Automatic License-plate Recognition using Image Segmentation & Processing

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Abstract:

Low-quality surveillance cameras throughout the cities could provide important cues to identify a suspect, for example, in a crime scene. However, the license-plate recognition is especially difficult under poor image resolutions. In this vein, super-resolution (SR) can be an inexpensive solution, via software, to overcome this limitation. Consecutive frames in a video may contain different information that could be integrated into a single image, richer in details. In this paper, we design and develop a novel, free and open-source framework underpinned by SR and automatic license-plate recognition (ALPR) techniques to identify license-plate characters in low-quality real-world traffic videos, captured by cameras not designed specifically for the ALPR task, aiding forensic analysts in understanding an event of interest. The framework handles the necessary conditions to identify a target license plate, using a novel methodology to locate, track, align, super-resolve, and recognize it's alphanumeric. The user receives as outputs the rectified and super-resolved license-plate, richer in detail, and also the sequence of license-plates characters that have been automatically recognized in the super-resolved image. Our experiments show that SR can indeed increase the number of correctly recognized characters posing the framework as an important step toward providing forensic experts and practitioners with a solution for the license-plate recognition problem under difficult acquisition conditions..

Keywords: IoT, RFID, Micro Controller, Automation

1. Introduction

Automatic license-plate recognition (ALPR) uses optical character recognition (OCR) on images to extract and recognize the characters of a vehicle registration plate. It is usually aided by cameras designed specifically for such task, since the license-plate recognition may be especially difficult under poor images resolutions (usually when the car is too far away from the camera, under adverse atmospheric conditions, or due to a low-quality acquisition camera) .However, there are a number of low-quality surveillance cameras scattered throughout our cities that could help to identify a suspect, for example, in a crime scene. The OCR systems and the forensic specialists may fail to recognize the alphanumeric in such setups, and super-resolution can be an inexpensive path, via software, to overcome this limitation. Multi-frame super-resolution usually referred to only as super-resolution (SR), is a process of constructing a high resolution (HR) image using a set of low-resolution (LR) images of the same scene [13].

As a matter of fact, there exist some techniques in the literature that leverage side information from other sources, the internet, for instance, or from large collections of images and can operate with a single image. Although effective in different setups, these techniques are not the focus of this work. Fortunately, in our setup, a sequence of video frames recording a dynamic scene may contain different information about the object of interest. Generally, a moving object in the scene can be recursively seen at many positions along its moving path in the video. Due to these recurrences, many self-similar appearances between different positions can be found throughout a video sequence. Therefore, in this work, we choose to combine information from multiple video frames, instead of working with the recent Single-Image Super-Resolution (SISR) algorithms [14].

Consecutive frames in videos may differ not only by rigid or perspective transformations. Notwithstanding, we do not aim here at super-resolving features such as human faces, for example. Rather, we focus on enhancing the details in vehicle license-plates that could help to identify a criminal suspect or activity in a crime scene. In such forensic setup, it is feasible to super-resolve only a region of interest (ROI) of a video, discarding less important parts. The main contribution of this paper is a free and open source end-to-end framework that super-resolves a sequence of frames containing license-plates in low-quality real-world traffic videos, captured by cameras not designed specifically for the ALPR task, aiding forensic analysts and practitioners in understanding a given event of interest. Additionally, we also design and develop a novel SR method that papers the license-plates separately onto the rectified grid, and then fill in the missing pixels using interpolation techniques [15]. The framework has two main outputs:

• The first one is a rectified and super-resolved image, richer in details. The user can simply use such image for a better visualization of the alphanumeric, or even as an improved input for a SISR algorithm.

• In addition, we apply ALPR to the output image, suggesting a sequence of license-plates characters for the user

Automatic vehicle license plate detection and recognition is a key technique in most of traffic related applications and is an active research topic in the image processing domain. Different methods, techniques and algorithms have been developed for license plate detection and recognitions.

Approach: Due to the varying characteristics of the license plate from country to country like numbering system, colors, language of characters, style (font) and sizes of license plate, further research is still needed in this area. Results: In most of the middle East countries, they use the combination of Arabic and English letters, plus their countries logo. Thus, it makes the localization of plate number, the differentiation between Arabic and English letters and logo's object and finally the recognition of those characters become more challenging research task [10].

Number Plate Recognition system is a security system. Image processing concept is used in Number Plate Recognition system. OCR (Optical Character Recognition) scheme is also applied in this for reading the image of vehicle number plate. Number Plate Recognition system is used for many purposes like toll way authorities uses this system for allowing the vehicle to enter the toll road by detecting their number plate automatically and provide them with pay-slip and then open the road for that particular car. Parking authorities also use this system for allowing the vehicle to park in their area. In this system, firstly we capture the image of number plate then process it and read each and every character present in the number plate for their perfect recognition [12]. The most significant phase is OCR, where the letterings on the image of number plate are changed into the texts which can be decoded later. In this given research paper, a full algorithm and network flow for ANPR and its efficient applications are shown. The concept of ANPR system is based on the matching of templates and exactness (result) of this system was established as 75-85% for Indian number plates [11].

2. Proposed Architecture

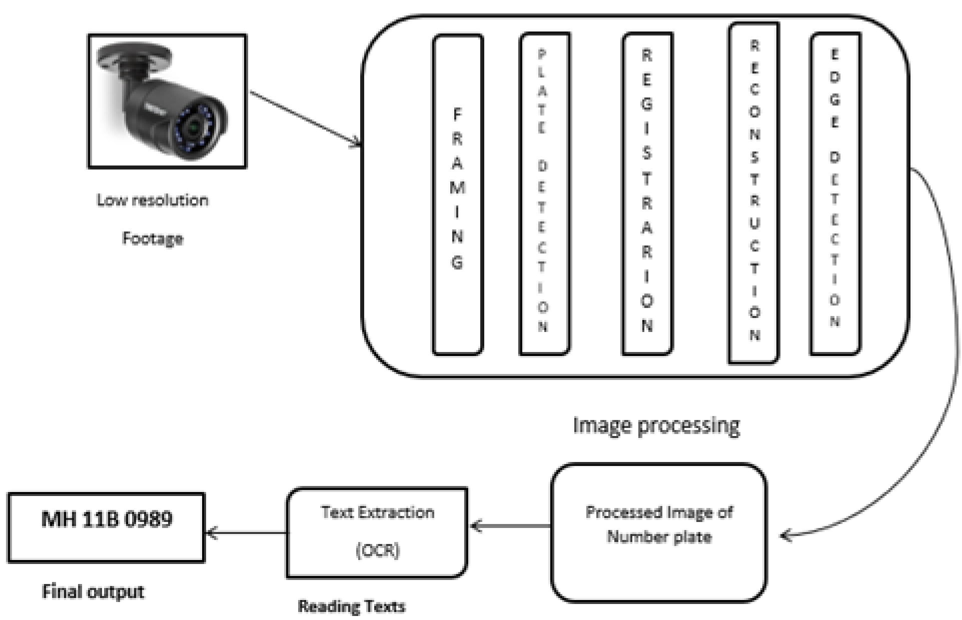

Figure 1 .proposed system design

License Plate Detection: The first step is to detect the License plate from the car. We will use the contour option in OpenCV to detect for rectangular objects to find the number plate. The accuracy can be improved if we know the exact size, color and approximate location of the number plate. Normally the detection algorithm is trained based on the position of camera and type of number plate used in that particular country. This gets trickier if the image does not even have a car, in this case we will an additional step to detect the car and then the license plate.

Character Segmentation: Once we have detected the License Plate we have to crop it out and save it as a new image. Again this can be done easily using OpenCV.

Character Recognition: Now, the new image that we obtained in the previous step is sure to have some characters (Numbers/Alphabets) written on it. So, we can perform OCR (Optical Character Recognition) on it to detect the number

Choosing a starting frame and locating the license-plate;

To detect an object in an image we first study its general characteristics and how it is different from other objects within the image.

1. plates have high contrast foreground/back ground, this is designed for humans to be able to read easily, which is a bless for a computer vision problem.
2. the shape of the plate is horizontal rectangle, the aspect ration and the size of this rectangle is standard.

Finding the license plate over the consecutive frames;

use a track's state (velocity and position of its sides) from the previous frame to predict its new state in the current frame, use object recognition to find the tracked car in the current frame (and discover new cars not in the previous frame), search the track, cropped from the current frame, for license plate text, identify the characters in the text to label the car by its license plate number.

Aligning the frames with respect to the plate positions;

An enhanced design of multiple zone plates precision alignment apparatus for better view is provided. The precision alignment apparatus includes a zone plate alignment base frame; a plurality of zone plates; and a plurality of zone plate holders, each said zone plate holder for mounting and aligning a respective zone plate for hard x-ray focusing. At least one respective positioning stage drives and positions each respective zone plate holder. Each respective positioning stage is mounted on the zone plate alignment base frame. A respective linkage component connects each respective positioning stage and the respective zone plate holder. The zone plate alignment base frame, each zone plate holder and each linkage component is formed of a selected material for providing thermal expansion stability and positioning stability for the precision alignment apparatus.

Combining the frames into a high-resolution grid; Super resolution is a process where a high resolution image can be reconstructed from a set of blurred and noisy low resolution images which are at a specific pixel shift from each other. Each sub-pixel shifted low resolution image contains some new information about the scene and super resolution is to combine these to give a higher resolution image. Frame alignment is very much important concept in super resolution process which is achieved by image

Post-processing

Applying refining image processing operations to thereconstructed image, to improve the results in the final step; Due to image reconstruction process of all image capturing methods, image data is inherently affected by uncertainty. This is caused by the underlying image reconstruction model, that is not capable to map all physical properties in its entirety. In order to be aware of these effects, image uncertainty needs to be quantified and propagated along the entire image processing pipeline. In classical image processing methodologies, pre-processing algorithms do not consider this information. Therefore, this paper presents an uncertainty-aware image pre-processing paradigm, that is aware of the input image's uncertainty and propagates it trough the entire pipeline. To accomplish this, we utilize rules for transformation and propagation of uncertainty to incorporate this additional information with a variety of operations. Resulting from this, we are able to adapt prominent image pre-processing algorithms such that they consider the input images uncertainty.

Furthermore, we allow the composition of arbitrary image pre-processing pipelines and visually encode the accumulated uncertainty throughout this pipeline. The effectiveness of the demonstrated approach is shown by creating image pre-processing pipelines for a variety of real world datasets.

RGB To Gray:

Color Image to Grayscale Image Conversion C. Saravanan, Image processing is a vital research area and the utilization of images increases in various applications. On different research areas, scientists are working on such as image compression, image restoration, image segmentation etc. to enhance the existing image processing techniques and invent new method of solving image processing problems. The latest image processing applications such as medical image processing, satellite image processing, and molecular image processing uses various image processing techniques. Conversion of color image to grayscale image is one of the image processing applications used in different fields effectively. In publication organizations' printing, a color image is expensive compared to a grayscale image. Thus, color images have converted to grayscale image to reduce the printing cost for low priced edition books. Similarly, color deficient viewer requires good quality of grayscale image to perceive the information, as the normal people perceive the color picture. Likewise, various image processing applications require conversion of color image to grayscale image for different purpose. Conversion of a color image to a grayscale image requires more knowledge about the color image. A pixel color in an image is a combination of three colors Red, Green, and Blue (RGB). The RGB color values are represented in three dimensions XYZ, illustrated by the attributes of lightness, chroma, and hue. Quality of a color image depends on the color represented by the number of bits the digital device could support. The basic color image represented by 8 bit, the high color image represented using 16 bits, the true color image represented by 24 bit, and the deep color image is represented by 32 bit. The number of bits decides the maximum number of different colors supported by the digital device. If each Red, Green, and Blue occupies 8 bit then the combination of RGB occupies 24 bit and supports 16,777,216 different colors. The 24 bit represents the color of a pixel in the color image.

The grayscale image has represented by luminance using 8 bits value. The luminance of a pixel value of a grayscale image ranges from 0 to 255. The conversion of a color image into a grayscale image is converting the RGB values (24 bit) into grayscale value (8 bit). Various image processing techniques and software applications converts color image to grayscale image. However, the image processing techniques or applications are unable to handle the disparity in the chromaticity and the luminance. In the literature, several linear and non-linear techniques had discussed for converting color image to grayscale image. The recent techniques handle these disparities much better than the earlier techniques. Nevertheless, the techniques involve several computational procedures such as conversion of RGB space to XYZ space then approximations then mapping or other related techniques. Grayscale mappings of color images that are constructed by approximating spectral uniformity are often inadequate [1]. The recent technique used to convert from color image to gray image highly consumes computational time and memory. Thus, a new algorithm proposed to convert color image to grayscale image in a minimum amount of time.

There are several issues related to conversion of color image to grayscale image and different solutions to address these issues have addressed in the literature. The software such as Adobe Photoshop devised custom non-linear paperions and required users to set image dependent parameters by trial and error [2]. The following writings discuss recent six prime research works focusing on the conversion of color image to grayscale image. A technique proposed has utilized the L*a*b luminance chrominance representation [3]. The proposed technique introduces an additive correction term for spatial chrominance variations. The first step of this algorithm computes high pass filtered versions of all three channels, and the high-pass content from the two chrominance channels combined into a single signal that represents high frequency chrominance information. Another alternative, used in the implementation, is the slightly computationally simpler 1-norm metric. The main feature of this technique is 2010 Second International Conference on Computer Engineering and Applications 978-0-7695-3982-9/10 $26.00 © 2010 IEEE DOI 10.1109/ICCEA.2010.192 196 the same color in the input image can map to different grayscale values depends on the spatial surround. Another novel technique proposed to handle fluorescent colors effectively [4]. Source color image converted to uniform color space, then target differences were calculated, and finally least squares optimization technique has applied. T

he experiment shows that the isoluminant colors handled perfectly. The cost of setting up and solving the optimization problem is proportional to the size of the image. The proposed technique is highly resource (time and memory) consumable. In addition, the technique has not provided large improvements for scenes with high dynamic luminance range like natural scenes. A technique proposed for re-coloring of images for color-deficient viewers without introducing visual artifacts [5]. The mapping of color to grayscale preserves contrasts and maintains luminance consistency. The quadratic objective function has defined for contrast preservation. Further, constraints added to enforce luminance consistency within narrow chrominance bands. The technique performed well for certain images and as standard for other images. Another technique proposed enhances the contrast and converts color to grayscale [6]. The proposed technique used Gaussian pairing technique for image sampling, dimensionality reduction, and sampling color differences.

The predominant component analysis used for analyzingcolor differences. The technique has satisfied Continuous mapping, Global consistency, Grayscale preservation, Luminance ordering, Saturation ordering, and Hue ordering. The process controlled by three parameters: the degree of image enhancement; the typical size of relevant image features in pixels; and the proportion of image pixels assumed to be outliers. First, the algorithm converts the RGB values into YPQ color space. Further, to analyze the distribution of color contrasts between image features, color differences between pixels considered using Gaussian pairing. Dimensionality reduction by predominant component analysis performed to find the color axis that best represents the chromatic contrasts lost when the luminance channel supplies the color to grayscale mapping. Next, has combined luminance and chrominance information. The final step used saturation to calibrate luminance while adjusting its dynamic range and compensating for image noise. The decolorize algorithm is effective at enhancing contrast. The algorithm avoids the noise, contouring, and halo artifacts. However, tuning on parameters required individually to suit each image.

A recent technique demonstrated color to grayscale conversion based on the experimental background of the Coloroid system observations [7]. A survey of the coloroid system to and from CIE XYZ system formulas completed. Observations based on the Coloroid system discussed. The seven basic Coloroid hues fixed. Relative gray-equivalent differences of the basic hue pairs calculated. Proposed two formulas based on the CIELabcolor space and the Coloroidcolor space for building the gradient field. Further, the inconsistency of gradient field corrected. Finally, 2D integration applied to get the grayscale image. From the demonstration noted that the isoluminantcolors and bluish colors transformed to grayscale more realistic. The technique preserves overall appearance of the color image. A most recent work converted the color image and video to grayscale [8].

3. Discussion & Results

The first step in this License Plate Reader is to detect the License Plate. Let’s take a sample image of a car and start with detecting the License Plate on that car. We will then use the same image for Character Segmentation and Character Recognition as well.

Fig. 2. Image of Car

Step 1: Resize the image to the required size and then grayscale it.

Resizing we help us to avoid any problems with bigger resolution images, make sure the number plate still remains in the frame after resizing. Gray scaling is common in all image processing steps. This speeds up other following process sine we no longer have to deal with the color details when processing an image. The image would be transformed something like this when this step is done

Figure.3.Gray scale image of car

Step 2: Every image will have useful and useless information, in this case for us only the license plate is the useful information the rest are pretty much useless for our program. This useless information is called noise. Normally using a bilateral filter (Bluring) will remove the unwanted details from an image.

Syntax is destination_image = cv2.bilateralFilter(source_image, diameter of pixel, sigmaColor, sigmaSpace). You can increase the sigma color and sigma space from 17 to higher values to blur out more background information, but be careful that the useful part does not get blurred. The output image is shown below, as you can see the background details (tree and building) are blurred in this image. This way we can avoid the program from concentrating on these regions later.

Figure.4.Thresholds Identification

Step 3: The next step is interesting where we perform edge detection. There are many ways to do it, the most easy and popular way is to use the canny edge method from OpenCV.

The Threshold Vale 1 and Threshold Value 2 are the minimum and maximum threshold values. Only the edges that have an intensity gradient more than the minimum threshold value and less than the maximum threshold value will be displayed. The resulting image is shown below

Figure.5.Resulting image after performing canny edge detection

Step 4: Now we can start looking for contours on our image, we have already learned about how to find contours using OpenCV in our previous tutorial so we just proceed like the same.

Once the counters have been detected we sort them from big to small and consider only the first 10 results ignoring the others. In our image the counter could be anything that has a closed surface but of all the obtained results the license plate number will also be there since it is also a closed surface.

To filter the license plate image among the obtained results, we will loop though all the results and check which has a rectangle shape contour with four sides and closed figure. Since a license plate would definitely be a rectangle four sided figure.

The value 0.018 is an experimental value; you can play around it to check which works best for you. Or take it to next level by using machine learning to train based on car images and then use the right value there. Once we have found the right counter we save it in a variable called screenCnt and then draw a rectangle box around it to make sure we have detected the license plate correctly.

Figure.6.Image of number plate detection

Step 5: Now that we know where the number plate is, the remaining information is pretty much useless for us. So we can proceed with masking the entire picture except for the place where the number plate is. The code to do the same is shown below

The masked new image will appear something like below

Figure.7. Masked image

Character Segmentation

The next step in Raspberry Pi Number Plate Recognition is to segment the license plate out of the image by cropping it and saving it as a new image. We can then use this image to detect the character in it. The code to crop the roi (Region of interest) image form the main image is shown below

The resulting image is shown below. Normally added to cropping the image, we can also gray it and edge it if required. This is done to improve the character recognition in next step. However I found that it works fine even with the original image.

Figure.8. Character Segmented image

Character Recognition

The Final step in this Raspberry Pi Number Plate Recognition is to actually read the number plate information from the segmented image. We will use the pytesseract package to read characters from image

4. Conclusions

This work presents a free and open-source framework that relies upon super-resolution and automatic license-plate recognition to help forensic analysts to identify the license plate's alphanumeric of the vehicle of a criminal suspect, for example in a crime scene. The framework handles the necessary steps to identify the target license plate, using a methodology to locate, track, align, super-resolve, and recognize the alphanumeric in low-quality and challenging traffic videos. The framework provides a user interface for the forensic analyst to choose the license plate of interest. The interaction with the user is required only in the initial step (this is reasonable, since she needs to identify which of the moving vehicles in the video is the suspect one). The only input of the framework is the traffic video, and the ultimate result is not only a super-resolved image, as in the traditional SR techniques, but the recognized license-plate alphanumeric. After this initialization, the framework comprises a series of methods for tracking, registration, super-resolve, post process and recognize the alphanumeric of a detected license plate. Each method may be more or less advantageous, depending on a number of situations (e.g, different illumination conditions through the license-plate' sroute, high vehicle speeds, etc). There is one default solution for each step. However, if the framework does not find an appropriate solution, the user can customize the framework and change the method for any of the framework steps.

Another suggestion for future work is to automatically locate the license plate, substituting the user interaction in the first step. Hence, it might be possible to create a completely automatic and unsupervised framework, and use it for real-time applications. In addition, it might be useful to automatically detect and discard blurred frames that may appear while the camera loses focus, and improve the recognition training process including real-world license-plate images

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