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Character recognition from deblurred motion distorted Vehicle image using Neural Network

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ABSTRACT:*One of the severe hitches in Digital Imaging is to recuperate a deblurred image from a lone blurred image primarily when the blur category is motion. Here we put forward an approach to eradicate blurring a single image caused due to motion. Under certain appropriate redundant tight frame arrangement, the sparsity of both the blur kernel and original image are regularized by framing the blind blurring as an innovative combined optimization problem. In addition to this an adapted version of Split Bregman method is proposed to perform Blind Image deconvolution. Without demanding any former information of the blur kernel a deblurred vehicle image is obtained. Edge detection and morphological operation is implemented to extract the license plate from the deblurred vehicle image. The Characters from the extracted License Plate are segmented by Matrix scanning. The features of these segmented characters are learned by using Radon transform. Finally, neural network (NN) is commonly used to perform character recognition due to their great noise tolerance.*

Keywords *-Blind Image Deconvolution, Edge Detection, Morphological Operation, Motion Blur, Neural Network*

I. INTRODUCTION

In modern society, intelligent transportation system (ITS) plays an important role. In numerous applications like identification of stolen vehicles, border control, automatic toll payment and traffic law enforcement, License Plate Recognition System is efficiently used everywhere. Images can be taken in diverse illumination conditions or when the vehicle is in slow motion. The distance between the vehicle and the camera can differ. This makes license plate detection to be the most important and challenging step. Images are fetched to record or display valuable information. Due to limitations in the imaging and capturing process, the recorded image invariably represents a corrupted version of the original scene. The field of image deblurring is mainly concerned with the restoration or estimation of the uncontaminated image from a blurred and noisy one. The main aim of Image Restoration is to reestablish the original image from a degraded image which is blurred by a degradation function commonly known as Point Spread Function (PSF). Generally, an image can be corruptedby means of low-pass filter as well as its noise and this filter is used to degrade or smooth the image using certain functions. One of the key causes of poor image quality in digital imaging is motion blur that can be caused due to camera shake. Many scholars have been working on restoring clear images from motion-blurred images. The motion blur caused by camera tremor usually is modeled by a spatial invariant blurring process:

$$f = g * h + n$$

Where, $*$ is the convolution operator, g is the clear image to recover, f is the observed blurred image, h is the blur kernel (or point spread function) and n is the noise. If the blur kernel is known in previous, recovering clear image from a degraded one is called a non-blind deconvolution problem and if there is no knowledge about blur kernel then the problem is called a blind deconvolution problem. Image deblurring is a linear image restoration problem where the constraints of the true image are predicted using the observed or degraded image and a known PSF (Point Spread Function). The benefits of Deconvolution are higher resolution and better quality of Image obtained after deblurring.

Transportation is a rapidly developing field. Lately, there has been remarkable improvement in this industry most notably Intelligent Transportation System (ITS). License Plate Character Recognition consists of four main phases:

- License Plate Extraction
- Character Segmentation
- Feature Extraction and
- Character Recognition.

The LPR is used in real-time systems; it should offer both accurateness and tolerable response time. Most of the LPR systems are based on image processing methods. Depending on our necessity we should make choice of the appropriate algorithms. In this paper we present a morphology based technique for extracting license plate location from car images. We can use any effective edge detection technique for finding the edges in image. Here we use the canny edge detection method for finding the edges in the image. One of the most traditional applications of the artificial neural network (ANN) is character recognition system. Artificial neural networks are usually used to achieve character recognition due to their high noise tolerance.

Objective:

- To restore a single motion blurred Image by using Blind Image Deconvolution Algorithm.
- To extract the license plate from the deblurred Image by using edge detection and morphological operation.
- To segment the characters present on the extracted license plate by using Matrix scanning.
- To perform feature extraction and recognize the Characters from the License Number Plate by using Neural Network.

II. LITERATURE REVIEW

A lot of study has been done discovering various techniques for image deconvolution as blind techniques but still, is a serious and challenging problem for the researchers. Primary works on blind deblurring generally used a single image and presumed a prior parametric form of the blur kernel, such as the linear motion-blur kernel model. Only by estimating a few parameters these parametric motion-blur kernel model can be obtained, but they are often excessively simplified for applied motion blurring. A tactic to eliminate motion blurring from a solo image by framing the blind distortion as an innovative combined optimization difficulty, which at the same time maximizes the blur kernelsparsity and clear image sparsityunder certain appropriate redundant tight frame systems, has been proposed in [1]. In addition to this, the fresh sparsity restraints under tight frame systems permits the application of a reckless algorithm called linearized Bregman iteration to capably solve the proposed minimization problem. Following this paper, we have performed experiments on simulated images that showed that our procedure can effectively remove complex motion blurring from images. A comparison between Blind Image Restoration and Non blind Image Restoration techniques like Lucy-Richardson, Weiner filter and Regularized filter is presented in [3].Optimal results are obtained by Blind Image Deconvolution in this paper. Another Blind Image Deconvolution approach by using Canny Edge detector is explained in [4]. Here, firstly the original Image is corrupted using the Degradation Model. Gaussian Filter is used for this purpose. At the edges of blurred image, the ringing effect can be revealed using Canny Edge detection and then it can be removed by using Restoration model. Different vehicle license plate extraction techniques are accessible. Most image processing methods for license plate recognition are based on neural network. Gabor transform or Hough transform and Ada-Boost model, the description of this method is given in [5]. The Dynamic Programming based algorithm does not consume processor time cycle for converting a gray scale image to binary and neither for edge detecting. Its two strength points are first, the capability of using in real-time applications, and second, the ability of applying both in indoor and outdoor environments. Gabor transform has high performance in License Plate detection due to the ability of multi-scale and multi-direction execution and it is desirable for outdoor environments. Its only drawback is high execution time regarding to its computational complexity and that is an obstacle in real-time applications. Morphology based system requires less executing speed and it has a simple implementation. In [6], they have projected a threshold based binarization process to be applied on off-line images. In few number plates the shadow and illumination surroundings are the causes of ineffective segmentation rate. Character segmentation using connected component analysis (CCA) has been implemented in [7].Here, depending on pixel connectivity the CCA scans and tags the pixels of a binarized image into components. Every pixel is labeled with a value based on the component to which it was allocated. The connected components are then examined to filter out long and wide components and only left with the components based on the defined values.

But the downside is that in this method the segmented result may not comprise the exact license plate regions. Radon transform is used as one of the feature extraction methods. Here the image of a character isRadon transformed and the outcome is used as features after passing through principal component analysis. In [8], Fan beam projection a variation of Radon transform is used to extract the features of thehandwritten Kannada numerals .Nearest neighbor classifier is used for classification and recognition. The study of image segmentation method by using five threshold methods is presented in [9] and they are compared with each another so as to decide the best technique for threshold segmentation. Artificial neural networks (ANN) are usually used to do character recognition due to their high noise tolerance. In [12], an optical character recognition based on ANN is presented.

III. METHODOLOGY

This paper is divided into two sections for proper understanding. Firstly, to get a deblurred image from single blurred image and then to recognize the characters from the license plate of that deblurred vehicle image.

A. To get a deblurred image from single blurred image by using Blind Image Restoration technique based on Split Bregman Iteration

As the name suggests, Blind Image Deconvolution or Blind Image Restoration is a Blind technique of image restoration which restores the degraded image that is blurred by an unidentified PSF. It is a deconvolution technique that allows retrieval of the target image from a solo or multiple distorted images in the presence of an unknown or poorly determined PSF. This technique can be accomplished iteratively as well as non-iteratively. In iterative approach, each iteration improves the approximation of the PSF and by using that PSF we can improve the resultant image repeatedly by bringing it closer to the original image.

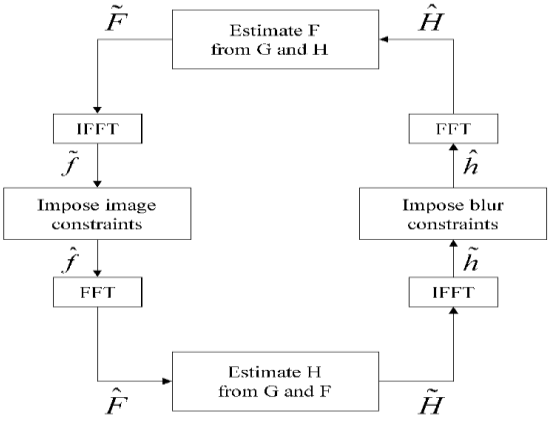

Fig.1. Relation between blur kernel and deblurred image

The iterative blind deconvolution algorithm was first projected by Ayers and Dainty in 1988. The basic relation between blur kernel and deblurred image is illustrated in the Fig.1. Here firstly, we have to make an estimate of the blurring operator i.e. PSF and then using that estimate we have to deblur the image. The aim of general blind deconvolution difficulty is to recuperate two convolved signals, f as well as h, when no information about either image can be obtained and only a distorted version of their convolution is available. We initiate with a randompresumption for the real image, the procedure alternates among the image and Fourier domains, using identifiedrestraints in each domain. Nonzero pixels and Negative-valued pixels are set to zero. Condition is that this pixel should be outside the region of support. The Fourier domain restriction is a significance of the fact that the product of the Fourier transform of both the true image as well as point-spread function should be almost equal to the Fourier transform of the observed imageif the noise level is low. Using this information, we can use inverse filtering to guess the point-spread function of the degraded observation using the Fourier transforms and the estimate of the true image. However, inverse filtering can result in the intensification of noise in regions where the inverted function has low values. The Flowchart for Blind Image Deconvolution by using Split Bregman is explained in Fig.2.

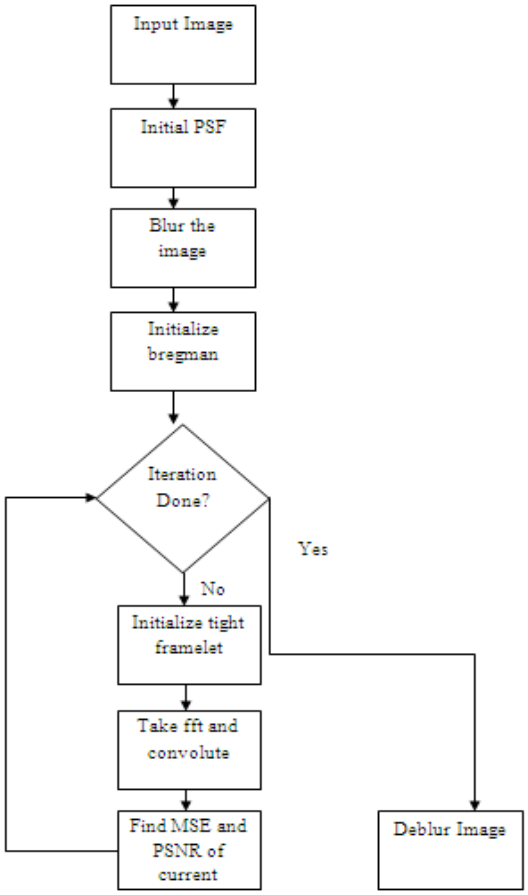

Fig.2. Flowchart for Split Bregman based Blind Image Deconvolution Algorithm

B. To recognize the characters from the license plate of that deblurred vehicle image.

These days Intelligent Transportation System (ITS) has become an indispensable part of the Transportation Industry and it mainly involvesLicense Plate Recognition (LPR) System. License Plate Recognition is also called Car Plate Recognition (CPR) System. In License Plate Recognition System, when any means of transportation steps over magnetic loop sensor, the detector senses the vehicle and takes image of it, following image preprocessing procedures for improvement in the quality of vehicle image. From this improved image, license number plate area is recognized and extracted by using Edge detection and Morphological operations. Then character disintegration is performed on extracted License Number Plate and these segmented characters are recognized using Neural Network in this paper.

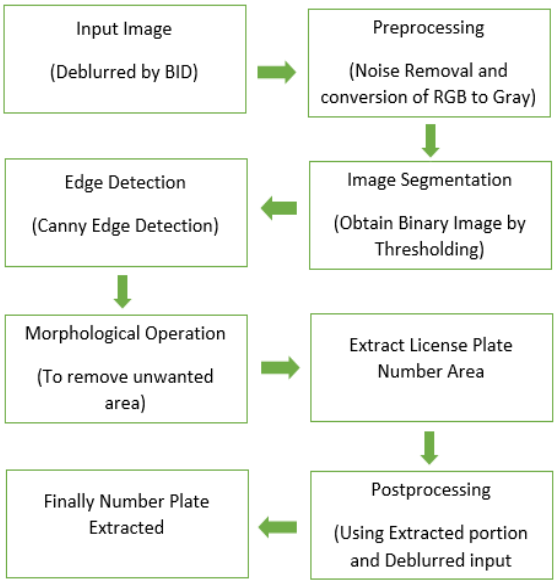

Fig.3. Methodology for Extraction of License plate

1. Preprocessing

In this part we transform the color image to gray scale image and adjust the contrast enrichment of the image using histeq. This RGB to gray scale conversion is essential because a grayscale (or graylevel) image is one in which the only colors are all shades of gray. The main reason for distinguishing these images from any other form of color image is that minimal information is required to be provided for each pixel. Another fact about `gray' color is that this color is one in which the red, green and blue color components have equivalent intensity in RGB space, and therefore it is necessary to specify only a solo intensity value for each pixel, as opposed to the three intensities required to postulate each pixel in a complete color image. The grayscale intensity is very often represented as an 8-bit integer giving 256 likely different shades of gray from black to white.

2. Image Segmentation

Threshold is one of the extensively used methods for image segmentation. The binary image contains all the essential information about the location and shape of the objects of interest

(foreground). The advantage of obtaining first a binary image is that these are images whose pixels have only two feasible intensity values. They are typicallyexhibited as black and white. Statistically, the two values are either1 or 255 for white and often 0 for black. Binary images are always obtained by Thresholding a grayscale image and this is done to separate an object in the obtained image from the background. It is useful in distinguishing foreground from the background. When the color of the object is white, it is considered as the foreground color. The remaining black is considered as the background color. However, based on the image which is to be threshold, this polarity might be reversed, in this case the object is exhibited with zero and the background is with a non-zero value. The most common way to convert a gray-level image to a binary image is to choose a single threshold value (T). Then all the gray level values below this T will be classified as black (0), and those above T will be white.

3. *Edge Detection Technique*

We can use any efficient edge detection method for defining the edges in image. Here we use the canny edge detection technique for plotting the edges in the image. The Canny method discovers edges by finding local maxima of the gradient of Image. The derivative of a Gaussian filter is used to calculate the gradient. This method uses two thresholds, to perceive weak and strong edges. It contains the weak edges in the result only if they are associated with strong edges. This technique is therefore less likely to be misled by noise, and more likely to determine true weak edges.

4. *Morphological Operation*

After detecting the true weak edges, morphological operator is used to extract the number plate from image. Morphological operators convert the edged image to image shown in Fig.3. In this image, number plate area is always larger than the rest of areas. Morphological operation eliminates rest of areas than larger area. License plate has the rectangle shape, so morphology is appropriate for because of the rectangle shape of plates. By using this technique, many candidates may be detected. To assess candidates and reject false ones and to find the license plate location, some features such as shape, aspect ratio, and width to height ratio are checked. The two most basic actions in morphology are erosion and dilation. Both of these operators take an image to be eroded or dilated and a constructing element (kernel) as input. Erosion and dilation are performed by converting the constructing element to different points in the input image, and inspecting the intersection between the translated kernels coordinates and the input image coordinates. In the case of erosion, the resultant coordinate set contains of only those points to which the origin of the constructing element can be interpreted, while the element although remains entirely `within' the input image. The post processing step includes the multiplication of input binary image and number plate extracted area image to get the final image. Apply the bounding box condition and extract only number plate from image.

5. *Character Segmentation*

The License Plate which is extracted by using edge detection and morphological operation consist of only two intensities because it has the background as black and the characters on it as white. When we read the image, we get the pixel intensity as 0 for Black and 1 for white. Matrix scanning is done first columnwise (height) and then row wise. As soon as scanning starts initially black pixels are observed then as the digit appears on the plate, the pixel intensity changes to 0. After scanning the last column (complete height) for the digit when the pixel intensity of the next column differs i.e. changes from 0 to 1, the character is segmented. This is repeated till the plate ends and all the characters are segmented. Then the feature extraction is performed.

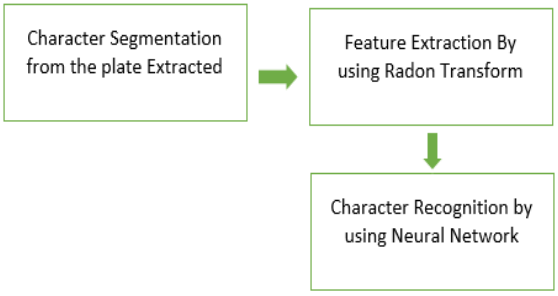

Fig.4. Methodology for Character recognition after Number Plate Area Extraction

6. Feature Extraction

Feature Extraction is implemented by using Radon Transform. In mathematics, the Radon transform in two dimensions, named after the Austrian mathematician Johann Radon, is the integral transform containing of the function integral over straight lines. The transform was introduced by Radon in 1917. The Radon transform is extensively applicable to tomography, the formation of an image from the scattering data related with cross-sectional scans of an object. Consider that a function f signifies an unknown density and then the Radon transform characterizes the scattering data obtained as the result of a tomographic scan. Reconstruction of the original density from the scattering data can be done by using inverse of the Radon transform, and thus it forms the mathematical supporting factor for tomographic reconstruction, also known as image reconstruction. The Radon transform of a function $f(x,y)$, denoted as $r(s,\theta)$ is defined as its line integral along a line inclined at an angle θ and at a distance s from the origin. Fig. 5 shows the geometry of Radon transform. The geometry of the Radon transform can be expressed by the following equation:

$$\int\int_{-\infty}^{\infty} f(x,y)\delta(xcos\theta + ysin\theta - s)dxdy, -\infty < s < \infty, 0 < = \theta < \pi$$

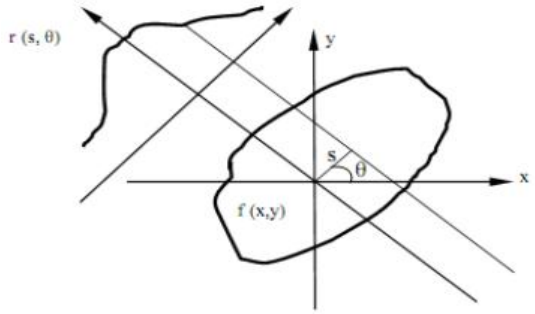

Fig.5. Geometry of Radon Transform

7. Character Recognition by Neural Network

Neural networks are representations of biological neural structures. Model neuron is the initial point for most neural networks, as seen in Fig.6. This neuron comprises of multiple inputs and a single output. Every input is modified by a weight which is multiplied with the input value. These weighted inputs are combined by neural network and, with reference to a threshold value and activation function, use these inputs to control its output. This behavior follows thoroughly our understanding of how real neurons perform.

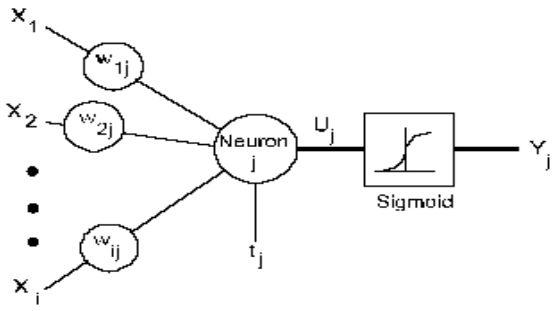

Fig.6. A model Neuron

While there is a fair thought of how a discrete neuron works, there is still a great scope for research and mostly speculation regarding the way neurons unify themselves and the processes used by arrays or set of neurons to familiarize their conduct to external stimuli. The Backpropagation network is the generalized and most prevalent neural network currently in use. To construct a Backpropagation network, it is required to continue in the following manner. Initially consider a number of neurons and array them to form a layer. The outputs of a layer are linked to either a following layer or to the external world, but never both within the same layer. Secondly, multiple layers are then arrayed one following the other so as to create an input layer, multiple intermediate layers and lastly an output layer, as in Fig.7. Intermediate layers are those that consist of no inputs or outputs linked with the external world and are also called as hidden layers. Backpropagation neural networks are generally entirely connected.

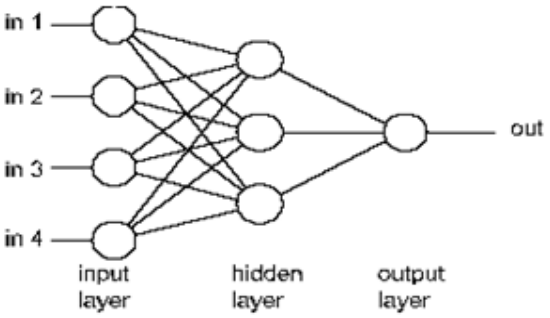

Fig.7. Backpropogation Network

Generally, the input layer represents a provider of the signals from the external world. Categorizers of such signals can be called as Hidden layers. A collector of the features perceived and creator of the response represents the output layer. While this interpretation of the neural network can be supportive in abstracting the utilities of the layers but the functions described may not be so precise or confined therefore we must not take this model too literally. An example of OCR by using neural network is described in fig.8.

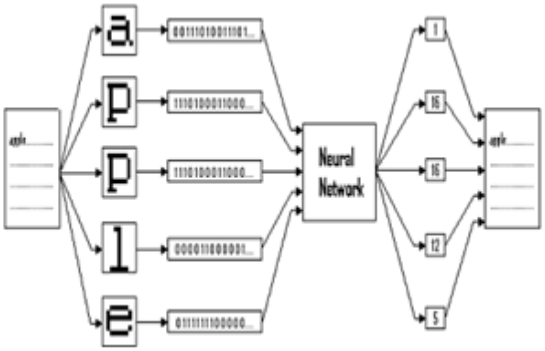

Fig.8. Example of OCR by Neural Network

IV. RESULT

Step 1:

A simulated image is blurred by a blur kernel to create motion blur image of the clear image. Then by using Blind Image deconvolution we have restored the blurred image.

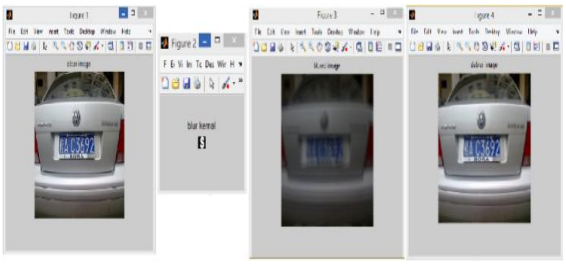

Fig.9. Deblurring by using Split Bregman Iterative Blind Image Deconvolution

Step 2:

Next step is to do preprocessing on deblurred image i.e. we have converted the deblurred image into Gray scale image.

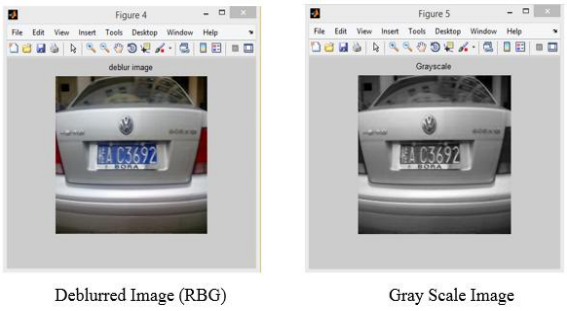

Fig.10. Preprocessing

Step 3:

We have performed Image segmentation on the preprocessed image i.e. to convert the gray scale image to binary image and detected the edges in the image by using Canny Edge Detection.

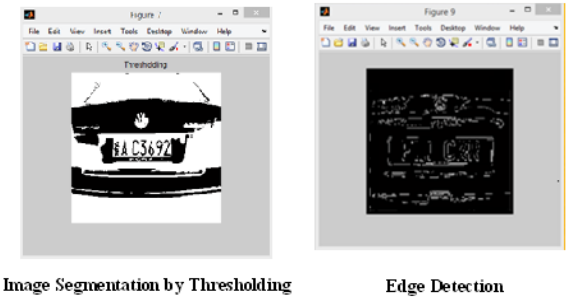

Fig.11. Image Segmentation and Edge Detection by Canny

Step 4:

We have performed Morphological operation on the Edge detected image by using erosion and dilation.

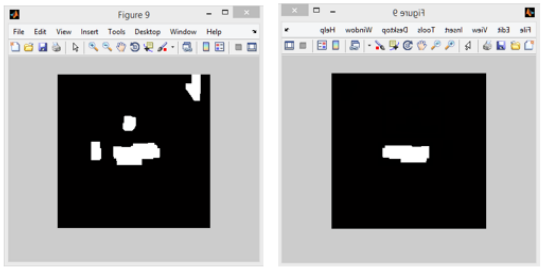

Fig.12. Post Morphological Operation

Step 5:

Here we have extracted License plate area by post processing. The exact location of the license Number plate is detected and extracted by using the Morphological output and deblurred image.

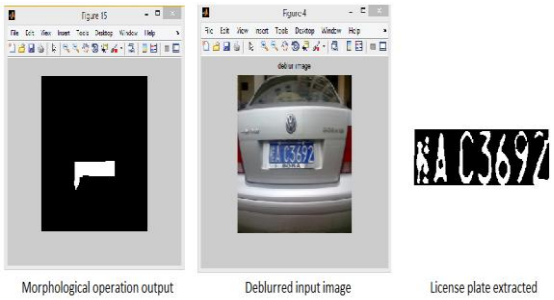

Fig.13. Post Processing

Step 6:

This is the final step in which we have recognized the characters from the Number plate extracted by using neural network.

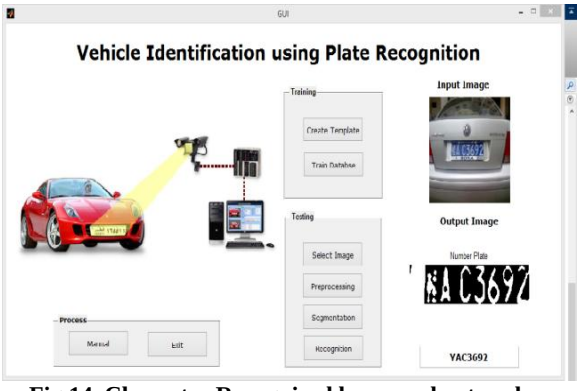

Fig.14. Character Recognized by neural network

V. CONCLUSION

In this paper we have implemented Blind Image deconvolution method to restore the degraded imagesince it does not need any prior information regarding the PSF. The canny edge detector sets two threshold values, to sense weak and strong edges. Canny comprises of weak edges in the output only if they are associated with the strong edges. This method of detection therefore can be considered as less likely to be fooled by noise and more likely to detect true weak edges. Radon transform is used to extract the features of the characters for testing purpose. Seeing the present stage of development, we can conclude thatthe software does perform well either in terms of speed or accuracy but not better. It is unlikely to change English text. Neural networks are generally used to perform character recognition due to their high noise.

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