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Car-Plate Image Enhancement by Using Median and Max Filters

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ABSTRACT

Nowadays, Optical Character recognition is one of the affected tools for recognition the plate of car from a still video or image in the intelligent transportation systems. The Optical Character Recognition accuracy incompletely depends on the input image quality. In this article, two efficient methods are used to enhance the quality of the car plate image selected from video clips. To minimize the error rate the proposed technique is used even at low resolution image. Maximum, and median filters are used in this work to enhance the quality of image. These technique extend to collect the pixels of the consecutive frames of the video in filtering approaches. The error rate of the OCR is tested on fifty road and street video clips by decreasing the resolution of the images and filtering them with common and proposed filtering methods. The test results indicate that both proposed methods, improve the accuracy of OCR, and the highest reduction of error is obtained by the proposed temporal maximum filtering method. Especially, when the resolution of image is 40% there is an obvious improvement by maximum filter that is 17.72% better than medium filter.

KEYWORDS: Database, Firebase, Website, PHP, NoSQL.

1. INTRODUCTION

Vehicle license plate recognition (LPR) is one of the types of Automatic Vehicle Identification (AVI). This not only identifies and counts cars, but it also characterizes them as unique. LPR has a wide range of applications in the fields of traffic monitoring. Overcrowding can be minimized by allowing vehicle drivers to bypass toll gates, time can also be saved, weigh arena or station non-stopping [1]. Using LPR to capture and processing car data without human involvement can yield financial benefits. Aiding in protecting areas for control access and assisting the law enforcement agency can also improve safety and security [2]. Automatic license plate recognition (ALPR) is a wide inspection technology that examines a car's license plates using optical character identification on photographs. Closed-circuit security cameras, highway regulation enforcement cameras, or a special gadget created for the purpose can all be used [3]. On a car license plate, optical character recognition is used to extract the plate number in text format. Many factors influence OCR accuracy, including the performance of devices used to capture plate images, the distance between the automobile and the camera, and the car's movement, which blurs the image [4]. These factors have an impact on how well you read the characters. Low resolution license plate images obtained from long distances frequently fail to be recognized by OCR. High-quality video or image capture equipment is both expensive and difficult to use. They may not be available at all times or in all conditions. Using consecutive image frames, the frame before and after the selected frame in a video, a way of enhancing the contents information in the image is utilized to boost the accuracy of the OCR software in this study. This article aims to use OCR error rate in case of low resolution video. Two filters (Median and Max) had been applied on three frames to enhance the information on the plate. This paper mainly contains the five sections which describes the different algorithms and techniques. Section 1 describes the simple introduction about image filtering. Section 2 we have describe the various techniques for filter the images. Then, in section 3 our dataset. Section 4 implementation and results. Section 5 contains the conclusion of this paper.

2. METHODOLOGY

In this study a simple method is provided to assess if temporal filters improve the quality of license plate images. Figure 1 illustrates the testing method's process diagram. Vehicle videos are recorded, and consecutive frames are extracted from the recorded videos. The next step is to choose a frame from the video, as well as one frame after and before the chosen frame. In all three frames, the car plate region is clipped. After that, OCR is used to process the cropped image of the primary selected frame, and the text output is referred to as reference-text. The resolutions of the plate photos are decreased by 10% continuously until it reach the stop condition (10% of the original resolution). The low resolution raw images are fed to OCR process to get the same text, however with a considerable error due to the loss of information for reduced resolution. This OCR text output is called the raw-text. The error between reference text and raw text is a measure for the loss of information due to the limited resolution. This error is called the raw-error. The temporal filtering on low resolution images generates an image with higher information content with respect to the raw low resolution images. The OCR text obtained by the temporal filtered image is called filtered-text. The filtered-text is expected to have less error compared to raw-text if the filter has higher performance in improving the quality of the image.

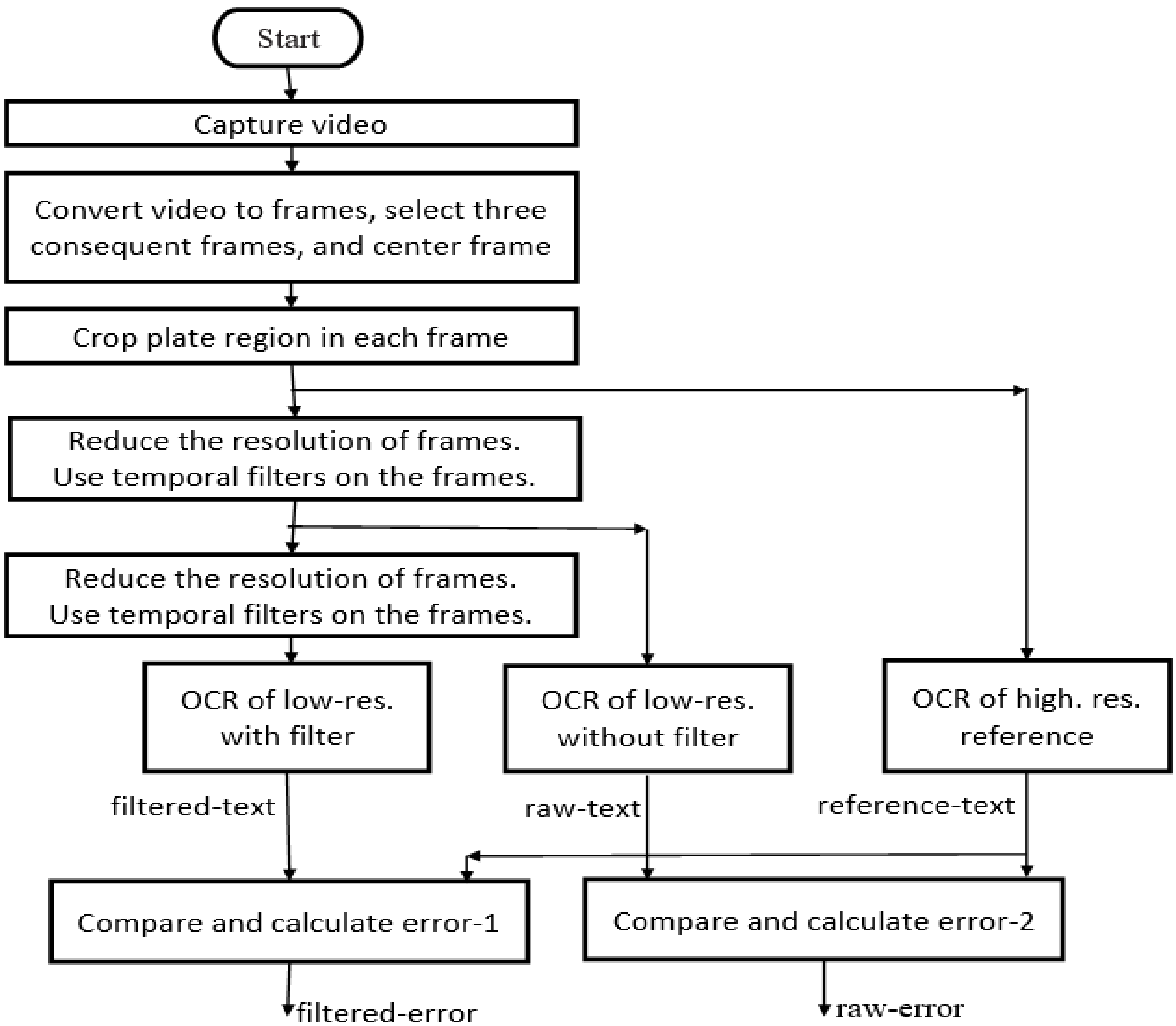

FIG 1: FLOWCHART OF PROPOSED METHOD

2.1 Optical Character Recognition (OCR)

Is a technique for converting printed or scanned material into ASCII characters that may be handled by information computerized systems. The text image could be produced by written by hand, machine, or a combination of both. An OCR system speeds up the input process and lowers the risk of human errors caused by factors such as a lack of time or inadequate illumination. Image processing procedures on the raw image should be used in a high-quality character identification approach to smooth the image, obtain accurate identification, categorize patterns, extract features quickly, and train the system. [5].

Recently MATLAB program added OCR function to library. The optical character recognition (OCR) function accepts an image, reads the text within the image, and then converts it to digital text. [6]. The Tesseract approach is dependable by the OCR function in the MATLAB application. As shown in Fig 3, The outlines of the components are saved in the first phase of the Tesseract method, which is analysis of connected components. Blobs are created by matting together the outlines at this point. Blobs are changed into lines of text, and then monospace or non-fixed-pitch text is checked in the regions and lines. the Text lines are divided into words by depending on the type of character spacing. Monospace texts are easily chopped by text cells as shown in fig 2 because of the space between characters is fixed. Fuzzy spaces and definite spaces are used to divide non-fixed-pitch text into separate words. Recognition procedure is the next step, the process of recognition is passing through two stages. Making an attempt to recognize each word in turn is the first pass. Recognized words are utilized as training data to an adaptive classifier. This increases the accuracy of the adaptive classifier for recognition of text lower down the sheet. It recognizes Words that were not identified well enough by making a second pass over the sheet, because the adaptive classifier learnt some new patterns very late in the first run, allowing it to contribute near the top of the sheet [7].

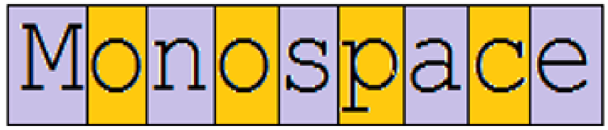

FIG 2: MONOSPACE TEXT [7]

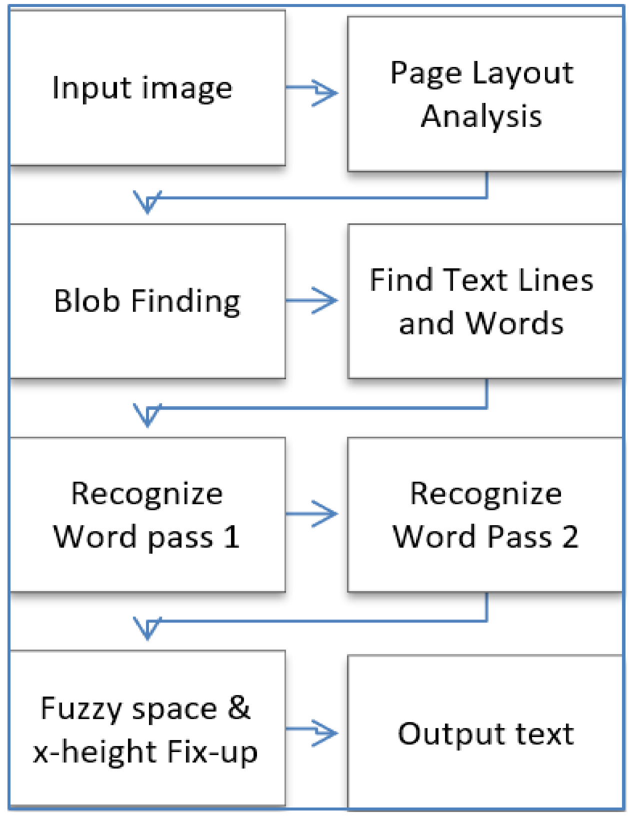

FIG 3: TASK FLOW OF TESSERACT METHOD

2.2 Region of Interest Extractions

Following video acquisition, video frames are extracted using the MATLAB built-in function read, which reads the frames of a video with a certain index and returns the frame with that index as an output. Colored JPG images are used to capture the frames of mp4 video. After reading the video to MATLAB memory buffer, a specific frame is selected manually, considering the full appearance of plate and the distance between car and camera, and called as center-frame. The main frame, its previous and its next frame are selected for temporal filtering. Then the license plate regions of these three frames are cropped using MATLAB function "imcrop". The imcrop function produces cropping rectangular box, which can be moved or resized to place it on any area of the image using the mouse to get the cropped image. Because of the difference of distances and the original size of the plate, the cropped image size varies from one plate to another. However, the cropped photos of the same plate in each of the three frames are all of the same size [8].

After cropping the region of plate on the high quality images, a set of reduced quality image is generated from these raw high quality images to test the efficiency of the proposed filters on these low quality images. Each image's resolution is reduced by 10 percent. Resizing the photos is done using the bicubic interpolation method. The intensity of pixels is calculated via bicubic interpolation, which uses a weighted average of the pixels in the nearest 4x4 pixels.

2.3 Filtering Method

The proposed temporal image filtering method is a novel idea that has been introduced. It extends the spatial filtering techniques to the temporal domain by including the previous and next frames into the filtering operation. The temporal filter generates a less-noisy image from the three consecutive low quality car plate images using the intensity of pixels in the neighborhood of a center pixel. Two spatial filters (Median and Max) are adapted to generate enhanced images using the proposed temporal filtering method.

a) Temporal median filters

It depends on the neighbor pixels intensities. The median intensity filtered output pixel fo(x,y) is determined by placing the middle of ranked set of values for the filtered image, as shown in Eq 1. There are two ways to use the median strategy. The first one involves calculating the median of a pixel's intensity value across a set of frames in order to generate new pixel values for a higher-quality image [9].

$$f_o(x,y)=\text{median}\begin{bmatrix} f_p\,(x-1,y-1), & f_p(x,y-1), & f_p(x+1,y-1), \\ f_p(x-1,y), & f_p(x,y), & f_p(x+1,y), \\ f_p(x-1,y) & f_p(x,y+1), & f_p(x,y+1), \\ f_c\,(x-1,y-1), & +f_c(x,y-1), & f_c\,(x+1,y-1), \\ f_c\,(x-1,y), & f_c(x,y), & f_c(x+1,y), \\ f_c\,(x-1,y), & f_c(x,y+1), & f_c(x,y+1), \\ f_n(x-1,y-1), & +f_n(x,y-1), & f_n(x+1,y-1), \\ f_n(x-1,y), & f_n(x,y), & f_n(x+1,y), \\ f_n(x-1,y), & f_n(x,y+1), & f_n(x,y+1) \end{bmatrix} \text{ Eq (1)}$$

where, the listed 27 illumination values are sorted to determine the middle value as the median value.

The second filter is pure temporal median, where only the temporal neighbor pixels are included to median operation, can be illustrated in Eq 2.

$$f_o(x,y) = \text{median}\,[f_p(x,y) + +f_c(x,y)+f_n(x,y)] \text{ Eq (2).}$$

b) Temporal Max filters

Max filter is an extension of the median filter with only a simple difference. Instead of using the middle value as common for median, max filter uses higher values. A max value is obtained just by replacing median to max in the expression of the median filter [10]. Both spatial and temporal maximum over the range of 3 pixels per dimension gives (3x3x3) temporal max filter, as illustrate in Eq 3.

$$f_o(x,y)=\text{Max}\begin{bmatrix} f_p(x-1,y-1), & f_p(x,y-1), & f_p(x+1,y-1), \\ f_p(x-1,y), & f_p(x,y), & f_p(x+1,y), \\ f_p(x-1,y) & f_p(x,y+1), & f_p(x,y+1), \\ f_c(x-1,y-1), & +f_c(x,y-1), & f_c(x+1,y-1), \\ f_c(x-1,y), & f_c(x,y), & f_c(x+1,y), \\ f_c(x-1,y), & f_c(x,y+1), & f_c(x,y+1), \\ f_n(x-1,y-1), & +f_n(x,y-1), & f_n(x+1,y-1), \\ f_n(x-1,y), & f_n(x,y), & f_n(x+1,y), \\ f_n(x-1,y), & f_n(x,y+1), & f_n(x,y+1) \end{bmatrix} \text{ Eq (3)}$$

Similar to the median filter case, an only temporal max filter that processes 3 frames can be called a temporal (1x1x3) max filter, can be illustrated in Eq 4.

$$f_o(x,y) = \text{Max}\,[f_p(x,y) + +f_c(x,y)+f_n(x,y)] \text{ Eq (4).}$$

These techniques are applicable on the three layers of

RGB coloured images by carrying the operation on each layer individually, and, combining them after the filtering.

3. VEHICLE PLATE VIDEO DATA SET

The videos used to perform the suggested method were ta ken with a "LG V10" mobile phone camera. The output video resolution of this device is (1280x720). Video recordings are in the "MP4" format, with a frame rate of 30 frames per second. On a public road, videos are taken. Cars speeds vary between 50 and 80 km/h during the recording. Aside from changes in illumination, the distances between the car and the camera, as well as the types and colors of recorded autos, were not constant. The distance between the camera and the vehicle varied from 6 to 12 meters, while the automobile plates collected varied in size, color, and font type.

4. IMPLEMENTATION RESULTS

The data set for the testing was gathered by shooting video records with a mobile phone. When compared to professional video recorder equipment, which is required for effective OCR, mobile phone video recordings have low resolution. After recording the videos, and selecting the center frames, the plate in each frame is extracted, and passed through the OCR, to obtain the reference-text. The center and neighbor plate images are reduced in resolution at 9 steps, with 10 percent size reduction per step, to obtain the raw plate images. Then the raw center plate image is fed to OCR to get the raw-text. Two temporal filters: median and max filters are applied on raw plate image sets to obtain filtered plate images. Finally, the OCR outputs of the filtered plate images, which are called filtered-text, are compared to the reference-text to count the missed and false characters as error-count. The following sections compare the errors for raw-error against the filtered-error to determine the performance of the introduced filters.

The OCR error results for temporal median and max (3x3x3) filtering (for each RGB layer) are shown in Fig 4 and Table 1.

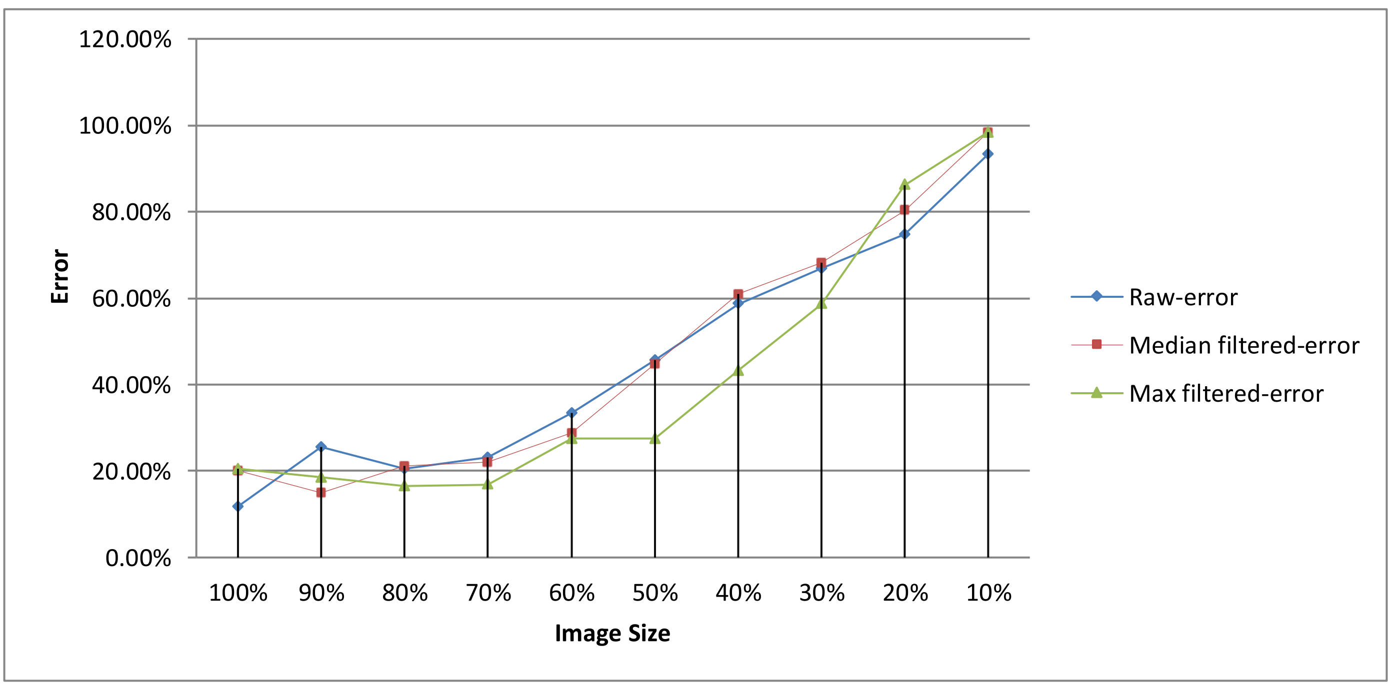

FIG 4: ERRORS FOR RAW, AND TEMPORAL-SPATIAL (3X3X3) MEDIAN AND MAX FILTERED IMAGES

Table 1: Errors for raw, and temporal-spatial (3x3x3) median and max filtered images

Size compared to HD-image	Raw-error	Median filtered-error	Max filtered-error
100%	11.81%	20.07%	20.47%
90%	25.59%	14.96%	18.50%
80%	20.47%	21.25%	16.53%
70%	23.22%	22.04%	16.92%
60%	33.46%	28.74%	27.55%
50%	45.66%	44.88%	27.55%
40%	58.66%	61.02%	43.30%
30%	66.92%	68.11%	58.66%
20%	74.80%	80.31%	86.22%
10%	93.30%	98.42%	98.42%

Fig 4 illustrates that max filter method is more efficient and produces better results because mistakes are decreased for most levels of resolution, particularly between 20% and 60% of the original frame's resolution. In contrast, the error of reading a character is reduced by small amounts at higher resolution levels, and this technique does not operate at very low resolutions of less than 30% of the original resolution. On the other hand, median filter has low effect on the process of enhancing as illustrated in table1.The only improvement happened in 90% and 20%.

FIG 5: A SAMPLE OF ORIGINAL, MEDIAN AND MAX FILTER IMAGES

A sample of the filtered images are shown in Figure (5). Inspecting the images, the main reason that might cause positive results of max technique may be explained by the high illumination level of the plate background. Max filter improves the contrast level of the text and provides more accurate binarization. It also makes the gap between the characters more contrast as well, which reduces the errors in associating and chopping characters by the OCR algorithm. Another reason might be the thickening effect of max filter that helps extraction step in the OCR.

5. CONCLUSION

In this study, Consecutive images of video records of car plates are filtered using two methods Median and Max filters, after reduction of their size to convert them to low resolution images. The OCR output of raw image (raw-text) and temporal filtered images (filtered-texts) are compared agains the OCR-text of high resolution image to determine the raw-error and filtered-error for the specified resolution.

The results of tests show that the purely temporal max filter has better effect after enhancing on the plate image for text recognition purpose. Especially between the resolutions 80% to 30% as shown in table 1, the max filter improved the resolution of image compared with the original image. As it is clear the most affected resolution is 40%, that is because the error is 61.02% for median and is 43.30% for max filter, this shown that max filter improved the quality of car plate 17.72% more than the median filter. The median filters do not affect the OCR error significantly.

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