence the required output is obtained.

ISSN : 2229-4333(Print) | ISSN : 0976-8491(Online)

VI. Result

Fig. 6 : Image obtained after performing thresholding

Fig. 7 : Image obtained after performing edge detection

Fig. 8 : Image obtained after performing Hough rectangular transform

References

[1] Balazs Enyedi, Lajos Konyha, Kalman FazekasA, "REAL TIME NUMBER PLATE LOCALIZATION ALGORITHMS".

[2] Velappa GANAPATHY School of Engineering, Monash University Malaysia,Jalan Kolej, Bandar Sunway, Petaling Jaya, Selangor Malaysia,"A Malaysian Vehicle License Plate Localization and Recognition System".

[3] KWA´SNICKA, H.—WAWRZYNIAK, B., "License Plate Localization and Recognition in Camera Pictures", AI-METH 2002 Artificial Intelligence Methods, November 13-15, 2002, Gliwice,Poland.

[4] ENYEDI, B.KONYHA, L.FAZEKAS, "Threshold Procedures and Image Segmentation", 47th International Symposium ELMAR-2005 (Multimedia Systems and Applications), 08-10 June 2005, Zadar, Croatia.

[5] SAVAKIS, A. E. "Adaptive Document Image Thresholding Using Foreground and Background Clustering", International Conference on Image Processing (ICIP'98), 1998

Mr.Varun Manchikalapudi received his M.tech degree in information technology (Networking) from VIT University, TamilNadu, India, in 2010 and B.tech degree in computer science engineering from Adams Engineering College, paloncha, Andhra Pradesh, India in 2008. He is working as a Lecturer with Department of Information Technology in V R Siddhartha Engineering College (A), Vijayawada, Andhra Pradesh, India since 2010. His research interest includes image processing and wireless networking.