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BMM Filtering Approach for Image Enhancement of Indian High Security Registration Number Plate

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Abstract: ***The population of India is growing expeditiously with a national average growth rate of 1.41per cent per annum (Census of India, 2011). Increase in population and economic activities the travel demand has increased many folds. The inadequate public transport and the easy availability of financing facilities for private vehicles have resulted in increased vehicle ownership levels and their usage.***

Crumbling road infrastructure coupled with the increase in vehicle population has hurled the city's traffic problem to ungovernable levels. There could be two possible viewpoints to solve this problem. First viewpoint is to come up with an infrastructure which involved wider roads, expressways, flyovers and bypasses. But in developing age of developing countries like India, Malaysia, Sri Lanka, etc money and space are very big concerning problem. Second viewpoint is to manage the existing traffic load on the same available infrastructure, with the use of technology. This calls for the vital need of Intelligent Transportation Systems (ITS), which helps in managing billion vehicles that are running on the roads.

This paper mainly focused on image enhancement and segmentation phase of high security registration number plate recognition system. We present the Hybrid approach of the Boat operator filter and Montane filter, which is very useful and successful filtering technique for image enhancement and edge detection.

Keywords: BMM approach, hybrid, boat operator, montane, HSRNP

1) Introduction

The population of India is growing expeditiously with a national average growth rate of 1.41per cent per annum (Census of India, 2011). Increase in population and economic activities, the automobile manufacturers, transport industries and road transport atop more responsibility of fulfilling the travel demand. To fulfil the travel demand, the automobile companies procures so many various types and models of vehicles in the market. The inadequate public transport and the easy availability of financing facilities for private vehicles provided by automobile companies and local dealers have resulted in increased vehicle ownership levels and their usage.

Shattering road infrastructure coupled with increases in vehicle population has hurled the city's traffic problem to ungovernable levels [9]. There could be two possible viewpoints to solve this problem. First viewpoint is to come up with an infrastructure which involved wider roads, expressways, flyovers and bypasses. But in developing age of developing countries like India, Malaysia, Sri Lanka, etc money and space are very big concerning problem. Second viewpoint is to manage the existing traffic load on the same available infrastructure, with the use of technology [10]. This calls for the vital need of Intelligent Transportation Systems (ITS), which helps in managing billion vehicles that are running on the roads.

Intelligent Transportation System (ITS) is a system which effectively manages the traffic congestion and automated traffic management. High Security Registration Number Plate Recognition System (HSRNPRS) is one important part of the Intelligent Transportation System, which helps in managing traffic congestion and automated traffic management of intelligent transportation System (ITS). In the real time HSRNPR system plays an important role in monitoring and controlling of the traffic rules and regulations and maintaining law enforcement in public roads [1].

2) Document Structure

Section 1 consists the Introduction of the paper which describes the how we need the High Security Registration Number Plate Recognition System (HSRNPRS) in intelligent transportation system (ITS). Section 2 consist the document structure which describes the paper outline. Section 3 consist the Indian High Security Registration Number Plate specification with format of Indian number plate. Section 4 consists the methodology of a proposed system. In this methodology define the pre-phase image, image processing and edge enhancing filtration algorithm. Image processing consists gray scale conversion, proliferation operation, rotation, intensity transformation phase and histogram equalization. Edge enhancing filtration algorithm consists the new BMM filter description which is merging result of Boat operator and Montane filter. Section 5 consist the conclusion and section 7 consists the reference of the paper that we use in it.

3) Indian High Security Registration Number Plate Specification

To maintain the traffic congestion with a fully automated system Indian Government amends the Rule 50 of the Central Motor Vehicles Rule, 1989 with temper proof High Security Registration Number Plate [7]. India is a developing country and is necessary to maintain some specific attributes of the vehicle's number plate like the size of the plate, background color of the plate, location of the plate, font face, font size, font color of the characters, spacing between the continuing characters, no of lines in the number plate, number plate material etc. [2] [7]. The high security registration number plate is designed or manufactured by the government authorized companies as – Shimnit Utsch India Pvt. Ltd., Mumbai [8]. This company is collaborating with the Erich Utsch AG of Germany [4]. HSRNP is designed in a different manner for each vehicle type by some standard size and technical specification as described in G.S.R.No.221 (E) dated 28.03.2001 and S.O. No. 814 (E) dated 22.08.2001, S.O.No. 1041 (E) dated 16.10.2001 and GSR No. 589 (E) dated 16th September, 2005 notified in the Gazette of India [5].

In India, vehicles population is divided into two categories. First category is named as vehicle's privatization and the second category is named as vehicle's commercialization.

Vehicle's privatization includes all types of private vehicles like two wheelers, cars, jeep etc. consists white background number plate with black numbering [2]. Number plate of private vehicle is shown in figure 1.

Figure 1: Number Plate of Private Vehicle

Vehicle's commercialization includes all types of taxies, trucks, local, private and Government buses, public passenger's vehicles, hire vehicles, pick up vans and truck etc. which are driven for the citizen. It texture is based on yellow background number plate with black numbering [2]. Commercial vehicle's number plate is shown in figure 2.

Figure 2: Number plate of Commercial Vehicle

3.1 Indian Vehicle Registration Format

All the registration number of the vehicle is issued by the district level Regional Transport Office – RTO of the respective states [7]. The current Indian vehicle registration scheme contain according to the [2] [3] [7]–

i. First two letters on the number plate is represent the code of the state, where from vehicle is registered as RJ for Rajasthan, GJ for Gujrat, CH for Chandigarh.
ii. After the state code two digit numeric codes is come that represents the district of the state. In the union territories the district code is omitted as 27 for Udaipur, 09 for Chittorgarh, 14 for Jaipur, 19 for Jodhpur, 30 for Rajasamand in Rajasthan State.
iii. After the district code the series code is come that mostly represent the vehicle type like CC series or C series for private cars, T for taxies, P for public passenger vehicles, MM for motor bikes, AA for other two wheelers. This series code is generally two in size, but some state is taken one in size.
iv. After the series code the unique four digit number is come that identify the vehicles uniquely like 8071, 1111, 0630 etc.

4) Methodology

The proposed Methodology is working for the HSRNPR system. The algorithm for the proposed technique is shown in figure 3.

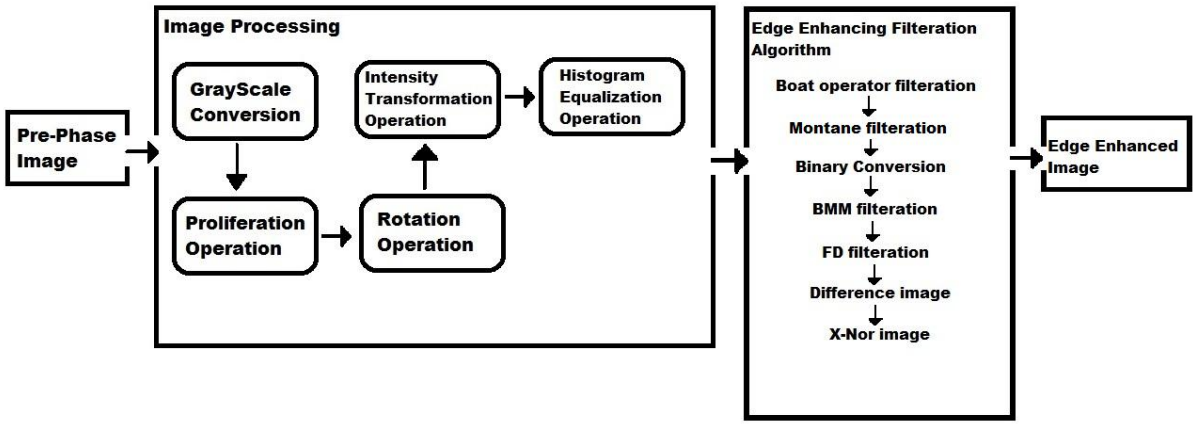

Figure 3: Proposed Methodology Structure

4.1 Pre – phase image

To find the number plate section in the vehicle, take the image captured by the CCTV camera or a high resolution camera. Camera distance from the vehicle is approx 3 meter [1] and makes 45^{o} angle with the road. Resultant captured image is come with some impurities like skew, noise, dullness, without proper illumination etc. Figure 4 image is original image or pre-phase image shown with high contrast.

Figure 4: Pre-phase image

4.2 Image Processing

To remove the image impurities like noise, dullness, improper illumination, skew we applied image processing methods as below –

a) Gray Scale Conversion

Take the acquisitive double image and convert the image into the gray scale image using MATLAB syntax [4]-

$$gray\_image = rgb2gray(acquisitive\_image)$$

Here the $acquisitive\_image$ is the captured image and $gray\_image$ is the resultant gray scale image. Figure 5 is shown the resultant gray scale image.

Figure 5: Gray Scale Image

b) Proliferation Operation

After gray scale conversion square the resultant image and enhance the image quality. The MATLAB syntax [4] for the operation is-

$$breed\_image = (gray\_image)\text{^}2$$

Here $breed\_image$ is the resultant image. Figure 6 is shown the resultant proliferation or squared image.

Figure 6: Proliferation Image

c) Rotation Operation

Generally the CCTV camera or high resolution camera is situated on the height from the road with some angle [2]. So that when the camera captured the image is skewed with some angle. In proposed method we take camera distance from the vehicle is approx 3 meter [1] and makes 45^{o} angle (in average cases) with the road. For skew correction rotate the every pixel (i, j) of the image with ω angle using following formula as in [3] –

$$\begin{bmatrix} rotate\_i \\ rotate\_j \end{bmatrix} = \begin{bmatrix} \cos(\omega) & \sin(\omega) \\ -\sin(\omega) & \cos(\omega) \end{bmatrix} * \begin{bmatrix} i \\ j \end{bmatrix}$$

Here (i, j) is the location of the pixel in the result of the previous operation, ω is the skew angle and $(rotate\_i, rotate\_j)$ is the new location of the pixel(i, j). Figure 7 is shown the result of rotation phase.

Figure 7: Rotated Image

d) Intensity Transformation Operation

Perform the intensity transformation operation (gamma and negative) on the resultant image. Than select the best contrast image either from the $gamma\_image$ or $negative\_image$. MATLAB syntax for the intensity transformation [4] is given by –

$$negative\_image = imcomplement\ (process\_image)$$

$$gamma\_image = imadjust(process\_image, [x], [y], gamma)$$

$$transformed\_image = either\ negative\_image\ or\ gamma\_image$$

Here $process\_image$ is the image, on which operation will perform, $negative\_image$ is the resultant image after negative transformation, $gamma$ is the value of intensity level, $x\ and\ y$ is the value of *[low_in, high_in]*, *[low_out, high_out]* and $gamma\_image$ is the resultant image after gamma transformation. Figure 8 is shown the negative intensity transformed image and Figure 9 is shown the gamma intensity transformed image. Figure 9 image is choosing as the final transformed image in between the both image.

Figure 8: Negative Image

Figure 9: Gamma Image

e) Histogram Equalization

Histogram Equalization is the method used to re-distribute intensities on the histogram of the image [4] i.e. the area of the low contrast will gain the higher contrast and vice-versa. It enhances the contrast of image by transforming the values in an intensity image. So that histogram of the equalized image approximately matches a specified histogram. The MATLAB syntax for this process as [4] is shown below –

$$hist\_equal\_image = histeq(transformed\_image, index\_value)$$

Here $transformed\_image$ is the previous step result; $index\_value$ is the specific transforming value that by whole image is transformed and $hist\_equal\_image$ is a histogram equalized image. Figure 10 is shown the histogram equalized image.

Figure 10: Histogram Equalized Image

4.3 Edge Enhancing Filtration Algorithm

The main goal of this step is to sharp the edges of all features present in image [2]. So those edges are easily detected by the detection method in the next step. The important features and changes in the properties of objects like depth discontinuities, surface discontinuities and brightness discontinuities, feature boundaries are easily detectable [2] so that probability of evidence capturing is increased.

In this work, the main boundaries or edges are created by the number plate and the alphanumeric characters that are present in the number plate. To enhance the boundaries 'Boat-Operator' filter and 'Montane' filter is used. The mathematical equation of the both filter and graphs are shown below in Figure 11 and Figure 12 respectively.

boat_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

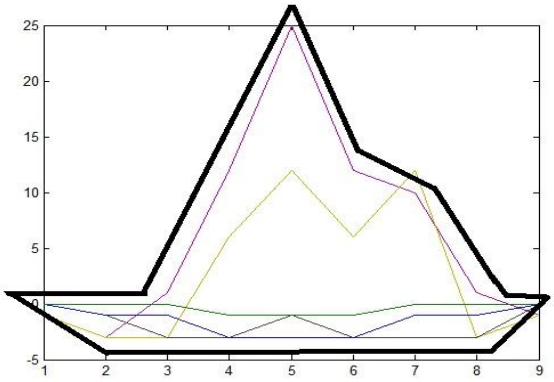

Figure 11: Boat – Operator Filter

montane_filter =

1	0	0	-5	-5	-5	0	0	1
3	1	1	-7	-7	-7	1	1	3
1	1	-7	-3	-5	-3	-7	1	1
3	-7	-3	6	12	6	-3	-7	3
3	-7	1	15	20	15	1	-7	3
3	-7	-3	6	12	6	-3	-7	3
1	1	-7	-3	-5	-3	-7	1	1
3	1	1	-7	-7	-7	1	1	3
1	0	0	1	1	1	0	0	1

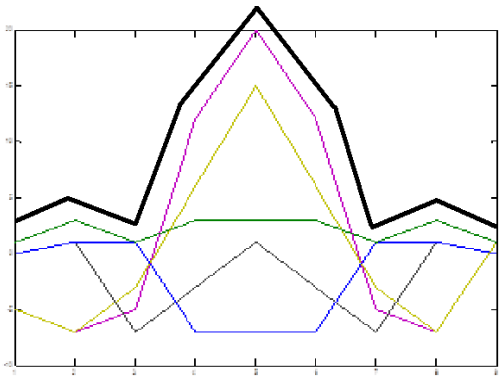

Figure 12: Montane Filter

Step 1: Apply the boat-operator filter on the pre-processed image and $boat\_img$ is produced as a result. Figure 13 is shown the boat filtered image.

$$boat\_img = boat\_operator\_filter(pre\_processed\_image)$$

Figure 13: Boat Filtered Image

Step 2: Apply the montane filter on the pre-processed image and $montane\_img$ is produce as result. Figure 14 is shown the result of the montane filtered image.

$$montane\_img = montane(pre\_processed\_image)$$

Figure 14: Montane Filtered Image

Step 3: Convert both results into binary image and add it. Result is named as new_bmm_img. Figure 15 is shown the BMM filtered image.

$$new\_bmm\_img = imbw(boat\_img) + imbw(montane\_img)$$

Figure 15: BMM Image

Step 4: Create a mask using frequency domain filter generated by the linear spatial filter using $freqz2$ [4] and apply to the pre-processed image and produce the result $freq\_image$. Figure 16 is shown the result of the frequency domain filter obtaining by LS filter.

$$freq\_image = dftfilt(pre\_processed\_image, mask)$$

Figure 16: FD Image

Step 5: Compute the difference of the new_bmm_img and the $freq\_image$ and get the $diff\_nbf\_img$. Figure 17 is shown the result of the subtraction of BMM image And FD image.

$$diff\_nbf\_img = new\_bmm\_img - freq\_image$$

Figure 17: Subtraction Image

Step 6: Compute the XNOR of the new_bmm_img and the $freq\_image$ and get the$xnor_nbf_img$. Figure 18 is shown the Exclusive-NOR Image.

$$xnor\_nbf\_img = XNOR(new\_bmm\_img, freq\_image)$$

Figure 18: Exclusive-NOR Image

Step 7: Compare the $diff\_nbf\_img$ and $xnor\_nbf\_img$ on the histogram basis and select edge enhanced image. Get the $edge\_enhance\_img$ as output. Figure 19 is shows an Edge Enhance image.

$$edge\_enhance\_img = choose(diff\_nbf\_img, xnor\_nbf\_img)$$

Figure 19: Edge Enhanced Image

5) Conclusion

This system is designed in MATLAB for image enhancement and number extraction in high security registration number plate recognition system. For image enhancement process we use the boat-operator filter, montane filter and collect the result in variables. Add both the results and save this result as BMM filter image. Subtract the BMM filter result and frequency domain filter result. Then perform the Exclusive-NOR (XNOR) does operation on BMM filter result and frequency domain filter result. Compare the difference image and XNOR image on the basis of histogram and choose the best result. We have implemented this technique in

MATLAB with for 50 vehicle images and get the accurate result. This algorithm is easy and simple.

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