



VEHICLE NUMBER PLATE DETECTION USING KIRSCH COMPASS KERNEL EDGE DETECTION TECHNIQUE

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Abstract: Vehicle number plate recognition is that the foremost exhilarating and challenging research topic from past few years. Number plates are of various shapes, size and even have different color in different countries. In India the foremost common vehicle number plates used have yellow or white as background and black as foreground color. General problems faced by the captured image while moving is quite missing all its originality due to the addition of noises and due to the environmental situations. The captured image which is analyzed by our eyes can only see a few lines of the image obtained. So we are in need of the better algorithms for processing. In this paper we proposed a system for localization of number plate for vehicles and segmented the numbers as to identify each number separately. We generally focus on two steps: one is to locate the number plate and second is to segment all the numbers and letters to identify each number separately. Modified Edge detection is an important task for the resulting clear cut image output and it is the midpoint between the image and its background. The developed system first detects the vehicle then captures the vehicle image. Vehicle number plate region is extracted using the image segmentation in a picture. The data which came is used for comparing with some records on database and getting the precise information like vehicle owner details, registration place, address, etc. This whole process is done by using MATLAB, which is used for testing on real image.

Index Terms- Kirsch Kernel Edge detection, Morphological image processing, Bounding Box, Character Segmentation

I. Introduction

Engineering and Science plays a vital role in providing innovative technologies for the welfare of society which is used for solving real time problems in various fields. The versatility of applications may range from engineering design, optimization theory and medical diagnosis to image processing [1-3]. Vehicle number plate detection system is a digital image processing [4] technique broadly used in vehicle transportation system to identify the vehicle. In highly restricted areas the security is big issue and also in public places. Reducing Vehicle Crime, Burglaries, Shop Theft can be done by VNPR [5]. Number plates are of different shape, size and also have different colour in different countries. In India the most common vehicle number plates used have yellow or white as background and black as foreground colour. We generally focus on two steps; one is to locate the number plate and second is to segment all the numbers and letters to identify each number separately. The automatic number plate recognition is a mass surveillances method that uses optical character on image to read the license plates on vehicles. There are used by the various securities, police forces and as a method of electronic toll collection on the payments, and to monitor traffic activity as a red light at an intersection. This algorithm will take input as an image of a vehicle; perform pre-processing process. The pre-processing helps us to get an improved image data which suppresses the unwanted which leads to misrepresentations and improves important features of the image for further processing. The processed image is given to segmentation. The captured digital image of vehicle is the input in this procedure in order to perform pre-processing. The input RGB image [6] in the pre-processing is first converted into gray scale image [7] and then into a binary image when you apply the thresholding technique. To locate the boundaries in the image we need to apply image segmentation. Kirsch compass kernel [8] is used to locate the number plate region. Morphological image processing like dilation and erosion are applied on the edge detected image for further processing. Thereafter it undergoes some stages such as character segmentation and bounding box techniques which results the final desired output. The ability of the human eye will not support us to analyze the captured image. The image also contains noises which may result in losing its originality. So we should apply efficient algorithms to get the expected output. Edge detection plays a crucial role in detecting clear cut image output. If the edge detection is done perfectly then the properties of the image like intensity, area etc., can be analyzed perfectly.

II. Kirsch Compass Kernel Edge Detection

The below process shows the complete working process

- ❖ Taking **Input Image** which is in RGB form.
- ❖ Converting **RGB 2 Gray Scale** will be done.
- ❖ **Gray to Binary Conversion** will be done for getting better results.
- ❖ Now applying **Kirsch Compass Kernel Edge Detection** to latest converted image.
- ❖ The above process will be done by comparing all mask values of kirsch method.
- ❖ Applying dilation, erosion with structuring elements will be done by **Morphological Image Processing** method.
- ❖ **Extraction of Number Plate Region** [9] which covers each pixel of an image and helps to locate digits/numbers in number plate.
- ❖ The final process is **Character Segmentation**, segmenting each individual character from number plate.
- ❖ The **Output Image** will be shown in MATLAB programming.

A. Captured Image

Two dimensional function $f(x, y)$ represents an image, here x and y are spatial co-ordinates, and the amplitude of f at any pair of coordinates (x, y) is called the intensity or gray level of this image at that point. Processing digital images by means of a digital computer refers digital image processing. The term pixel is most widely used to elements of a digital image.

Firstly, the input image is image captured by a digital camera.



FIG-1: Input RGB image

B. Pre-processing

Performing some operations and converting an image into digital form there is need of image processing, by using this method we get an enhancement image by extracting some useful information from it. This entire process is like signal dispersion [10] in which input is image, like video frame or photograph and output may be image or characteristics associated with that image. The input RGB image is converted into binary image by two steps. Firstly, the RGB image is converted into gray scale image and secondly, this gray scale is converted into binary image.

a. CONVERSION OF RGB TO GRAY:

The RGB image is converted into gray scale image by using the formula [11]:

$$Y = 0.30R + 0.59G + 0.11B$$

The input is needed to be converted into gray scale image because gray scale image helps us to identify important edges (i.e. step change in the pixel values and other features). The value of each pixel is a single sample representing only an amount of light, that is, it carries only intensity information in digital photography, and colorimeter a gray scale or gray scale image. Gray scale images, a kind of black-and-white or gray monochrome, are composed exclusively of shades of gray. Grayscale images have many shades of gray in between 0 and 255.



FIG-2: Gray scale image

b. CONVERSION OF GRAY SCALE TO BINARY

This gray scale image contains wider range of values ranging from 0 to 255. so in order to overcome that, this gray scale image is further converted into binary image which has only two values 0 and 1. Converting to binary is used to find the region of interest in our image. Here our region of interest is only the number plate of the vehicle. Thresholding technique is used to binarize the image. In general plates are of rectangular in shape hence it is necessary to detect the edges of rectangular plates. It is a process of taking gray scale image & converting to black and white reducing information contained in 256 shades of gray to 2 colors i.e., black and white. It works by finding the threshold value in histogram, which divides the histogram into 2 parts [12]

$$G(x, y) = \begin{cases} 1 & \text{if } f(x, y) > T \\ 0 & \text{if } f(x, y) \leq T \end{cases}$$

Now the further processes are applied on this binary image for number plate extraction. Thus the preprocessing technique converts the input RGB image into binary image.

III. DETECTION OF EDGE USING KIRCH METHOD

Kirsch edge detector is a linear edge detector [13] which named after the scientist RUSSEL.KIRSCH. Kirsch edge detection is used to find the maximum edge strength in its eight predetermined compass directions. The magnitude of the edge detection can be determined by considering the maximum magnitude among its eight predetermined directions. The edge that contains the maximum magnitude determines the direction of the edge.

KERNAL MASK VALUES:

Kirsch operator takes a single kernel and rotates it in 45 degree agreement which results in all 8 possible compass directions i.e. north, northwest, northeast, south, southeast, southwest, east and west. The fixed 3*3 kernel mask values [14] for all the images in 8 compass directions are as follows.

$$\begin{array}{l} N = \begin{vmatrix} 5 & 5 & 5 \\ -3 & 0 & -3 \\ -3 & -3 & -3 \end{vmatrix} \quad NW = \begin{vmatrix} 5 & 5 & -3 \\ 5 & 0 & -3 \\ -3 & -3 & -3 \end{vmatrix} \quad W = \begin{vmatrix} 5 & -3 & -3 \\ 5 & 0 & -3 \\ 5 & -3 & -3 \end{vmatrix} \quad SW = \begin{vmatrix} -3 & -3 & -3 \\ 5 & 0 & -3 \\ 5 & 5 & -3 \end{vmatrix} \\ E = \begin{vmatrix} -3 & -3 & 5 \\ -3 & 0 & 5 \\ -3 & -3 & 5 \end{vmatrix} \quad NE = \begin{vmatrix} -3 & 5 & 5 \\ -3 & 0 & 5 \\ -3 & -3 & 5 \end{vmatrix} \quad S = \begin{vmatrix} -3 & -3 & -3 \\ -3 & 0 & -3 \\ 5 & 5 & 5 \end{vmatrix} \quad SE = \begin{vmatrix} -3 & -3 & 5 \\ -3 & 0 & 5 \\ -3 & 5 & 5 \end{vmatrix} \end{array}$$

The algorithm for the kirsch kernel edge detection is as follows:

READING THE IMAGE:

The input image is captured by the digital camera and is converted into gray scale image. This gray scale image is further converted into binary image.

SMOOTHING:

Smoothing operation [15] is performed on the binary image. Smoothing operation is nothing but image enhancement followed by low pass filtering. Image Enhancement [16] means processing an image to make it more appropriate for certain applications by improving edges, boundaries, changes in intensity. Low pass filtering is performed to remove the higher frequency components. The Gaussian filter [17] is used to remove the uniform noise and also the salt and pepper noise.



FIG-3: Gaussian filter output

COMPUTING GRADIENTS:

After performing smoothing operation, Gradients are computed for the image. Gradient is a measure of how steep a line or slope is. Gradients are computed in order to find the direction change in intensity or color.

NON MAXIMUM SUPPRESSION:

Next the image is subjected to Non Maximum Suppression. It is used to make sure that a particular object only once. It takes a cell with largest probability of object as prediction and then discarding the remaining cell with intersection over union >0.5 with that prediction cell. Non maximum suppression is used in object detection to eliminate the different cells of the object without changing the image.

THRESHOLDING:

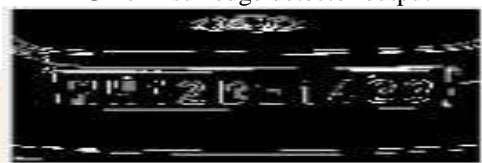
Next the image is subjected to Thresholding. Thresholding is performed by setting a threshold value. The Threshold value can be set by dividing the image into two parts then calculating the mean of the two parts individually and then finally calculating the average of the these two means gives the threshold value.

Now the pixels of the image are compared with this threshold value. If they are greater than the threshold value then those pixels are assigned with 1 (WHITE). If they are less than the threshold value then those pixels are assigned with 0 (BLACK). The output image is in terms of 1's and 0's.

OUTPUT OF KIRSCH COMPASS KERNAL EDGE DETECTION:

Therefore the output of Kirsch Compass Edge Detection is our required edge detected output which gives the maximum edge strength.

FIG-4: kirsch edge detector output



IV. MORPHOLOGICAL IMAGE PROCESSING

Collection of non-linear operations related to the shape or morphology of features in an image is called morphological image processing. The operations of morphological are especially suited to the processing of binary images and they rely on relative ordering of pixel values, not on their numerical values. By applying these operations to grey scale images such that their light transfer functions are unknown and therefore their absolute pixel values are of no or minor. Morphological techniques probe an image with a small shape of template called a structuring element. The structuring element is nothing but a matrix which features to measure the shape of the image. The structuring element is positioned within the least possible locations in the image and it's compared with the corresponding neighborhood of pixels. Some operations test whether the element "fits" within the neighborhood, while others test whether it "hits" or intersects the neighborhood. In simple words, a morphological technique modifies an image with a small shape or template called a structuring element.

A. DILATING AN IMAGE:

In the area of mathematical morphology there are two operators existed namely dilation [18] and erosion [19]. There are various versions that work on grayscale images but dilation is typically applied to binary images. Enlarging the boundaries of regions of foreground pixels (i.e. white pixels, typically) will be done by this dilation operator. While holes within those regions become smaller then the areas of foreground pixels grow in size. Taking two pieces of data as inputs by this operator. The first is the image which is to be dilated. The second is a (usually small) set of coordinate points known as structuring element (also known as a kernel). An essential part of the morphological dilation and erosion operations is the structuring element used to probe the input image. A structuring element is a matrix that identifies the pixel in the image being processed and defines the neighborhood used in the processing of each pixel. You typically choose a structuring element an equivalent size and shape because the objects you would like to process within the input image. For example, to seek out lines in a picture, create a linear structuring element. Dilation operation needs to be performed because the binary gradient mask obtained after the edge detection process shows lines of high contrast in the image. These lines do not highlight the object of interest. Compared to the input image, the gaps present in the lines are observed that surrounds the object in the binary gradient mask. These linear gap disappears if the gradient image is dilated using the structuring elements. Dilation can made directional by using less symmetrical structuring elements.

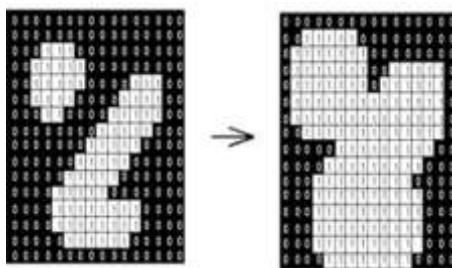


FIG-5: Dilation

APPLIED DILATION OPERATION ON KIRSCH EDGE OUTPUT:



FIG-6: Dilated image

B. PROCESS OF REMOVING INTERNAL GAPS:

The gradient mask which is obtained after dilation shows the edges and the still present interior holes. Holes are a set of background pixels that are not processed during dilation. The `imfill()` function that is provided by the MATLAB toolbox helps to fill the holes in the dilated image.

C. ERODING AN IMAGE:

The erosion operation helps us to remove the objects that are connected to the border of interest. This process is used for the extraction of the number plate. In mathematical morphology erosion is one of the two basic operators. It is typically applied to binary images, but there are versions that run on grayscale images. Erosion is also called as the process of dual of dilation $b=f-(f \ominus s)$ Where f is an image of the regions, s is a 3×3 structuring element, and b is an image of the region boundaries.

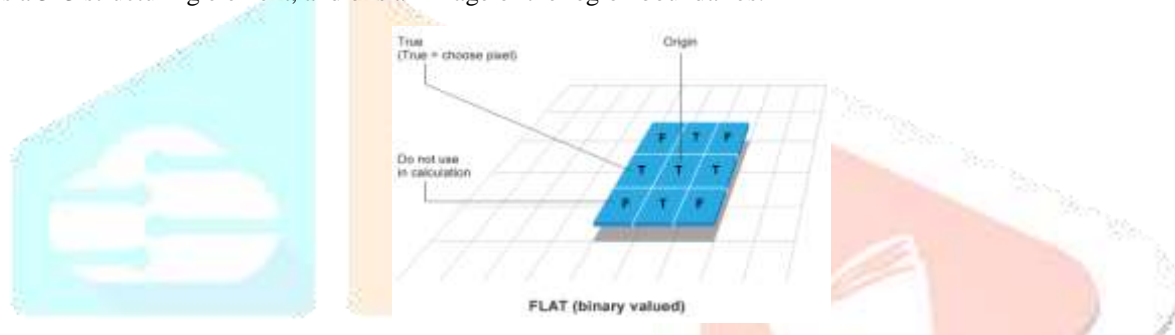


FIG-7: Structuring element

Erosion operation is performed in order to make the segmented object look natural; the image is eroded TWICE with the structuring element in order to have better results.

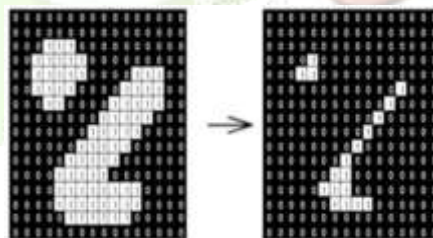


FIG-8: Eroded image

This extraction process helps in extraction of number plate area of the vehicle. This erosion operation also helps in removing the connected objects to the border of region of interest.



FIG-9: Eroded car image



FIG-10: second eroded image

APPLIED EROSION OPERATION ON DILATED IMAGE

V. SEPERATION FOR NUMBER PLATE SECTION

The extraction process [20] followed by this proposed paper is initially MATLAB should be trained with all the characters (A-Z) and numbers (0-9). In order to extract the number plate region from the entire image segmentation operation is performed. Segmentation is one of the most crucial steps in the number plate detection, because the characters are the smallest unit of any language script and all further steps depends on this process. If the segmentation fails, an image or the object of interest can be improperly divided into two pieces. A poor segmentation process leads to incorrect recognition or rejection for better performing the segmentation process bounding box technique is used. The bounding box technique is used to measure the properties of the image region where it is placed.

A. IMAGE CROPPING:

Imcrop () function [21] is used to crop the number plate location from the processed image. It is done by giving the eroded image as input and with the properties obtained by the bounding box technique. Imcrop(y, bb) crops the image y according to the position and dimensions specified in the crop rectangle or bb. Bounding box in other words can be defined as crop rectangle which is a vector form[x, y, width, height] which specifies the size and position of cropped image. The cropped image includes the pixels in the input image that are enclosed by bb.



FIG-11: Cropped image

B. IMAGE AREA OPENING:

Bwareaopen () function is used to remove some object of width is too long or too small of given desired area. Bwareaopen (BW, P) removes all connected components or objects that have fewer than P pixels that have fewer than P pixels from the binary image BW, producing another binary image, BW2. This operation is known as an area opening. Connectivity can be defined in a more general way for any dimension by using a CONN a 3 by 3 matrix of 0's and 1's. The 1-valued elements define neighborhood locations relative to be center element of CONN. It must be symmetric about its center element.



FIG-12: Opening an image

C. CHARACTER SEMENTATION

Character segmentation [22] is the most crucial step for any OCR system [23] because the characters are the smallest unit of any language script. After segmentation of the character features can be ext, cannot be recognized in character segmentation, we extract only characters from word. Character segmentation is a difficult step of OCR systems as it extracts meaningful regions for analysis. This step decomposes the images into classifiable units called character. A poor segmentation process leads to incorrect recognition or rejection segmentation process carried after out only after the preprocessing of the image accurately by feature extraction algorithm. Segmentation of character is quite easy in case of printed documents as compared to the handwritten documents. Vertical projection is used for character segmentation. Bounding box is a rectangular border that fully encloses a digital image where it is placed over a page. Bounding box technique is important to perform in order to segment each character and display them individually in MATLAB window. The properties of individual character such as length are given to the bounding box operation. Once each character and number is separated for reorganization of number plate then they are compared with the each individual character against the database which consists of both numeric as well as alphabets using template matching. MATLAB window displays the extracted characters.

VI. RESULT ANALYSES



FIG-13: M.bmp

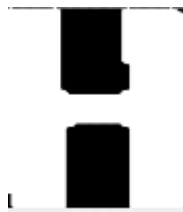


FIG-14: H.bmp



FIG-15: 1.bmp



FIG-16: 2.bmp



FIG-17: D.bmp



FIG-18: E.bmp



FIG-19: 1.bmp



FIG-20: 4.bmp



FIG-21: 3.bmp



FIG-22: 3.bmp

VII. APPLICATIONS:

Wide range of applications since the vehicle number plate is the primary, most widely accepted, human readable, mandatory identifier of motor vehicles. The main applications of vehicle number plate recognition are:

A. Motorway Road Tolling:-

Reducing fraud related to non-payment, makes charging effective, reduces required manpower. License plate recognition is usually used as a really efficient enforcement tool [24].

B. Theft control:-

Automatic number plate recognition is an ideal technology to be used for theft control purpose. It is able to automatically identify stolen cars based on the up-to-date blacklist.

C. Border Control:-

Supporting the homeland's security against terrorism, illegal cross border traffic [25], smuggling and criminal activities. This recognition adds significant value by alarming on suspicious passings, at many more.

ADVANTAGES:

1. Detection and recognition can be done on real time process for vehicle license plates.
2. Reliable performance and good accuracy for different license plates.
3. Transmits real-time stamp of entry or exit of the vehicle to the database.
4. Supports capture of license plate along with the vehicle image.

VIII. CONCLUSION

In this a real time number plate detection method was proposed based upon the noises and algorithms. In this we have overcome the drawbacks of previous methods. In this project, the input image is an RGB image of a vehicle number plate captured by a digital camera is being processed and segmented into characters which are displayed in individual MATLAB windows. Due to this process vehicle number plate detection is more accurate. The procedure involves techniques like Edge detection, Bounding Box technique, Morphological image processing like erosion and dilation, Bounding Box technique plays a crucial role in extracting the number plate from the captured image by taking the input properties like area, width, height etc. The kirsch compass kernel edge detection technique is different from the edge detection techniques like sobel, canny, prewitt, etc. This technique involves a kernel masks in eight compass directions like north, east, west, south, Northeast, northwest, southeast, southwest for better edge detection, whereas in other techniques there involved only single mask in a specified direction. Kirsch edge technique gives more accurate results and involves less code complexity and time consumption and very economical unlike in other types of edge detection methods.

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