High Security Number Plate Recognition System with Different Filtering Techniques for Image Enhancement

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ABSTRACT

High Security Number Plate Recognition could be used to automatically open a gate or barrier into a secured area for authorised members. This could replace or assist security guard at the gate or barriers of premises. If a vehicle is stolen, it could be marked in the Number plate recognition system as so if any point the stolen vehicle happens to pass a camera on the road side that belongs to the license plate recognition system, an alarm is set off to alert a guard. To control the Traffic Flow Management, Automatic Number Plate Recognition is very popular in tracking trespass vehicles, which are breach the speed rule on highway or use illegal bus lane. Each highway follows the specific speed. If any vehicle violates that speed limit the camera capture the image of that vehicle with license plate. In this paper frequency domain filter, maxican hat operator filtering and spatial filter are used for the image enhancement.

KEYWORDS

HSLP, Frequency domain filter, spatial filter, Fourier transformation, difference, Threshold.

1 INTRODUCTION

Today, more than billion vehicles are running on the roads that make the roads very busy. Due to this controlling of the transportation is very difficult [9]. Intelligent Transportation System (ITS) helps us in managing billion vehicles that are running on the roads. Auto population is increased in proportionality with economy, technology and need of persons. Due to these problems like congestion of traffic and high rate of accident is increased. Build more and more infrastructures such as highways, local roads are not a proper solution of this problem because of limited space in city, funds and geographical conditions [9]. So that needs very efficient intelligent system that improves the traffic management. In this paper we have used frequency domain filter and spatial filter for the image enhancement of Intelligent Transport System. A High Security Number Plate Recognition System (HSNPRS) is one of the parts of the Intelligent Transport System (ITS) that spot the vehicles by using their number plate [1]. An HSNPR system is designed for identifying the vehicles by using their number plate. This system has the ability to automatically capture the image and collect and recognize the vehicle's number plate characters from the image.

2 AUTOMATIC NUMBER PLATE RECOGNITION

Automatic Number Plate Recognition could be used to automatically open a gate or barrier into a secured area for authorised members. This could replace or assist security guards at the gate or barriers of premises. If a vehicle is stolen, it could be marked in the Number Plate Recognition System as so if any point the stolen vehicle happens to pass a camera on the road side that belongs to the license plate recognition system an alarm is set off to alert a guard [2] [3] [9] [10].

To control the Traffic Flow Management automatically Number Plate Recognition is very popular in tracking trespass vehicles, which are breach the speed rule on highway or use illegal bus lane. Each highway follows the specific speed. If any vehicle violates that speed limit the camera capture the image of that vehicle with license plate. And then get the number plate registration

they fine him [3] [6]. The process of license plate recognition is shown in Figure 1

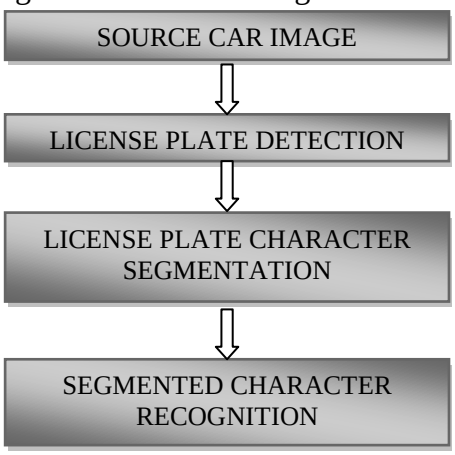

Figure 1. Flowchart for the automatic License Plate Recognition

To manage the paid parking system [3] [6], automatic number plate recognition system read the number plate of the vehicle when it enter in the parking area and store data in the database. On exit time it's again read the license plate and calculates the parking fee according to the duration of the parking [5] [10]. This system is work differently for pre-paid or non paid members.

2.1 Automatic Toll Collection System

Automatic Toll Collection or highway ticketing system [11] [14] is other one main application in which camera captures the vehicle, get the number of the license plate and feed all input detail in system automatically and calculate the toll fee. After paid the toll fee toll gate automatically open and close for next vehicle.

2.2 High Security License Plate and Features

Our Indian government launch the high security number plate that will prove to be great check on smuggling, terrorism, crime etc. [7]. High Security Number Plate has special features like leaser code, locking system, embossed alpha numerals and borders, hot stamping hologram and special number encryption. HSLP has some special features according to the rules of Govt. of India [Rule 50], as in [7] shown in Figure 2 are following-

Figure 2. High Security Number Plate with features

Figure 3. Third Number Plate Sticker Pasted on Wind Screen

1) According to the DIN 1745/ DIN 1783 or ISO 7591 the license plate shall be a solid unit made of 1.0 mm aluminium.
2) License plate border edges and corners shall be rounded to avoid injuries.
3) License plate's borders must be embossed.
4) The plate material shall be appropriate for the hot stamping.
5) The superior grade reflective sheet has to be guaranteed of their undestroyable property for minimum five years.
6) High Security License Plates (HSLP) will have a high quality retro reflective sheet with lamination and embossed. This sheet provides excellent clarity during day time and offer high reflectivity in night. By order of reflective sheeting the vehicle is visible from a minimum

difference of 200 meters in night irrespective of the working of its tail lamps etc.

7) Hot-stamping of chromium based hologram makes it possible for a license plate to withstand the inclemency of the weather for many years; the hologram have the image of 'CHAKRA' as notified by the Govt. of India. This hologram is hot stamped by high pressure at 220^{o} Celsius, so that it cannot be tampered with or removed or replace. Hologram on license plates is clearly visible with naked eyes that are giving a direct hint about cheat if they are missed or tempered or destroyed on plates.

8) Pearl Pigment color ink is used for the inscription purpose to avoid copying such kind of product by using a simple print. It easily verified this kind of color by changing the visual direction between the license plate and the viewer in day light. They can see the changes in the intensity of the color.

9) Plate is decorated by the laser code placed on the left hand side just below the word IND. This laser code is unique for each license plate across the country. It is sequentially generated for individual license plate. It is work as a watermark that cannot be tempered or erased. On the basis of this laser code collect the complete detail of the vehicle from the records of the HSRP supplier or Regional Transport Office (RTO).

10) As shown in Figure 3, this is a self-destructive self-adhesive sticker pasted on wind screens. It contains all information pertaining to a vehicle's registration like laser number, engine number, chassis number, hologram etc. This serves the purpose of double secure identification mark of a vehicle.

11) License plate is snap locked to the vehicle body. This is an external fastening device used as normal bolting procedure. Due to this device any type of tempering with the plate and snap lock is easily detectable by naked eyes. This technique makes easy for the law enforcing agencies to detect any abnormality in the License Plate. This snap locking system is used in various countries worldwide including Japan, Korea, Vietnam, Indonesia etc.

2.3 Elements of Standard ANPR System

Standard ANPR system has following elements as following: -

1) Camera: A good quality and resolution camera for capturing images of vehicles from either front or rear end [3], [4].

2) Illuminator: A device that focused the light for bright- up the license plate. In some cases illuminator is infrared illuminator that is not visible to the driver [4].

3) Frame Grabber: An interface board between the camera and the PC or computer that allow the software to read the image information [4] [12].

4) Computer: Basically computer provides the interface between application and system to run the ANPR system. Computer handle the process of ANPR system as reading of image, analysing, identification of license plate, character segmentation , character recognition and interface with other applications [3] [4].

5) Software: Software that contains the ANPR application with segmentation and recognition package [4] [14].

6) Hardware: To interact with the real world required various input or output boards like keyboard, control board, networking board, printer etc [4] [13] [14].

7) Database: The most important element of the ANPR system that store all the processed data. The database contains the recognition results or vehicle's image or driver image. All actions are stored on a local database and transmitted it on the network for future processing [4].

8) Sensors: It indicates enter or exit of the vehicle. When vehicle enter it close the gate

and after payment it open the gate. When vehicle exit it again close the gate for next upcoming vehicle [2 - 4].

2.4 Working of HSNPR system

1). Steps of HSNPR System

Working steps of HSNPR system are following as discuss in [1-3]. Figure 4 has shown the steps of HSNPR system.

a) Capturing: - Capture a vehicle image.
b) Extraction: - Extraction of the number plate from captured image.
c) Normalization: - Normalized the extracted image.
d) Segmentation: - Get individual characters from the normalized image using image segmentation techniques.
e) Recognition: - Recognize the individual characters with the help of database, storage of each and every alpha-numeric characters.

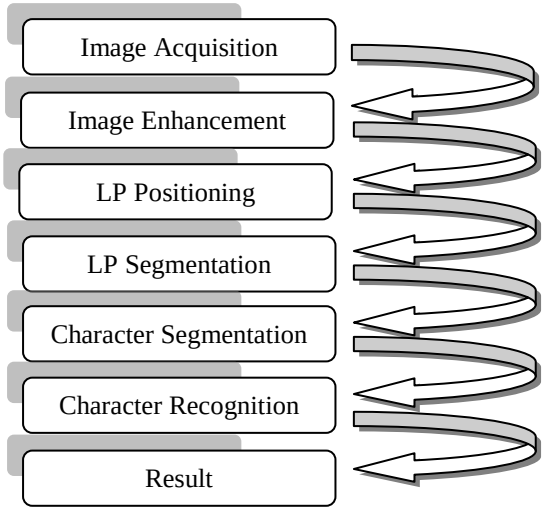

Figure 4 Working steps of HSNPR System

2). Working of HSNPR System

In the current scenario where technology on their height, ITS should need High security number plate recognition system for vehicle identification. To complete the process action successfully need perfect image of the vehicle [4] [5]. When the vehicle enters in the secured area, sensor senses the vehicle and active the illuminator for proper lighting. In some areas ITS use infrared light that are invisible for human beings.

Our digital camera place on secured area by facing towards the vehicle is capture either the front or rear end image of the vehicle in proper lighting condition. After capturing process image is feed into the HSNPR system for further processing as input image [6] where image is enhanced and further processed. Further process includes finding the plate position, segment the plate, segments the characters placed on plate and recognize the segmented characters.

Then system checks that vehicle number is legal or illegal by comparing with the predefined list of authorised vehicle. If the vehicle is authorised than it generate the green signal and open the gate by activating the relay. When the vehicle passed away or exit from secured area again red signal generated and gate is closed automatically for next vehicle [4]. The same process is again started for next upcoming vehicle. Working process of the HSNPR system is shown in Figure 5.

Thus HSNPR system is work is the secured area. The same process is applied on toll plaza or parking places with one extra step of payment collection gate are open after the area's fee collection.

2.5 Requirement for Best Results of Processed Image

If the vehicle image is not good then after processing best results are not achieved. So that to get best results after processing according to [5] [14] need following things in image–

1) Good spatial resolution
2) Good sharpness
3) High contrast
4) Adequate lighting conditions
5) Decent angle of view

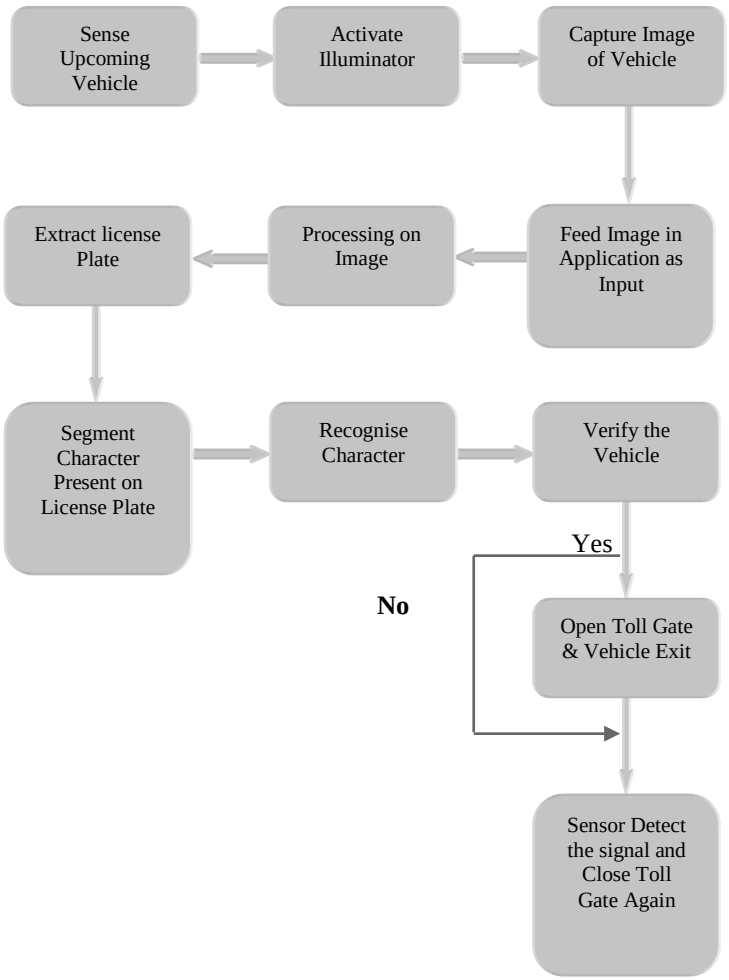

Figure 5 Working of ANPR System

When all these requirements are fulfil in the image to get best results after processing. Images captured in different condition with different resolution power and illumination condition is shown in Figure 6(a) resolution is 1600*1200 pixels, in figure 6(b) resolution is 640*480 pixels, in figure 6(c) resolution is 1280*1024 pixels but illumination condition is not proper and in figure 6(d) resolution is 1280*1024 pixels without proper illumination and angel.

Figure 6(a) Image captured by 1600*1200 pixels camera.

Figure 6(b) Image captured by 640*480 pixels camera.

Figure 6(c) Image captured by 1280*1024 pixels camera without proper illumination

Figure 6(d) Image captured by 1280*1024 pixels camera without proper illumination and angel

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3 LICENSE PLATE IMAGE ENHANCEMENT

According to the HSNPR system after capturing the image of vehicle it need to enhance the image for proper finding the plate position. For enhancement process we use Frequency Domain filter obtaining by spatial filter technique [8] and then get following images as shown in Figure 7 to Figure 11. For complete our purpose we perform discrete Fourier transformation on the source's gray scale image. Then we generate the frequency domain filter using the Sobel spatial filter that enhance vertical edges of the image as [8] by using

$$H=freqz2\ (h, R, C)$$

Where h is a 2-D spatial filter, R is the number of rows, C is the number of columns and H is the corresponding 2-D frequency domain filter.

Then we compare the result of filtering f getting by spatial domain with the result obtained by performing the equivalent process in the frequency domain.

3.1 Algorithm for Filtering

Step 1. Perform Fourier transformation of the gray scale image and get F image.

Step 2. Generate Spatial Filter h and convert h into frequency domain filter as by using

freqz2 (h) (1)

function**.**

Step 3. Perform the comparison between filtered image getting by spatial filter and frequency domain filter generated image.

Step 4. Apply some threshold values to shown the edged more clearly.

Step 5. Perform the difference between the Mexican hat operator filtered image and the frequency domain filtered image.

Figure 7 (a) Mexican hat Operator Filtered image

Figure 7 (b) Mexican hat Operator Filtered image

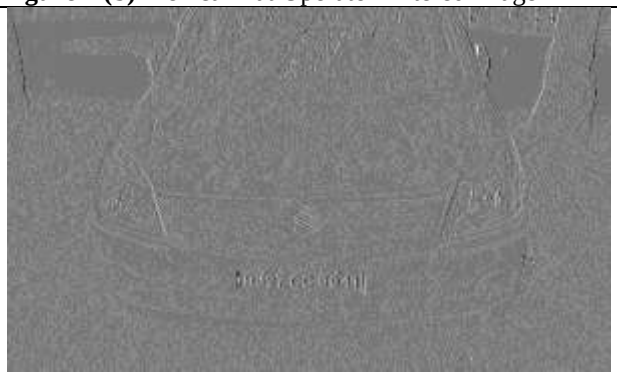

Figure 8 (a) Frequency domain filtered image

Figure 8 (b) Frequency domain filtered image

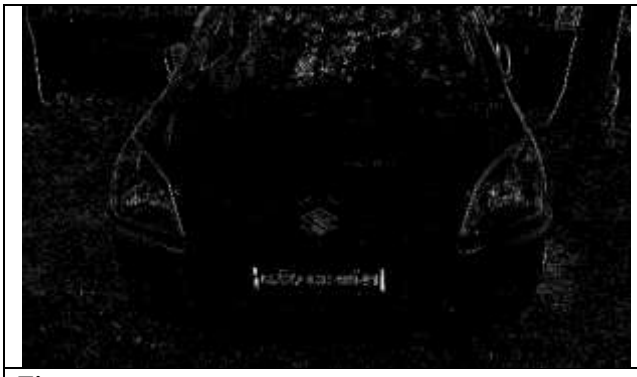

Fig
ure 9(a) Frequency domain filtered image with threshold of absolute value.

Figure 9(b) Frequency domain filtered image with threshold of absolute value.

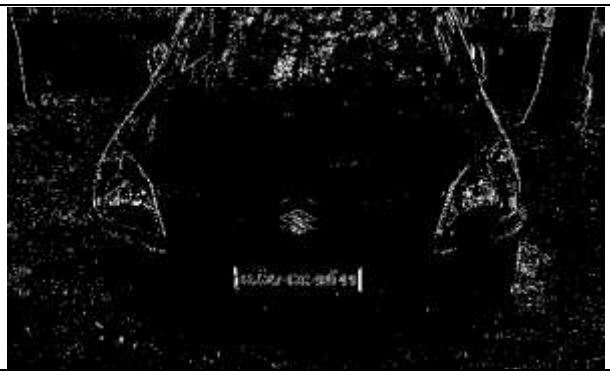

Figure 10(a) Frequency Domain Filtered image with threshold abs(gf)>0.2*abs(max(gf(:)))

Figure 10(b) Frequency Domain Filtered image with threshold abs(gf)>0.2*abs(max(gf(:)))

Figure 11(a) Differnce image of Maxican Hat operator filtered image and Frequency Domain Filtered image

Figure 11(b) Differnce image of Maxican Hat operator filtered image and Frequency Domain Filtered image

4 MATHEMATICAL SUPPORT

Step 1: Read input image and convert it into gray scale image.

```
grayimg=rgb2gray(imread('input image'));
d=double(grayimg);
[r c]=size(d);
```

Step 2: Create new Maxican Hat Operator filter and filter the input image by it and get the threshold value.

```
filter=[0 0 0 -1 -1 -1 0 0 0;
 0 -1 -1 -3 -3 -3 -1 -1 0;
 0 -1 -3 -3 1 -3 -3 -1 0;
 -1 -3 -3 6 12 6 -3 -3 -1;
 -1 -3 -1 12 25 12 -1 -3 -1;
-1 -3 -3 6 12 6 -3 -3 -1;
 0 -1 -3 12 10 12 -3 -1 0;
 0 -1 -3 -3 1 -3 -3 -1 0;
 0 0 0 -1 -1 -1 0 0 0];
gm=zeros(r,c);
for i=5 : 2 :r-5
    for j=5: 2: c-5
   gm(i,j)= sum(sum(double(grayimg(i-
4:i+4,j-4:j+4)).*filter,2));
    end
end
%After Threshold
```

```
fath=gm>2500;
figure,imshow(fath);
```

Step 3. Perform Fourier transformation of the gray scale image and get F image.

```
F=fft2(grayimg);
```

Step 4. Generate Spatial Filter h and convert h into frequency domain filter.

```
h=fspecial('sobel');
h=h';
freqz2(h);
pq=paddedsize(size(grayimg));
H=freqz2(h,pq(1),pq(2));
H1=ifftshift(H);
```

Step 5. Apply Sobel spatial filter on the grayimage and get new image(gs) and apply frequency domain filter on grayimage and get new image(gf).

```
gs=imfilter(double(grayimg),h);
gf=dftfilt(grayimg,H1);
figure,imshow(gs,[]);
figure,imshow(gf,[]);
```

Step 6. Apply different threshold values in step 5 to show the edged more clearly.

```
figure,imshow(abs(gf),[]);
figure,imshow(abs(gf)>0.2*abs(max(gf(:))
));
```

Step 7. Subtract the new boat filter operator image and the frequency domain filtered image and get the more enhanced image.

```
d=gf-fath;
D=abs(d)>0.2*abs(max(gf(:)));
figure,imshow(D);
```

5 CONCLUSION

In this paper we have used boat filter operator and frequency domain filter with different threshold value for image enhancement. We have implemented these filtering techniques in MATLAB for 100 Number Plates and get the best result. The algorithms used are easy and simple.

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