AUTOMATIC NUMBER PLATE RECOGNITION SYSTEM USING SUPER-RESOLUTION TECHNIQUE

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Abstract— **Super resolution is a technique which is used to enhance the visual quality of a sequence of low resolution image by constructing a single high resolution image. This paper is interested in acquiring the automatic number plate recognition system from the traffic surveillance video. The proposed system detects the number plate of a vehicle from video input and then performs the super resolution technique. Applying the Optical Character Recognition Technique it acquires the text from the super resolution image of vehicle number plate by means it compares with the RTO database and then it display the details of the vehicle such as owners name, vehicle registration etc.**

Keywords—Super Resolution, OCR, automatic number plate recognition

Introduction

In most imaging techniques, images with high-resolution are required often.HR (high resolution) image means that pixel density of an image is high, and it offers high details in various application. Moreover, it might be easy to differentiate an object from the similar ones using HR satellite and aerial images. In easier days, charge-coupled device (CCD) and CMOS image sensors mostly used to capture digital images. Although these sensors are appropriate for most imaging applications, the present resolution level and price will not satisfy the future demand. For example, people want either an inexpensive HR digital camera/camcorder or the price gradually reduces. Furthermore, scientists often require a very HR level close to that of an analog 35 mm film that has no visible artifacts when a captured image is magnified. Thus, to find out a technique to increase the current resolution level is needed. [4]

Super-resolution (SR) is the principal of combining several low-resolution images into a single higher resolution image [3, 20, and 21]. Popular SR reconstruction algorithms can be divided into two categories frequency domain and spatial domain algorithms. The frequency domain methods are based on the following three aspects the property of shifting of Fourier transforms, the spectral aliasing principle and the limited bandwidth of the original HR image. For spatial domain algorithms, the non-uniform interpolation-based method is carried out and the common advantage is that their computational cost is relatively low so they are ready for real-time applications.

I. SYSTEM ARCHITECTURE

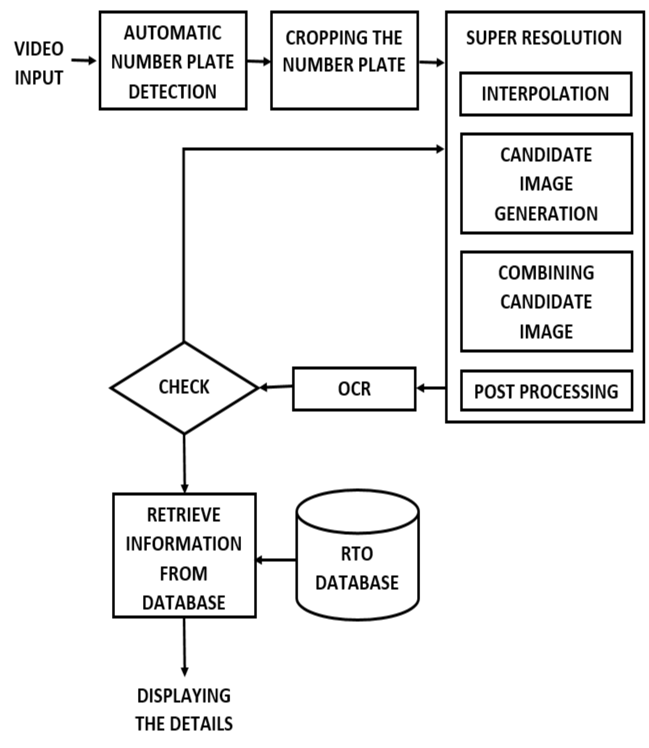

Figure1: Overall Architecture of the Proposed System

A. THE CONTRIBUTION OF THE PROPOSED SYSTEM

1. Selection of vehicle number plate
2. Super resolution of number plate
3. Display of vehicle details

ADVANTAGE

1. Automation for detection of vehicle number plate
2. Easy retrieval of image to data using OCR
3. Less complexity
4. Faster access

II. SELECTION OF VEHICLE NUMBER PLATE

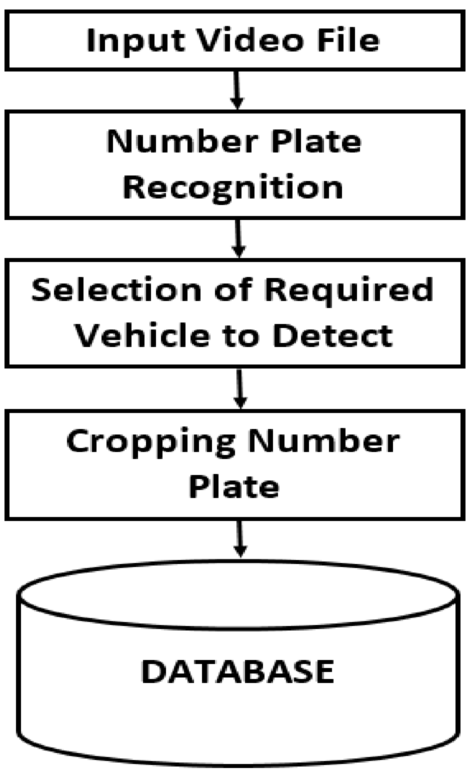

FIGURE 2:BLOCK FOR SELECTION OF VEHICLE NUMBER PLATE

In this input video file is taken from the surveillance and then we perform number plate detection in the video frame, which tends to find out the number plate automatically using LPR algorithm. [22, 23]

Select the required vehicle from the video sequence and then crop the number plate. Cropping is defined as cutting the required part of an image. In our proposed system we are cropping the required part of an image (frame / scene) which we gathered from a video (sequence of image). Cropping process is mathematically expressed as follows,

$$A = I (X_1, Y_1, X_2, Y_2)$$

Where I is defined as the input frame to crop the required part to apply super resolution X_1 , Y_1, X_2, and Y_2 denotes the axis of the rectangle, which have to select and cropped, and A denote the cropped image from the frame. In our proposed system as we concentrate on traffic surveillance (which means number plate detection), we crop the number plate, and store it in the database.

Figure 3. Input video, Selecting desired area

Figure 4 Cropped image of Selected area

III. SUPER-RESOLUTION OF NUMBER PLATE [1, 2, 5, 15]

Super resolution is a current researching technique, which is defined as generating high resolution of an image from a low resolution image or a set of low resolution image. In this paper we use single image super resolution. Single image SR [4] (super-resolution) is the task of constructing an HR (high resolution) enlargement of a single LR (low-resolution) image, (which we cropped from a frame). Our proposed system method performs four main sub steps as mentioned below,

1. Interpolation.
2. Generation of a set of candidate images. (Regression)
3. Combining candidate images to produce a single image.
4. Post-processing.

Interpolation

Interpolation is defined as a process of providing specified values at specified points. There are four different Interpolations namely, [17]

I. Nearest Neighbor Interpolation.
II. Linear Interpolation.
III. Cubic Interpolation.
IV. Spline Interpolation.

In our paper we perform Spline Interpolation. We select Spline Interpolation because it is more sophisticated and produces the smoother edges. Converting a cropped image into the desired scale.

Algorithm to find the Spline Interpolation

Let us consider a third order polynomial p (x) for which we produce

$$P(x_1) = y_1$$
$$P(x_2) = y_2$$
$$P'(x_1) = k_1$$
$$P'(x_2) = k_2$$

We can write it in symmetrical form as,

$$P = (1-t)\, y_1 + t y_2 + t\,(1-t)\,(a\,(1-t) + bt)$$

Where,

$$t = \frac{x - x1}{x2 - x1} \quad \text{And}$$

$$a = k_1 (x_2 - x_1) - (y_2 - y_1)$$
$$b = - k_2 (x_2 - x_1) + (y_2 - y_1)$$

Double Differentiate P we get as follows,

$$P'' = 2\frac{b-2a+(a-b)3t}{(x2-x1)(x2-x1)}$$

Double differentiation with respect to x_1 and x_2 as given below,

$$P''(x_1) = 2\frac{b-2a}{(x2-x1)(x2-x1)}$$

$$P''(x_2) = 2\frac{a-2b}{(x2-x1)(x2-x1)}$$

In spline interpolation, left of the leftmost "knot" and the rightmost "knot" thus, it form of a straight line with $q'' = 0$, because ruler can move freely.

$$P''(x_n) = -2\{\, 3\,(y_n - y_{n-1}) - (2k_n + k_{n-1})\,(x_n - x_{n-1}) \;/\; (x_n - x_{n-1})^2 \,\} = 0$$

Following graph show the example of Spline Interpolation clearly,

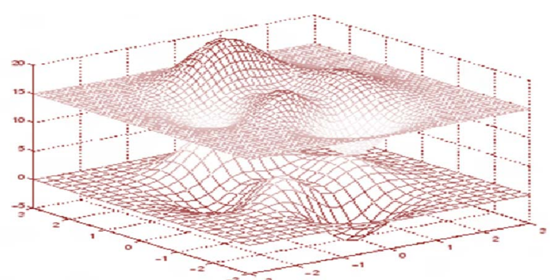

Figure 5. Graphical representation of interpolation

Applying Spline Interpolation in our cropped image is shown below,

Figure 6 Cropped image

Figure 7 Interpolation image

Generation of set of candidate images.

A set of candidate images is generated based on patch-wise regression. To reduce the time complexity we utilize kernel ridge regression. By combining gradient descent and kernel matching pursuits we found a spare basis [6,8,9].

Gradient descent

We use Gradient descent because it's a best optimization algorithm. It provides plenty of data available everywhere and extract information efficiently. The column vector is denoted as,

$$\vec{\theta}_t = \left(\theta_t(1), \theta_t(2), \ldots, \theta_t(n)\right)^T$$

Where T denotes transpose.

Gradient-descent general mathematical expression is given bellow,

$$\vec{\theta}_{t+1} = \vec{\theta}_t - \frac{1}{2}\alpha \nabla_{\vec{\theta}_t} \left[V^{\pi}(s_t) - V_t(s_t)\right]^2$$

Where, $V_t(s)$ is a smooth differentiable function of $\vec{\theta}_t$ for all $s \in S$

Let us generate candidate images using the interpolation image as shown below,

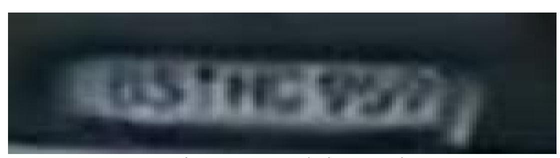

Figure 8 Interpolation Resultant Image

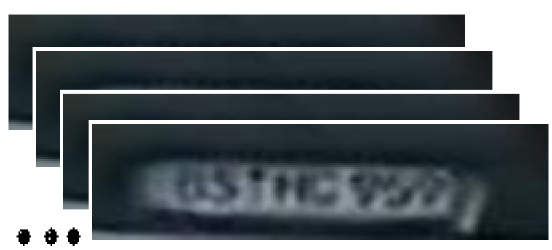

Figure 9 Regression results

Combining candidate images to produce single image

We produce a single image by convex combinations of candidate images by noting that the KRR (kernel ridge regression) (spares) corresponds to the Map estimated with the GP (sparse) prior [10], GP (Gaussian process) is defined as a learning technique, seeks to predict the value of unknown function of any valid input when we provided with of a set of input/examples. By using GP we produce combiner and regresses simultaneously so that error measure is minimized [11]. We produced set of linear repressors' (candidate images) which is trained such that for the each location (x, y) by applying GP we receive a patch of output image as Z (Nl (x, y) , :) and also produce estimation difference as given below,
$(\{d_1(x, y) \ldots d_n(x, y)\})$

Where d is the difference between the various x and y values present between the set of images (candidate images), the final estimation of the pixel we obtain as a convex combination of candidates which is formulated below,

$$Y(x, y) = \{\textstyle\sum_{i=1}^{N} \{W_i(x, y)\, Z(x, y, i)\}\}$$

Where,

$$W_i(x, y) = \{\exp(M) / \textstyle\sum_{j=1,\ldots,N} \exp(M)\}$$

$$M = -|di(x, y)|\frac{1}{\sigma\alpha}$$

We re-moving hyper parameters which are chosen based on the error rate of SR for a set of images. To combine two image values the difference is considered as given below,

$$D([x_i,y_i], [x_j,y_j]) = \sqrt{(\|x_i\, x_j\|^2 + (\sigma_x / \sigma_y)\, \|y_i - y_j\|^2)}$$

Where σ_x and σ_y are the variances of the distances between the pairs of training data points in x and y respectively [10].

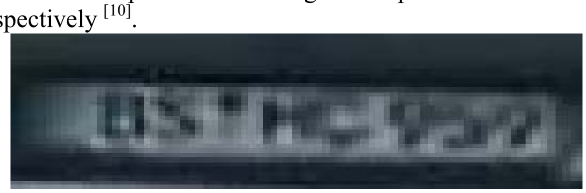

Figure 10 Combining candidate

Post-processing

Post processing is carried based on Based on Image Prior. Image prior is flexible high-order MRF (Based on Image Prior). Here we use modification of the NIP (natural image prior) framework which was proposed by tappen et al [14].

$$P(\{x\}|\{y\}) = \frac{1}{C} \prod_{(j,i \in \mathcal{N}_S(j))} \exp\left[-\left(\frac{|\hat{x}_j - \hat{x}_i|}{\sigma_N}\right)^{\alpha}\right] \cdot \prod_{j} \exp\left[-\left(\frac{\hat{x}_j - y_j}{\sigma_R}\right)^{2}\right]$$

Where,

$\{y\}$ Observed variables corresponding to pixel values of the y.

$\{x\}$ Latent variable.

$\mathcal{N}_S(j)$ j's pixel location, 8-connected neighbours.

C is normalization constant.

$\prod_{(j,i \in \mathcal{N}_S(j))} \exp\left[-\left(\frac{|\hat{x}_j - \hat{x}_i|}{\sigma_N}\right)^{\alpha}\right]$ to prevent the output image flowing far away from input(regression based SR) result of y.

The factor graph representation is given below,

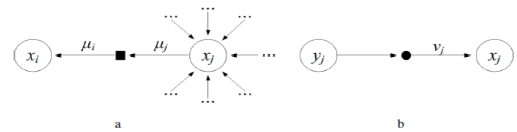

Figure a. NIP term, and b. Deviation penalty term.

The input is blurred, and removed the very high spatial-frequency components from it. The major edges are found by the thresholding the each pixel based on the Laplacian and range of pixel values present in local patches. Applying the post processing in our sample we get the following output [16].

Figure11. Final output

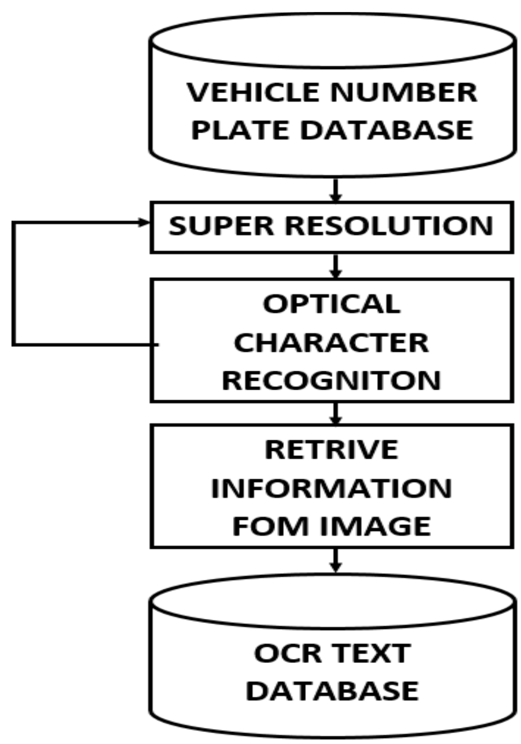

Figure 12: Block for Optical Character Recognition

The stored number plate is taken from the database and then we apply super resolution technique to the number plate image. We apply Optical Character recognition technique is used for retrieval of characters and then text from the number plate; we use super resolution technique to find the high precision image content. If the content cannot be identified clearly by the OCR it has to undergo again for the super resolution till the content is identified by OCR. And the text is stored in the database.

VI. DISPLAY OF VEHICLE DETAILS

The stored vehicle number plate details from the OCR text database is compared with the RTO database if the search is found then it display the details of the owner of the vehicle if it is not found then it shows details of the vehicle is not available.

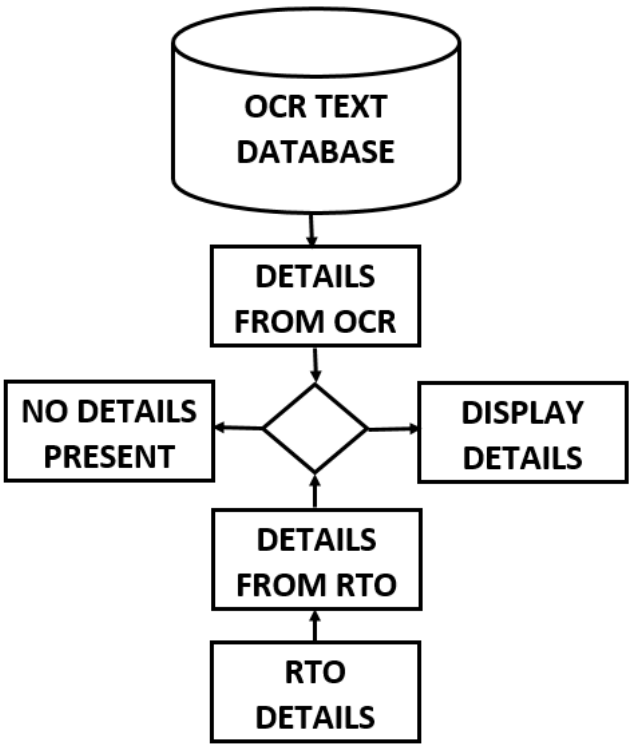

FIGURE 13 :BLOCK FOR DISPLAY OF DETAILS

CONCLUSION

The automatic number plate recognition method using Super-Resolution from a video is performed. The super resolution is carried by using interpolation, regression (where we generate set of candidate images), then we combined candidate images produced in regression and finally we perform post- processing to get Super-Resolute image as output and using the OCR we will be analyzing the text with RTO database and then the details of the vehicle and their owner details will be displayed.

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